The European Journal of Development Research (2019) 31:1197–1226
https://doi.org/10.1057/s41287-019-00207-5

ORIGINAL ARTICLE

Targeting Agricultural Investments and Input Subsidies in Low-Income Lagging Regions of India

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Published online: 27 February 2019

Abstract
Poverty in India has been declining consistently over the years, yet it is home to 172 million poor people. Most of India's poor are concentrated in rural areas and are dependent on agriculture. This poses a serious challenge to the exploration of potential pathways that could effectively eradicate poverty and accomplish the United Nations Sustainable Development Goals. We estimate the effects of various types of investment in rural areas in accelerating agricultural productivity and reducing rural poverty, and find differential impacts of investments and subsidies across low-, middle-, and high-income states. Private investment in minor irrigation, public investments in agricultural research and development, and subsidies on irrigation and electricity have the highest marginal returns in low-income states. Further, the payoffs from additional spending in promoting agricultural income are also higher in low-income states, suggesting targeting these locations with strategic investments and subsidies to improve agricultural productivity and reduce poverty.

Keywords Rural poverty · Agriculture productivity · Public expenditure · Input subsidies · Private investment · Marginal returns

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Introduction

Among the key drivers that have helped India reduce its rural poverty rate from 29.6 to 12.7% of the rural population during the post-1991 period, rural economic growth is of critical importance (Datt et al. 2016). Pro-poor growth, driven mainly by the agricultural and more recently the services sector, can be attributed to increased public spending in agriculture, irrigation development, and various employment-generation and welfare schemes that have been implemented since 2003–2004. Although this shift indicates that India may be able to achieve the United Nations Sustainable Development Goals target of eradicating poverty by 2030, the key challenge will be to achieve this target in areas with a higher concentration of poor people, specifically in the less-developed, agriculturally dominant states. Lifting as many as 172 million people out of abject poverty and backwardness within a stipulated time span requires an effective public policy that enables agricultural growth, creates more farm and nonfarm jobs, and provides better opportunities for employment.

Past research has laid considerable emphasis on accelerating agricultural growth as an important means of reducing poverty and inequality in most developing countries (Ravallion and Chen 2007; Fan et al. 2008a, b; Dastagiri 2010). The literature is replete with examples of the key role of public expenditure in poverty reduction (Ahluwalia 1978; Barro 1990; Ravallion and Datt 1995; Fan 2008; Mogues et al. 2015). In the Indian context, studies show that the marginal returns on public investments in agricultural research and development (R&D), rural infrastructure, and education have contributed significantly to poverty reduction (Fan et al. 1999, 2008a, b). An updated analysis through 2013–2014 validates the higher payoffs from additional public spending on these lines, along with health, energy, rural development, and irrigation subsidies (Bathla et al. 2017a, b).

This paper examines the effects of public investments and input subsidies on agricultural productivity and rural poverty at the subnational level, an approach that is less present in existing analyses of India.[1] Intracountry analysis is particularly important as some of the lagging states—namely Bihar, Madhya Pradesh, Odisha, Rajasthan, and West Bengal—have had a higher growth trajectory over the past decade following a push in investment along with other initiatives.[2] However, the prospect of these states catching up with the developed states appears a distant dream, owing to large differences in agroclimatic conditions and levels of land and labor productivity (Birthal et al. 2011). Further, these less developed states, along with the States of Assam and Uttar Pradesh, have been affected by persistent poverty, interpersonal income inequalities, and disparities in economic and social indicators—all

[1] Only a handful of studies have carried out analyses at the agroecological and regional levels. For India, see Fan et al. (2000) and Fan and Hazell (2000). For China, see Fan et al. (2002), Fan et al. (2008a) and Zhang and Fan (2004).

[2] These initiatives include favorable terms of trade, increased institutional credit, private investment, and public outlays on centrally sponsored schemes such as the National Horticulture Mission, the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), the National Food Security Mission (NFSM), and Rashtriya Krishi Vikas Yojana (National Agriculture Development Programme). See Joshi et al. (2006) and Bathla and Kumari (2017).

of which need serious attention to enhance India's overall economic welfare (Panagariya et al. 2014).

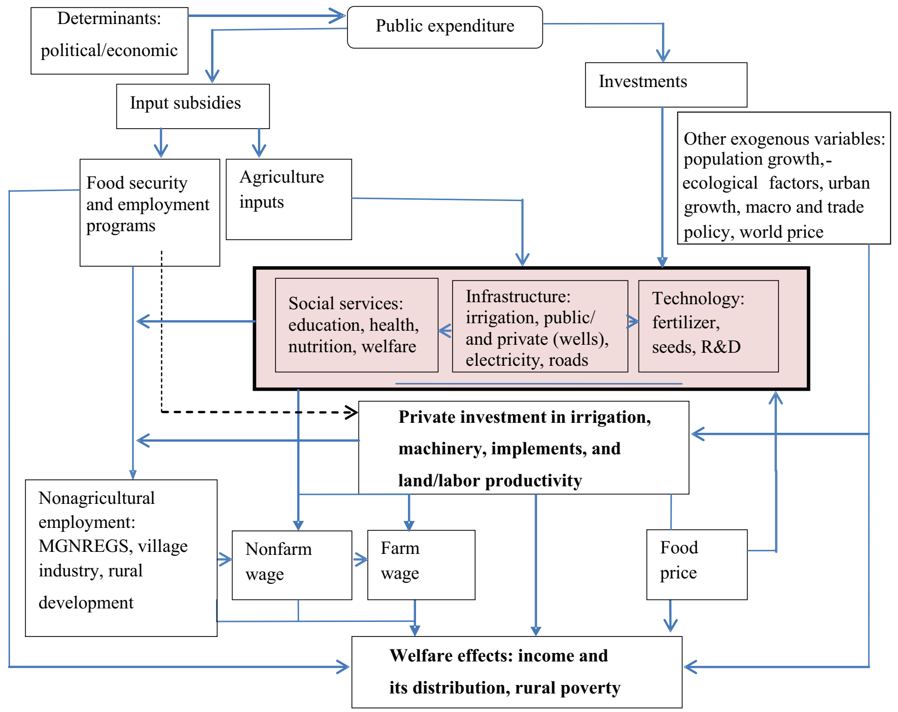
We aim to understand the contribution of key social and economic public expenditures along with private (farm household) investment toward agricultural income and poverty reduction across heterogeneous states. Since agriculture and irrigation are state subjects in India,[3] such analysis will help to delineate the contribution of different types of expenditure to agricultural growth, prioritize them, and customize policies for better outcomes. To do so, this paper addresses three key issues that may help to explain the role of fiscal policy in targeting investments and subsidies across geographical locations while keeping in view the interests of farmers at large. First, what has been the magnitude of public expenditure on key services and private investment in rural India from 1981–1982 to 2013–2014, and how do states compare? Second, what is the impact of investments and input subsidies on farm productivity, income, and poverty alleviation, and which investments have yielded higher marginal returns? Third, is there any relationship between efficiency and welfare objectives owing to public expenditure at the subnational level, and how can such a relationship be addressed?

The next section explains the conceptual framework and structural equation model used in this study, along with the database. Section "Spatial Patterns in Investments and Subsidies and Outcomes" contains an analysis of spatial trends in public expenditure on various social and economic categories and estimates four key farm input subsidies in each group of states. Section "Welfare Effects of Public Expenditure" presents the estimated empirical results and marginal returns from different types of incremental investments and subsidies in low-, middle-, and high-income states. The final section suggests the implications of our findings, particularly with reference to potential policy applications.

Conceptual Framework and Model Estimation

Figure 1 portrays the conceptual framework for this analysis. Public expenditure on various investments and subsidies is assumed to affect agricultural growth and poverty through several channels, primarily through improved technology and availability of inputs, irrigation, relative prices, wages, and nonfarm employment. The availability of resources, and the prices at which these are available, influences the use of various inputs. Subsidized prices provide incentives to farmers to use these inputs and make long-term investments, but such subsidies are a burden on the national exchequer. Their impact on agricultural growth and rural poverty can be examined by analyzing the complex interlinkages among productivity, private (farm household) investment, input use, rural nonfarm economy, and rural wages as discussed in the literature (Hazell et al. 2000; Fan et al. 2008a, b; Mogues et al. 2012).

[3] The Union (central) Government cannot legislate on activities of agricultural produce cultivation. However, it can intervene through promotional schemes for a particular produce by providing financial incentives. It may legislate on interstate trade and on the quality of produce and its distribution. The center can also influence spending on agriculture R&D and fertilizer subsidies, which solely fall within its domain.



Note: Dotted line indicates indirect effects.

Fig. 1 Analytical framework of the impact of public expenditure on agriculture and welfare

Accordingly, the conceptual framework and the model are built up in a four-step sequence. First, the model identifies the determinants of rural poverty through a poverty equation. Second, it identifies public spending that influences the identified determinants of poverty, along with other factors. Third, it splits irrigation intensity into canals and wells to examine the effects of subsidies and public investment on private irrigation investment, and land productivity. Finally, based on the estimated elasticities of each variable (both direct and indirect), it calculates the marginal impacts of selected expenditure categories on farm income and rural poverty.

A system of equations models the relationships of government spending, input subsidies, farmer investment, agricultural growth, and rural poverty through different pathways, as illustrated. Equation (1) explains rural poverty as determined by land productivity, rural wages, nonfarm employment, terms of trade, rainfall, and population density. This equation further endogenizes agriculture productivity (*AY*), rural wages (*NAWAGE*), nonfarm employment (*NFEmpl*), and terms of trade (*TT*), as reflected in Eqs. (2) to (5). Each equation is linked to input use [fertilizer, electricity, canal and well irrigation (tube wells)], input subsidies and government expenditure such as agricultural R&D, rural roads and transport, rural electrification, education, irrigation, and health, in Eqs. (6) to (13). The role of technology through use of high-yielding varieties could not be included, because such technologies have been universally adopted since 2000.

$$\text{Poverty} = f1(AY, TT, NAWAGE, NFEmpl, Pop\ Density, RAIN), \tag{1}$$

$$AY = \text{f2}(Agri\ R\&D, LAND, LABOR, WellIRRI, CanalIRRI, ELECT, EDU, FERT, ROAD, RAIN, NFSM), \tag{2}$$

$$NAWAGE = \text{f3}(GDPGNA, AY, ELECT, ROAD, EDU, Health\ Status, MGNREGS), \tag{3}$$

$$NFEmpl = \text{f4}(GDPGNA, AY, NAWage/AWage, ROAD, EDU, ELECT, Rural\ Development\ Exp, MGNREGS), \tag{4}$$

$$\text{Terms of Trade}\,(TT) = \text{f5}(AY, World\ price, GDPGNA, ELECT, Trend), \tag{5}$$

$$FERT = \text{f6}(Subsidies{-}fertilizer, credit, electricity, irrigation, TT, IRRI, RAIN\ Agri.\ R\&D, ROAD), \tag{6}$$

$$CanalIRRI = \text{f7}(Irrigation\ Exp.), \tag{7}$$

$$WellIRRI = \text{f8}(CanalIRRI, Public\ Exp.\ Minor\ Irri., Private\ Irri.\ Exp., TT, Electricity\ Subsidy), \tag{8}$$

$$ELECT = \text{f9}(Energy\ Exp.), \tag{9}$$

$$ROAD = \text{f10}(Road\ Transport\ Exp.), \tag{10}$$

$$EDU = \text{f11}(Education\ Exp.), \tag{11}$$

$$\text{Health Status}\,(IMR) = \text{f12}(Health\ Exp.), \tag{12}$$

$$\text{Rural Development}\,Exp. = \text{f13 (per capita income)}. \tag{13}$$

In Eq. (1), rural poverty is determined by land productivity in terms of agricultural income—gross state domestic product agriculture (GDPA) per unit of cropped area (*AY*), nonagriculture (rural) wages (*NAWAGE*), the 3-year moving average of terms of trade (*TT*), nonfarm employment (*NFEmpl*), population density, and weather conditions (*RAIN*), represented by an annual rainfall index. Wages from nonagricultural employment are equally important as a source of income in rural areas. Urbanization (captured through growth in nonagricultural GDP or nonagricultural per capita income) promotes jobs outside of agriculture, resulting in an increasing share of nonfarm activities in the income portfolio of rural households. The terms of trade (*TT*) measure the impact of changes in agricultural prices relative to nonagricultural prices to test the underlying hypothesis that the poor, who are net buyers of food, are affected negatively by higher agricultural prices.

Equation (2) is a land productivity function, taken to be influenced by conventional inputs including land (*LAND*), labor (*LABOR*), irrigation (*WellIRRI* and *CanalIRRI*), rainfall (*RAIN*), and fertilizer use (*FERT*), along with public expenditure on agricultural R&D and other variables such as the education of the rural population

(*EDU*), road density (*ROAD*), and electricity use in agriculture (*ELECT*). *WellIRRI* represents private investment in minor (wells) irrigation, whereas *CanalIRRI* is indicative of public investment in major and medium irrigation systems. A dummy variable is used to capture the impact of the government's flagship program, the National Food Security Mission (*NFSM*), on productivity. NFSM was initiated in 2006 with an aim of raising food grain productivity.

Equation (3) captures the impact that various factors have on adjusting rural nonfarm wages to alleviate poverty. The wage function is determined by land productivity (*AY*), electrification (*ELECT*), roads (*ROAD*), and education (*EDU*). Some of these variables capture the impact of government expenditure on poverty reduction through improvements in farm and nonfarm activities. Nonagricultural GDP growth (*GDPGNA*) is included to control for the effects of urban labor demand on rural wages. Health and nutrition status, represented by the infant mortality rate (*IMR*) in rural areas, is used to gauge the impact of public investment on health status, which influences both farm and nonfarm wages by improving productivity of workers. A dummy variable captures the impact of another flagship government program, the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), on agricultural wages from 2005.[4]

In Eq. (4), nonfarm employment is determined by GDPGNA, productivity (*AY*), relative wage rate (*NAWage*/*AWage*), education (*EDU*), roads (*ROAD*), and electrification (*ELECT*). The latter two variables are taken as infrastructure variables to capture their impact on investments in off-farm activities and the search for suitable jobs. The equation also accounts for government expenditure on rural development and village industry. Most rural development expenditures are relegated to the creation of infrastructure and roads, which may positively affect off-farm employment. The impact of MGNREGS in generating off-farm employment is studied through a dummy variable. Education is highly correlated with other explanatory variables, and therefore is excluded from the equation.

Equation (5) models the terms of trade. It is hypothesized that growth in farm output would increase aggregate supply of agricultural products, and hence reduce their prices, which would help the poor. A world price index of five commodities is included to gauge the impact of international trade on agricultural prices in domestic markets. Electricity consumption (*ELECT*) is used to gauge the impact of infrastructure. The demand-side effects on agriculture prices are captured through GDPGNA. We add a trend in the equation to highlight the impact of supply-side variables other than agricultural income and world prices. Equation (6) is modeled to determine the fertilizer use per ha in agriculture by accounting for government subsidies in fertilizer, credit, irrigation, and electricity. Other variables include irrigation intensity, rainfall, roads, TT, and agricultural R&D. Most of these variables affect agricultural production through fertilizer use, and the impact of research on productivity is captured indirectly through fertilizer use.[5] The

[4] The program guarantees 180 days of employment in a year, which is expected to have a positive influence on both farm and nonfarm wages. This employment program, in conjunction with the highly subsidized NFSM, is expected to have significant impacts on poverty in rural areas.

[5] Fan et al. (2008a, b) reiterated that improved irrigation and new seeds from agricultural research would increase farmers' demand for fertilizer.

explanatory variable—TT measured as the 3-year moving average or lagged 1-year as supply response—is generally based on last year's price.

Equation (7) indicates the relationship between government spending on major and medium irrigation (*Irrigation Exp*) and the percentage of the cropped area under canal irrigation (*CanalIRRI*). Since expenditure on irrigation subsidies is subsumed in the total expenditure on irrigation and flood control, it was excluded from the equation. Equation (8) considers private investment in irrigation (*WellIRRI*), mainly through the use of electric pumps to extract groundwater. A bifurcation of cropped area irrigated as per canal and well irrigation is performed to capture the relationship between public and private investments in irrigation, which is found to be positive at the national level (Dhawan 1998; Gulati and Bathla 2002). Private investment in well irrigation is expected to be influenced by public investment in major and minor irrigation, TT (returns), expenditure incurred by farmers, and electricity subsidy. A favorable price structure is expected to encourage farmers to invest in irrigation and other machinery. Like irrigation, Eq. (9) takes agricultural electricity consumption (*ELECT*) as a function of government expenditure on rural energy/electrification (*Energy Exp.*). As in Eq. (8), subsidies for electricity are not included to avoid double-counting. Equations (10), (11), and (12) capture the relationships between improved road and transport, education, and health, as functions of their past expenditures. In Eq. (13), rural development is made a function of per capita income.

The system is estimated using the structural equation model (SEM), which provides a flexible framework to investigate more than one causal process among the variables. By estimating multiple equations, it has the advantage of evaluation networks of direct and indirect effects and their decomposition along with different error structures. It models the relationships among unobservable latent variables by allowing multiple measures to be associated with a single latent variable (Widaman and Thompson 2003; Kline 2011). As pointed out by Nachtigall et al. (2003) and Angrist and Pischke (2010), the question of directionality of paths and underlying assumptions are important during the process of model formulation. The model may not indicate causal dependencies or suffer from underidentification, and requires large sample size with intensive data. Further, the estimating parameters and computing model fit is the maximum-likelihood method, which may require multivariate normally distributed continuous variables. To address these issues, we performed multiple tests to determine whether the model is acceptable and fits the observations.[6]

Double-log functional forms are used for all the equations in the system. State dummies are added to each equation to capture state-level unobservable effects.

6 The test results indicate that the analysis is stable and has higher goodness of fit based on the combined rule of low root-mean-square error of approximation, low standardized root-mean-square residual, high coefficient of determination, and high stability values. Besides fitness tests, we also experimented with different model specifications to check for possible misspecification. Sargan test was performed for overidentification of the equations, and the test results show equations to be identified. A Hausman test indicated that some of the public expenditures and subsidy variables were endogenous. Variables lagged for 1 year were used, as they can be considered predetermined and weakly exogenous.

The endogeneity problem, which generally occurs in time-series models, is controlled by applying the variable in lagged form or redefining it using the instrumental variable method. As the impact of public investments usually lasts more than 1 year, we consider these as capital stocks using a 10% depreciation rate. It is also possible to determine the optimal lag length in variables in place of stock using adjusted R^2 or the Akaike information criterion, as done in Fan et al. (2008a, b). Still, measurements need to account for loss in the degrees of freedom and address the problem of high correlations among the lagged independent variables. Both current and lagged private investments are considered to account for their short- and long-term effects.

The total poverty and productivity effects (both direct and indirect) of various public expenditures, private investment, and subsidies are decomposed and obtained through two components: (1) the estimated elasticities of the variable in the poverty equation and (2) the elasticities of other variables in the poverty equation that are affected by the variables in other equations; For example, the effect of agricultural R&D on poverty may work through various channels to improve land productivity, and increased productivity can reduce poverty through terms of trade, input use, and wages. Equation (14) summarizes the total effect of agricultural R&D on poverty.

$$\begin{aligned}\frac{\partial Poverty}{\partial AgRD} = {} & \frac{\partial Poverty}{\partial AY}\left(\frac{\partial AY}{\partial AgRD} + \frac{\partial AY}{\partial FERT}\frac{\partial FERT}{\partial AgRD}\right) \\ & + \frac{\partial Poverty}{\partial TT}\frac{\partial TT}{\partial AY}\left(\frac{\partial AY}{\partial AgRD} + \frac{\partial AY}{\partial FERT}\frac{\partial FERT}{\partial AgRD}\right) \\ & + \frac{\partial Poverty}{\partial AWAGE}\frac{\partial AWAGE}{\partial AY}\left(\frac{\partial AY}{\partial AgRD} + \frac{\partial AY}{\partial FERT}\frac{\partial FERT}{\partial AgRD}\right).\end{aligned} \tag{14}$$

Based on the estimated elasticities, marginal effects of poverty and different types of government subsidies and expenditures are expressed as (1) increased agricultural GDP [Indian rupees (INR) per unit of public spending averaged from 2011–2012 to 2013–2014] and (2) reduced poverty headcount (number of rural poor brought out of poverty per unit of spending). Marginal effects compare the relative benefits of an additional unit of expenditure across different types of subsidies and investment items. These effects can be taken as useful indicators in setting government spending priorities to accelerate farm production and mitigate poverty.

The study focuses on six main categories of public expenditure related to economic and social activities (irrigation, agricultural R&D,[7] roads and transport, energy, education, and health and nutrition) and four input subsidies (fertilizer,

[7] Expenditure on soil conservation, crops, and animal husbandry are also included in agricultural R&D due to research components within each. Expenditure on medical and public health is broadened to include expenditure on social welfare and nutrition.

irrigation, electricity, and credit). Private investment is considered through minor irrigation (electric and diesel tube wells). In all, 17 major states are taken for a comprehensive analysis of public spending from 1981–1982 to 2013–2014.[8] The states are categorized into three groups: low, medium, and high income, based on average per capita income from 2000–2001 to 2013–2014. Accordingly, seven states are in the high-income category and five are in each of the middle- and low-income categories. The low-income states (LIS) are Bihar, Uttar Pradesh, Assam, Jammu and Kashmir, and Madhya Pradesh. The medium-income states (MIS) are Odisha, Rajasthan, West Bengal, Andhra Pradesh, and Karnataka. The high-income states (HIS) are Punjab, Himachal Pradesh, Tamil Nadu, Kerala, Gujarat, Haryana, and Maharashtra. These states cover almost 90% of India's net sown area and agricultural income. LIS are primarily agriculture dependent, with low productivity and high rural poverty. Annex Table 6 explains the measurement of variables and sources of data. Compared with earlier studies, some of the variables have been redefined and reestimated owing to better access to data.

Spatial Patterns in Investments and Subsidies and Outcomes

In India, public expenditure is broadly categorized into development and nondevelopment categories. This is further bifurcated into revenue (current) and capital expenditures. Development expenditure includes the promotion of economic development and social welfare, while nondevelopment expenditure refers to that incurred to maintain government operations. Major budgetary headings under the existing classification suggest that expenditures related to agriculture and rural development are generally development expenditure directly charged from the revenue account. Capital expenditure, used interchangeably with capital formation, is used to create assets such as irrigation structures, transport, machinery, construction, and land improvement.[9] For greater clarity, we categorize public expenditure on some economic services into "in" agriculture and "for" agriculture. While the former refers to investment in agriculture and irrigation, the latter is expanded to include expenditure on rural energy, roads, and transport.

Table 1 presents a snapshot of total public expenditure and its decomposition into key social and economic categories across all 17 states together and separately for LIS, MIS, and HIS during the triennium ending (TE) 2013–2014. Public

[8] The newly created states (Jharkhand, Chhattisgarh, and Uttarakhand) are merged with their respective parent states (Bihar, Madhya Pradesh, and Uttar Pradesh).

[9] Investments in financial assets, apart from physical assets, are included under capital expenditure. Notably, public expenditure on various categories is highly decentralized. Funds are routed through the central government to the respective state governments. The former also spends directly on many economic and social services in rural areas, the most important being the flagship programs and agricultural R&D. Money generally is routed through state budgets. Central government expenditure, loans, and advances are not taken into consideration to avoid double-counting.

Table 1 Percentage share of major social and economic categories of public expenditure and total expenditure (INR billions, 2004–2005 prices), TE 2013–2014

	Agriculture	Irrigation	Rural road transport	Rural energy	Rural development	Education	Health	Eco./social exp.	Total exp. (Rs)
Share in total expenditure (%)									
LIS	5.40	4.87	4.09	0.66	5.30	18.14	4.62	48.77	2643
MIS	5.60	8.11	2.98	1.82	4.29	16.89	4.76	49.62	2335
HIS	5.40	4.88	3.40	1.25	2.38	18.14	4.58	46.34	3231
All	5.47	5.79	3.50	1.25	3.91	17.75	4.64	47.72	8258
Expenditure intensity (expenditure/GSDP) (%)									
LIS	1.20	1.08	0.90	0.14	1.17	4.01	1.02	10.79	22.12
MIS	0.89	1.29	0.47	0.29	0.68	2.68	0.76	7.87	15.85
HIS	0.75	0.67	0.47	0.17	0.33	2.51	0.63	6.40	13.82
All	0.90	0.95	0.58	0.21	0.64	2.92	0.77	7.86	16.47
Share of capital expenditure in total (%)									
LIS	7.82	60.19	71.84	77.34	25.39	2.80	12.77	22.92	15.41
MIS	4.41	61.47	59.82	21.76	2.79	1.84	7.38	19.79	12.86
HIS	14.98	70.45	48.81	21.36	27.21	2.31	10.23	21.50	13.49
All	9.57	63.83	60.40	24.66	18.32	2.69	10.12	20.91	13.93
Annual growth rate (%) (2000–2013)									
LIS	8.73	8.18	14.26	6.89	10.14	9.39	9.44	10.01	8.71
MIS	10.64	8.14	9.06	8.57	8.53	7.21	6.43	8.76	7.05
HIS	7.86	4.76	11.84	6.15	6.89	7.69	8.02	8.41	7.35
All	8.92	6.91	11.80	6.64	8.90	8.12	8.00	9.05	7.74

Source Finance Accounts, Government of India. The expenditure shares do not add up to the numbers under total economic/social expenditure due to expenditure on other headings, viz. industry, minerals, telecommunications, science and technology, and environment expenditure has increased from INR 1108 billion in TE 1983–1984 to INR 8257 billion in TE 2013–14, growing at a rate of 6.73% per year at 2004–2005 prices (US $1 = INR 63). The average share of expenditure on social and economic categories (development expenditure) in total expenditure was 73% during the 1980s, which fell to nearly 65% during the 2000s, across the three state groups. The top four sectors in government expenditure were education (17.7%), irrigation (5.79%), agriculture (5.47%), and health (4.64%). The share of rural energy, road transport, and rural development is much lower than the other categories. There is little difference in the share of spending per heading across the states, except on rural development and road transport, where LIS spent more than other groups (5.30% on rural development and 4.09% on roads), whereas MIS spent more on irrigation. The priorities of the state governments in allocating resources toward various sectors are similar, except in the case of rural development.

The government preference is to allocate more resources toward education, manufacturing, communications, defense, and general administration. Spending on health and energy sectors receives low priority, and their share hardly increased over time. Even spending on social security has not received due priority, which indicates the persistence of income inequality among people and across states. Another disquieting aspect is that the share of agriculture and irrigation in total expenditure has remained the same at nearly 5.5% each, which has implications for accelerating agricultural growth and mitigating rural poverty. It is important to note that the majority of the poor live mostly in Bihar, Odisha, and Uttar Pradesh, and the majority of them depend on agriculture for their livelihood.

Spending on agriculture and irrigation as a ratio of gross state domestic product (GSDP) was less than 1% in MIS and HIS and slightly above 1% in LIS in recent years. Taken together, the share of agriculture and irrigation expenditure in GSDP is less than 2% and is lower than the fraction of GSDP spent on education (3%). Even if expenditure on agriculture is taken as a percentage of GSDP agriculture (GSDPA), the scenario is the same. Rural development is the only category that has a higher expenditure share in GSDPA in LIS (5.42%) compared with MIS (3.94%) and HIS (3.18%). This is a welcome development in view of the high proportion of poor and unemployed in LIS. Overall, the respective state governments have given a lower priority to spending in rural areas.

There has been a slight increase in expenditure "in" agriculture as well as "for" agriculture during the 2000s. However, the relative share of agriculture and irrigation spending has fallen substantially among the economic services.[10] Another disquieting aspect is a lesser share of spending on capital (investment), which indicates that government expenditure is more likely to be earmarked for day-to-day administrative expenditures, including subsidies. Among various services, the share of capital expenditure in total expenditure is relatively higher (> 60%) in irrigation,

[10] The declining share of irrigation was caused by low growth in investment in irrigation schemes. The steep decline in expenditure on irrigation during the 1980s and early 1990s was also attributed to a few extraneous forces, such as the escalation of irrigation cost, environmentalist movement, federal character of the Indian states, problems associated with interstate river disputes, and an overall reduction in capital expenditure (Shetty 1990; Mishra and Chand 1995).

and road transport, indicating lower capital formation in other sectors. According to Chandrasekhar and Ghosh (2002), a consistent cut in expenditure on capital account and a concomitant hike in revenue (current) expenditure may have been designed to achieve a targeted fiscal deficit and might have affected investments in key sectors.

A revival in investment in irrigation and road transport is noticeable from 2003–2004, whereas investment in agriculture, rural development, energy, and village industry was static. The annual rate of expenditure on agriculture and allied activities and irrigation was reasonably high at 8.92 and 6.91%, respectively, compared with that during the 1990s. The highest annual growth rate in the recent decade was in rural road transport at 11.80%, leading to an increase in the share of investment "for" agriculture, i.e., rural infrastructure in economic service spending.

Overall, total public expenditure witnessed the most rapid growth in the LIS during the 2000s, at 8.71% per year, while growth rates in the MIS and HIS were slightly lower, at 7.01 and 7.74%. An acceleration in public spending is explained by a growth momentum in GDP toward the end of the 1990s and expanded during the 2000s, with an annual growth rate of 7.9%. Agriculture was also able to contribute to high economic growth during this decade. The LIS had the most rapid growth in the 2000s, at 4.0%, compared with 3.8% and 3.5% in the MIS and HIS, respectively. GSDPA had minimal gaps across the three groups of states; it was nearly INR 1000 billion in TE 1983–1984 and rose to INR 2500 billion in TE 2013–2014 in each group. Increased spending seems to have influenced the incidence of rural poverty more in LIS and HIS.

A more detailed understanding emerges when looking at per capita rural spending across the different categories of states. Development expenditure has consistently outgrown population in each group of states. As shown in Table 2, the per capita development (social and economic) expenditure increased from INR 1586 in TE 1984 to INR 6469 in TE 2014. During the 1980s, the magnitude of per capita total expenditure was the lowest in LIS, followed by MIS and HIS. It increased more impressively in HIS over time, from INR 3073 to INR 15,653. Spending per person in TE 2014 was almost the same in LIS and MIS, at nearly INR 9000. Development expenditure shows a similar pattern in LIS and MIS but has shot up by four times in HIS. Among various services, per capita expenditure was highest in HIS during TE 2013–2014: INR 1853 on education, INR 745 on health, INR 684 on rural road transport, and INR 203 on rural energy. The expenditures on R&D, irrigation, and private agri-investment are taken on per hectare (ha) basis. It is encouraging to note a higher per ha expenditure on agricultural R&D in the LIS and HIS, at INR 2308 and INR 2800, respectively, compared with INR 1541 in the MIS. Owing to higher economic growth and greater spending power, the HIS spent more in categories "for" agriculture along with in education, and health. Per capita spending by MIS and LIS in these categories do not differ greatly, but there are glaring interstate differences in agricultural R&D spending—from INR 4968 per ha in Jammu and Kashmir to INR 531 per ha in Rajasthan. Similarly, Andhra Pradesh spends INR 10,105 per ha, the highest amount on irrigation among states, while Rajasthan, where rainfall is scant, spends the least, at INR 713 per ha.

In terms of investment in irrigation, the past practice is carried forward. Out of total spending, a major portion (81%) went to major/medium irrigation schemes,

Table 2 Public expenditure per rural resident and hectare (INR, 2004–2005 prices)

	Agriculture R&D (per ha)	Irrigation (per ha)	Rural roads	Rural energy	Education	Health	Economic and social exp.	Total exp.	Private investment (per ha)
LIS									
TE 1984	383	1174	115	8	299	150	1740	2271	1951
TE 1994	811	1067	113	51	508	210	2583	3683	2243
TE 2004	1042	1272	138	77	601	237	3227	5244	2547
TE 2014	2308	2854	299	51	1167	445	5931	9082	7288
MIS									
TE 1984	189	933	76	6	288	142	1555	2064	1665
TE 1994	348	1157	90	37	427	177	2182	3085	2500
TE 2004	413	1689	129	101	625	250	3038	5181	2673
TE 2014	1541	3844	309	178	1095	446	6729	9591	5315
HIS									
TE 1984	618	1160	206	10	426	216	2334	3073	5986
TE 1994	1294	1476	208	106	652	277	3486	5098	7043
TE 2004	1221	2006	336	162	967	373	4880	8570	10,568
TE 2014	2800	3300	684	203	1853	745	9997	15,653	22,309
All									
TE 1984	222	1012	89	6	294	142	1586	2108	471
TE 1994	491	1213	92	47	449	182	2251	3285	672
TE 2004	516	1638	137	102	633	229	3058	5248	687
TE 2014	1532	3206	341	121	1213	452	6469	9710	1645

Irrigation excludes expenditure on flood control. Agriculture R&D also includes expenditure on soil conservation, crop and animal husbandry. "All" refers to select 17 states. Statewise details given in Bathla et al. (2017a, b). Private investment is for all India and refers to 1981–1982, 1991–1992, 2002–2004, and 2012–2013 when the National Sample Survey (NSS) was conducted

ha hectare

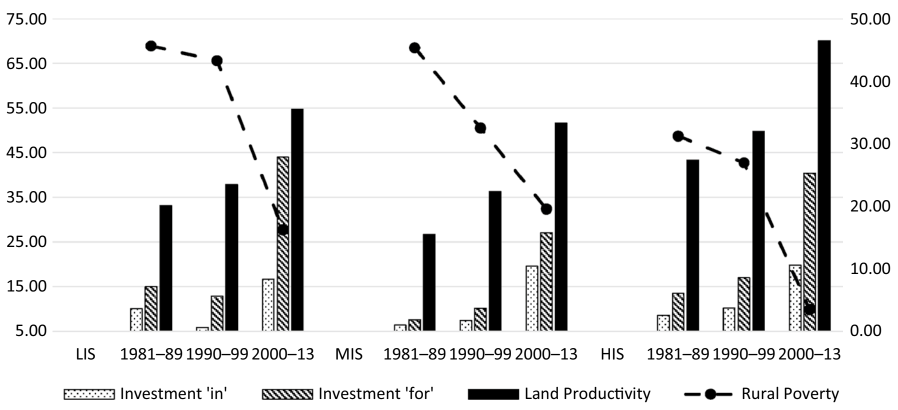


Fig. 2 Public investment "in" and "for" agriculture (INR 00/ha), land productivity (INR 000/ha), and rural poverty (headcount ratio)

nearly 13% went to minor irrigation works, 1% went to command-area development, and 5% went to flood control. Though the rate of investment in irrigation has been impressive, the share of irrigation, both in total investment and in expenditure (capital plus revenue), has invariably declined across states. The average share of public investment in irrigation and flood control in total investment was 50% during the 1980s, which decreased to 41% during the 1990s and to 32% by the end of the 2000s. In terms of total expenditure, the share fell from 6.9 to 4.2% over this period. The relatively lower priority that states gave to irrigation (and agriculture) may explain stagnation in area irrigated by canals and the continual deceleration in agricultural productivity.

Figure 2 shows a sizable increase in public investment "in" and "for" agriculture in each state toward the end of the 2000s, with the 17 states averaging between INR 653 per ha and INR 2328 per ha. The states with per ha public investment below the all-states average in the recent period include Andhra Pradesh, Assam, Kerala, Madhya Pradesh, Bihar, West Bengal, Tamil Nadu, Rajasthan, and Odisha. Similarly, private investment across India (Table 2) jumped from INR 471 per hectare to INR 687 per hectare, then to INR 1645 per hectare in 2012–2013 (at 2004–2005 prices).[11] As expected, private investment in agriculture is much higher in HIS, though it increased almost three times in LIS in recent years. Among the states, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Punjab, and Uttar Pradesh have made significant headway, perhaps because of better banking infrastructure and opportunities. The less-developed states continue to lag behind, which indicates

[11] The estimates are not strictly comparable with public investment on two accounts: (a) public investment is on the higher side as it includes investment in financial assets, (b) estimates on private investment of rural households, taken from NSS-AIDIS, are not comparable with the official (CSO) estimates owing to a wider coverage in the latter, on account of investments in livestock, forestry, fishery, and tea and coffee plantations.

Table 3 Magnitude of input subsidies (INR per hectare, 2004–2005 prices) and rate of growth

	Input subsidies				Annual rate of growth			
	LIS	MIS	HIS	All	LIS	MIS	HIS	All
Irrigation								
TE 1984	146	81	152	89	60.22	52.25	61.84	59.04
TE 2004	869	519	745	466	2.96	5.13	3.07	2.96
TE 2014	1110	850	1453	855	6.10	3.58	6.36	5.49
Electricity (power)								
TE 1984	221	80	331	197	12.65	29.30	21.14	20.83
TE 2004	608	1714	3505	1949	8.82	14.11	10.71	12.30
TE 2014	598	2070	4036	2339	1.96	3.57	2.55	3.22
Fertilizer								
TE 1984	157	177	337	207	23.69	24.92	22.38	23.07
TE 2004	741	921	1226	880	5.69	5.32	2.17	4.62
TE 2014	2692	2907	3682	2996	13.85	12.23	11.97	13.24
Credit								
TE 1984	66	104	218	108	10.61	8.88	9.08	9.38
TE 2004	68	138	274	127	−10.32	−9.16	−9.96	−9.83
TE 2014	838	1209	3525	1305	28.63	25.03	28.94	26.42
Total								
TE 1984	590	442	1038	601	17.50	23.88	21.02	22.18
TE 2004	2286	3292	5750	3422	5.44	8.05	5.68	7.34
TE 2014	5238	7036	12,696	7495	9.06	8.58	8.68	8.77

"All states" refers to select 17 states. Annual rate of growth is for 1981–1989, 1990–1999, and 2000–2013

a strong need to increase the flow of credit within them. Two states, Assam and Odisha, have very low levels of private investment compared with public investment. A somewhat higher public investment in irrigation in these states has not been able to induce private investment. Expenditure on tube wells and other irrigation resources constitutes almost 30% of total farm investment in HIS and MIS, compared with only 5% in LIS. Such differences indicate farmers' greater dependence on public irrigation in LIS.

Because public investments in rural areas affect agricultural growth and rural development in varying proportions across the states, it is difficult to say which investment will yield higher returns to agriculture. Also, the impact of many investments would be direct, in the sense of increasing land productivity, or indirect, through price reductions and increases in production and marketable surplus. A much higher increase in investment "for" agriculture is found in LIS, at INR 4500 per hectare. This increase appears to have had positive impact on land productivity and the incidence of rural poverty, but not as sharply as observed in HIS. A somewhat higher response in LIS could be explained by unfavorable initial conditions and a higher magnitude of poverty in most of the states (Fig. 2

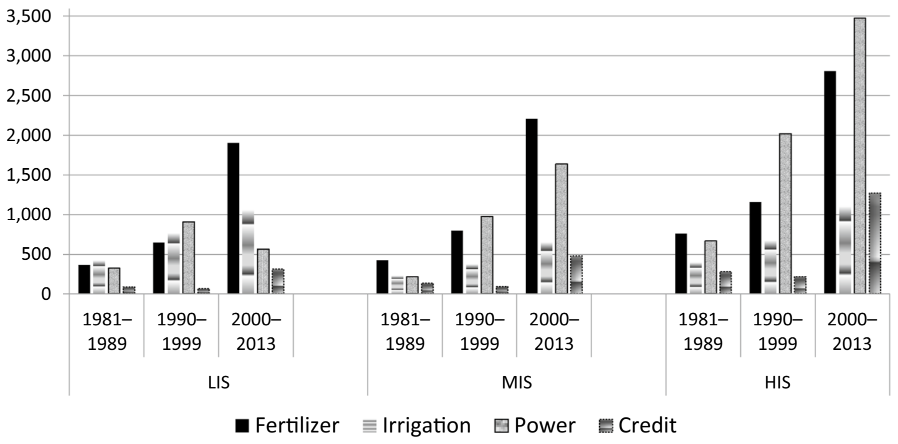


Fig. 3 Input subsidies per ha (INR, 2004–2005); Average 1981–1989, 1990–1999, and 2000–2013

secondary axis). From 1983–1984 to 2011–2012, the rural poverty ratio declined from 31.3 to 3.6% in HIS, from 45.4 to 19.6% in MIS, and from 45.7 to 16.3% in LIS.

Table 3 and Fig. 3 furnish estimates on per ha spending on subsidies for irrigation, electricity (power), fertilizer, and credit across LIS, MIS, and HIS. It validates that input use and subsidy distribution has been highly inequitable across the states. Like public expenditure in agriculture, the magnitude of various subsidies increased inconsistently between 1981 and 2013. The highest national increase was witnessed in fertilizer subsidy per ha, from INR 207 during TE 1983 to INR 880 in TE 2004 and INR 2996 in TE 2014. There was a significant change in the magnitude of each subsidy across states, particularly during the 2000s; For instance, fertilizer subsidies were lower than electricity subsidies until early 2000 but rose sharply in the subsequent years. Likewise, irrigation subsidies shot up in LIS from 2004 to 2014 and surpassed the quantum of electricity subsidy. Spending on electricity subsidies in HIS during TE 2014 reached INR 4036 per ha, which is slightly more than spending on credit and fertilizer subsidies, at INR 3525 and INR 3682, respectively. Irrigation subsidies per ha were found to double electricity subsidies in LIS, reaching INR 1110. Over the years, a much lower value of subsidies has been given to LIS, though these quantities increased between 1.96 and 28.63% from 2000 to 2013. The difference between per ha input subsidy spending in LIS and HIS has widened over the study period. The rate of growth in input subsidies was similar across all states during the 2000s, at around 8%. Among all, credit subsidies experienced the highest annual growth at 26% during the 2000s, followed by fertilizer at 13%, irrigation at 5.49%, and electricity at 3.22%.

In recent years, we find little evidence that an increased spending on input subsidies has impinged upon investment in agriculture–irrigation, as both achieved higher rates of growth during the 2000s. Nonetheless, the controversy on public spending on input subsidies continues. The subsidies were considered useful during the 1970s and 1980s in helping farmers raise food grain production. Over the years, however, they were argued to have outlived their utility and hardly reached the needy farmers (Fan et al. 2008a, b; Gulati and Narayanan 2003). These arguments may explain a deceleration in their rate of growth during the 1980s. A growing literature favors fertilizer subsidy and direct subsidy for micro-irrigation owing to their positive impact on food grain production and productivity (Chand and Pandey 2008; Kannan 2014). The studies also propose to find strategic ways by which input subsidies can be made "market smart" through better targeting, perhaps from the experiences of African countries (Chirwa and Dorward 2013).

Welfare Effects of Public Expenditure

This section provides empirical results on the effects of various types of public expenditure on welfare at disaggregate state level, in terms of land productivity and poverty reduction in rural areas. In doing so, it focuses on the relative effects of public investment "in" and "for" agriculture and reflects on the relationship between public and private investments and subsidies in agriculture. The three main hypotheses tested here are that (1) differences in investments and input subsidies explain interstate variations in agricultural productivity and rural poverty; (2) marginal returns from various investments vary between low- and high-income states and are relatively higher in the former; and (3) sizable tradeoffs exist between efficiency and equity objectives in rural areas of each state because of public spending.

Table 4 presents the estimation results from SEM. The coefficients of the rural poverty equation reveal that it is significantly influenced by land productivity in terms of income per ha, nonfarm employment and wages, terms of trade, and annual rainfall in each group of states. The relative prices matter the most in HIS. The coefficient of terms of trade is significant at a 5% level, and the elasticity is −1.99 in HIS, −1.91 in MIS, and −0.62 in LIS for the study period. This is closely followed by nonfarm employment, with an elasticity of −2.61, −0.21, and −1.10, respectively. The elasticity of nonfarm wages is far below the other variables at −0.92, −0.54, and −0.08, respectively. It is much lower in LIS, suggesting a comparably unimportant impact on poverty reduction compared with land productivity and nonfarm employment. The effect of annual rainfall on poverty reduction is positive but insignificant at the subnational level.

Notably, land productivity has also helped to reduce poverty significantly, particularly in LIS, which have higher elasticity at −0.52. These results validate the findings of earlier studies that agricultural growth, wages, and prices significantly contribute to poverty reduction (Ahluwalia 1985; Srinivasan 1985; Kumar et al. 2011). They further validate findings obtained by Fan et al. (2000) that agricultural growth has not benefited all of India's ecological regions equally, nor has it always benefited the poor.

All the variables together explain 72% to 84% of the variations in the incidence of rural poverty as indicated by the R^2 values. The SEM estimation reiterates that land productivity facilitated by better rainfall conditions, remunerative farm prices relative to the nonfarm sector, and nonfarm employment with better wages have been the main sources of poverty reduction in rural areas during the study period. In

Table 4 Determinants of rural poverty, land productivity, wage rate, nonfarm employment, and terms of trade, 1981–1982 to 2013–2014

	All states	HIS	MIS	LIS
Estimation method: maximum likelihood				
Observations	495	198	155	151
Log likelihood	3019.2	874.3	1900.6	369.8
1. Rural poverty				
Land productivity	−0.30***	−0.31	−0.32***	−0.52*
Nonfarm employment	−0.94*	−2.61*	−0.21	−1.10*
Rural wage rate	−0.55*	−0.92*$	−0.54*	−0.08$
Terms of trade	−0.98*	−1.99*	−1.91*$	−0.62*
RAIN	0.20**	0.31	-0.13	0.12
Constant	13.8*	20.9*	9.56*	14.6*
R^2	0.71	0.72	0.84	0.75
2. Land productivity				
Well irrigation	0.89*	1.13*	0.93*$	1.87*
Canal irrigation	0.18*	0.23*	−0.07	0.17*
Fertilizer consumption	0.14*	0.22*	0.41*$	0.088***
Employment	0.08*	0.05	0.33*	0.08**
Agriculture R&D	0.083*	0.11*	0.10*	0.28**
Electricity consumption	0.10*	0.19*	0.13*	0.13*
Road density	−0.02	−0.05*	0.14*	−0.01
NFSM (dummy)	0.085*	0.15*	0.18*	0.05
RAIN	0.06*	0.16*	0.21*	0.05**
Constant	2.8*	1.01	6.69*	−0.71*
R^2	0.96	0.96	0.96	0.95
3. Rural wage rate				
Land productivity	0.12**	0.24**	0.003	0.01
Education	0.31*	0.59*	0.28*	0.37*
Health	−0.56*	−0.40*	−0.24*	−0.64*
GSDPG nonagriculture	0.29*	0.28*	0.77*	0.17*
Road density	0.03	0.07	0.01	0.03
MGNREGS (dummy)	0.08*	0.01	0.054	0.13*
Constant	0.32	−2.6**	−4.65*	−3.3*
R^2	0.87	0.85	0.95	0.88
4. Nonfarm employment				
Land productivity	0.18*	0.17*	−0.03	0.09
GSDPG nonagriculture	0.35*	0.36*	0.53*	0.39*
Relative wage rate	−0.08***	−0.08	0.1	−0.16
Road density	0.07*	0.03	−0.05	0.12*
MGREGS (dummy)	0.04***	−0.04	−0.03	0.15*
Rural development expenditure	0.42*	0.074*	0.22*	0.08***
Constant	−3.86*	−3.3*	−3.29*	−3.3*
R^2	0.89	0.93	0.9	0.87

Table 4 (continued)

	All states	HIS	MIS	LIS
5. Terms of trade (TT)				
Land productivity	−0.24*	−0.10**	−0.02	−0.42*
Electricity consumption	0.11*	0.04***	−0.03***	0.19*
World price	0.24*	0.26*	0.07**	0.29*
GSDPG nonagriculture	0.24**	0.16*	−0.06	0.29***
Trend	0.01*	0.001	0.01*	0.01**
Constant	−9.7*	0.7	−21.3*	−2.88*
R^2	0.65	0.74	0.74	0.71
6. Fertilizer consumption				
Road density	0.14*	0.02	0.14**	0.23*
RAIN	0.05**	0.15*	0.25*	0.07***
Agriculture R&D	0.07*	0.11**	0.10*	0.45*$
Fertilizer subsidy	0.54*	0.31*	0.39*	0.54*
Credit subsidy	0.052**$	0.05**$	0.024$	0.03$
Electricity subsidy	0.01	0.08*	0.02	0.003
Irrigation subsidy	0.034**	0.03	0.09*	0.025
Constant	−1.18*	−0.16	−1.66*	−1.98*
R^2	0.96	0.94	0.95	0.94
7. Well irrigation (private)				
Canal irrigation	−0.08*	−0.08*	−0.20*	−0.07*
Electricity subsidy	0.001	0.001	0	−0.003***
Private investment (− 1)	0.02*	0.01*	0.02*	0.01
Public investment, minor irrigation	0.001	−0.01*	0.01***	−0.01***
Constant	4.7*	4.67*	4.95*	4.7*
R^2	0.97	0.97	0.95	0.98
8. Canal irrigation (public)				
Public expenditure	0.37*	0.23*	0.09**	1.07*
Constant	−2.2	−0.16	2.05*	4.45*
R^2	0.89	0.97	0.77	0.76
9. Electricity consumption in agriculture				
Public expenditure	0.24*	0.23*	0.49*	0.15*
Constant	5.5*	5.7*	4.2*	2.04*
R^2	0.89	0.9	0.89	0.84
10. Road density				
Public expenditure	0.34*	0.29*	0.52*	0.24*
Constant	4.4*	4.5*	3.3*	5.5*
R^2	0.88	0.89	0.81	0.88
11. Education				
Public expenditure	0.67*	0.51*	0.76*	0.72*
Constant	−0.58*	0.59	−1.15*	−3.4*
R^2	0.86	0.86	0.87	0.9

Table 4 (continued)

	All states	HIS	MIS	LIS
12. Health				
Public expenditure	−0.49*	−0.58*	−0.49*	−0.38*
Constant	7.3*	8.03*	7.37*	6.7*
R^2	0.9	0.91	0.89	0.71
13. Rural development				
Per capita income	0.99*	0.96*	0.89*	1.3*
Constant	−4.2*	−4.5*	−3.2*	−7.6*
R^2	0.61	0.54	0.67	0.7

Variables are specified on per hectare basis. Public expenditure is on per capita basis. $ denotes elasticity estimated in an alternative equation to address the problem of multicollinearity

*, **, and *** indicate significance at the 1%, 5%, and 10% level, respectively

spite of heavy state government investment in agriculture and irrigation, the effect of agriculture on poverty reduction is likely to be lower than that of nonfarm employment or prices.

The estimated results from Eq. (2) suggest agricultural productivity to be positively and significantly determined by farmers' investment in well irrigation, followed by fertilizer consumption, public spending on agricultural R&D and canal irrigation. Land was not found to be a significant variable, whereas labor is significant in LIS with elasticity of 0.08. Among public infrastructural variables, road transport is insignificant, and electricity significantly influences land productivity. The education variable, represented by the number of years of schooling of the rural population or the rural literacy rate, is dropped due to its high correlation with private irrigation investment. Among all variables, elasticity is found to be relatively high for private investment in well irrigation, at 1.12 in HIS, 0.93 in MIS, and 1.87 in LIS (see Eq. 2). The elasticity for R&D is the highest in LIS, suggesting that a 10% increase in spending would raise productivity by 2.8%. Rainfall shows a positive impact on productivity. The dummy variable that captures the National Food Security Mission (NFSM), started in 2006, has a positive impact on agriculture across all states. Manjunatha and Kumar (2015) also found the mission to be favorable to farmers in Karnataka.[12]

Nonfarm employment, an important factor in poverty reduction, is determined by land productivity in HIS only, and by nonagricultural income and rural development expenditure in all groups of states. Most rural development spending is directed toward the government's flagship employment program, the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), and toward infrastructure creation. The relative wage rate (nonfarm to farm) is not important

[12] Beneficiary households receiving seeds, manual- and power-operated sprayers, and other incentives and subsidies were able to realize higher productivity and income compared with nonbeneficiary farmers of most crops.

in HIS or LIS. Urbanization levels largely determine the variation in rural nonfarm employment. Among the factors that influence rural wage rate, land productivity has a positive impact in HIS. The education level of workers and nonfarm income exert positive influence on it across all state groups. The coefficients of health status (represented by IMR) are negative and significant on rural wage rate. Employment under MGNREGS is positive in each group of states but found to be significant only in LIS. Similarly, the road network that facilitates mobility of labor turns out to be more important to nonfarm employment than to wages in LIS. The results reveal that rural nonfarm employment and nonfarm wages act together as important factors in poverty reduction, and that both are enhanced by land productivity in HIS only. The amount of nonfarm income, health, and education unequivocally hold importance across all states. The share of nonfarm employment in total rural employment increased between 1983–1984 and 2011–2012, from 19 to 41.7% in HIS and from almost 16.6 to 36.5% each in MIS and LIS, respectively.

In each group of states, the prices that farmers receive for their produce relative to industrial products (terms of trade) are another important aspect of poverty reduction. However, the factors that influence relative prices in each state vary. World prices for agriculture influence terms of trade in HIS, MIS, and LIS, showing elasticity values at 0.26, 0.07, and 0.29 respectively. These prices assumed a positive and significant influence, which could be seen mainly during India's post-economic-reform period. Comparative advantage in many agricultural commodities, coupled with a relatively greater openness to international trade and a favorable price regime, has enabled better price integration. Although world prices and nonfarm income growth have had a positive impact on the prices received by farmers, an increase in land productivity and infrastructure (captured through electricity consumption) reduces the chances of farmers receiving relatively high prices for their products in MIS. Land productivity negatively affects TT, as an increase in commodity supply depresses farm prices. MIS do not seem to be gaining much through changes in the prices of agricultural commodities.

Fertilizer consumption and irrigation also emerged as important factors in agriculture productivity. The usage is facilitated by fertilizer subsidies, terms of trade, and public spending on agricultural R&D. The fertilizer consumption variable in Eq. (6), which represents the supply response of farmers, shows fertilizer subsidy, rainfall, and agricultural R&D to be the most important factors across the three groups of states.[13] Electricity subsidy turns out to be a significant factor in HIS, whereas irrigation subsidy matters more in MIS. Electricity and fertilizer subsidies appear to have a high impact on fertilizer use, though this varies greatly across the states.

In the case of private irrigation investment (Eq. 8), the coefficient of canal irrigation representing public investment is negative and significant. This finding refutes the complementary relationship between private and public investments in irrigation, which has been purported in several studies (Dhawan 1998; Gulati and Bathla 2002). However, public investment in minor irrigation has a positive impact on private investment in MIS. The question of whether public investment induces farmers to undertake

[13] The irrigation intensity variable was dropped due to high correlation with rainfall.

investment thus needs to be better understood in different settings and time periods, along with the specification of investments (Mogues et al. 2015). Also, to grapple with the ongoing debate on public investment "in" and "for" agriculture, it is useful to examine which public investments encourage farmers to invest in irrigation. The elasticity of electricity subsidy is positive in HIS and MIS but has an insignificant influence on private investment. It is found to be influenced by the farmers' investable resources.[14] Finally, canal irrigation, education, road density, health, and electricity consumption in agriculture (Eqs. 7, 9–13), which are essential for agricultural productivity and poverty reduction, are significantly determined by past government investments. The impact of public spending in each case varies widely across the states: elasticity of canal irrigation is the highest in LIS, at 1.07; education and roads are highest in MIS, at 0.76 and 0.52; and health is highest in HIS, at 0.58.

Table 5 presents the estimated total marginal effects of various categories of government expenditure on agricultural income and rural poverty reduction. The estimated elasticities are used to calculate the marginal returns per INR using the average value of each spending item over 2011 to 2014. It gives the percentage change in income (productivity) or poverty corresponding to a 1% change in government spending. These elasticities provide a measure of the relative benefits to growth and poverty reduction that arise from additional expenditure on different items, where the increases are proportional to the existing levels of expenditure (Fan et al. 1999). The estimates are based on the decomposition of various direct and indirect components, using each expenditure category and its corresponding estimate of elasticity in the model, as illustrated in Eq. (14).

The selected categories of public spending had a positive impact on agriculture across India and across the three state groups. However, they did not have similar marginal effects, as these differed significantly among the social and economic types of expenditure and among the states. At the national level, India received its highest returns from well irrigation (mainly private investment) and public investments in agricultural R&D, followed by education, health, and energy. The first four spending categories—well irrigation (INR 9.51), R&D (INR 2.47), education (INR 2.39), and health (INR 1.83)—have generated benefits that are 1.83 to 9.51 times the amount spent. It is evident that returns from well irrigation, undertaken primarily by farm households, far exceed returns from public investment in canal irrigation for all India and in LIS.

The rankings of marginal impacts of various spending on poverty are quite different from the marginal impacts of spending on agricultural income. Spending on rural development ranks first, a fact that may be attributed to significantly high

[14] The relationship between input subsidies and farmers' investment decisions has not been conceptualized in detail, owing to a lack of state-focused continuous series on input prices. Also, little empirical research has been undertaken to study the social and environmental costs of various public expenditures, such as the effect of electricity and fertilizer subsidies on groundwater extraction by farmers; soil and water degradation; and imbalance in the use of nitrogen, phosphorus, and potassium. World Bank (2014) indicates that subsidies may also contribute to lower productivity, compromising sustainability and future productivity growth. This finding requires further probing, as the withdrawal of fertilizer subsidy is estimated to reduce food grain production by 8% (Chand and Pandey 2008), which would be especially detrimental given the number of poor people and the massive requirements of food stock.

Table 5 Marginal effects of additional investments and subsidies on agricultural income and rural poverty, 1981–2014

	Elasticity:				Agriculture income (INR per INR spent)			
	All states	HIS	MIS	LIS	All states	HIS	MIS	LIS
Rural development	0.011	0.001	0.001	0.001	0.14 (12)	0.01 (12)	0.02 (11)	0.01 (12)
Irrigation investment (canals)	0.042	0.068	0.002	0.115	0.15 (11)	0.19 (10)	0.01 (12)	0.64 (10)
Road investment	0.052	0.010	0.131	0.041	0.42 (10)	0.06 (11)	1.42 (5)	0.21 (11)
Electricity subsidy	0.029	0.063	0.065	0.039	0.69 (9)	0.94 (8)	1.31 (6)	3.60 (4)
Credit subsidy	0.022	0.018	0.026	0.019	0.92 (8)	0.51 (9)	1.21 (7)	1.28 (8)
Fertilizer subsidy	0.059	0.062	0.157	0.073	1.07 (7)	1.05 (7)	3.18 (2)	1.34 (7)
Irrigation subsidy	0.020	0.031	0.004	0.098	1.67 (6)	2.71 (2)	0.41 (10)	6.48 (3)
Energy investment	0.058	0.056	0.037	0.028	1.73 (5)	1.57 (5)	1.18 (8)	1.01 (9)
Health investment	0.261	0.245	0.104	0.255	1.83 (4)	1.55 (6)	0.84 (9)	1.74 (5)
Education investment	0.505	0.459	0.367	0.317	2.39 (3)	1.74 (3)	2.27 (4)	1.50 (6)
Agriculture R&D investment	0.087	0.154	0.119	0.314	2.47 (2)	3.23 (1)	4.44 (1)	9.92 (2)
Well irrigation (private investment)	0.015	0.016	0.022	0.011	9.51 (1)	1.66 (4)	2.87 (3)	19.80 (1)
	Elasticity:				Poverty: Decrease in number of rural people per INR million of spending			
	All states	HIS	MIS	LIS	All states	HIS	MIS	LIS
Irrigation investment (canals)	−0.006	−0.020	−0.001	−0.050	3 (12)	5 (12)	21 (9)	43 (9)
Fertilizer subsidy	−0.006	−0.008	−0.300	−0.040	11 (11)	11 (10)	585 (1)	114 (6)
Irrigation subsidy	−0.002	−0.006	−0.001	−0.044	19 (10)	47 (8)	15 (10)	441 (3)
Electricity subsidy	−0.009	−0.041	−0.002	−0.021	23 (9)	52 (7)	5 (11)	302 (4)
Credit subsidy	−0.005	−0.004	−0.024	−0.010	24 (8)	9 (11)	105 (3)	103 (7)
Road investment	−0.034	−0.032	−0.053	−0.034	35 (7)	18 (9)	55 (6)	28 (12)
Agriculture R&D investment	−0.014	−0.048	−0.038	−0.241	45 (6)	85 (4)	136 (2)	1231 (2)
Education investment	−0.166	−0.671	−0.147	−0.043	88 (5)	214 (2)	88 (5)	31 (10)
Energy investment	−0.029	−0.029	−0.010	−0.012	97 (4)	68 (5)	30 (8)	66 (8)

Table 5 (continued)

	Elasticity:				Poverty: Decrease in number of rural people per INR million of spending			
	All states	HIS	MIS	LIS	All states	HIS	MIS	LIS
Health investment	−0.139	−0.218	−0.056	−0.028	109 (3)	115 (3)	43 (7)	30 (11)
Well irrigation (private investment)	−0.002	−0.006	−0.007	−0.004	166 (2)	55 (6)	88 (5)	1286 (1)
Rural development	−0.398	−0.193	−0.047	−0.084	605 (1)	253 (1)	92 (4)	124 (5)

Based on averages from 2011–2012 to 2013–2014 using direct and indirect elasticity estimates. "All states" refers to select 17 states. Numbers in parenthesis show rankings from high to low outlays toward employment programs during the 2000s. Rural development is followed in the rankings by investment in well irrigation, public health, energy, and education, in that order.

Across LIS, MIS, and HIS, the estimates show differential impacts of investments and subsidies, albeit little tradeoff between poverty and productivity outcomes. Private investment in minor irrigation, public investment in R&D, and subsidies on irrigation and power have highest marginal returns in LIS, whereas the first three along with public investments in education and energy are top ranked in HIS. The payoffs from additional spending in promoting agriculture income are also higher in LIS, mostly confined to the eastern and rainfed regions. Such differential marginal returns from each investment across the three groups of states indicate the efficacy of a location-specific public policy. The common themes (across national level as well as across the state groups) in the rankings of income growth and poverty reduction include private investment in wells and public spending on agricultural R&D. One possible explanation is that spending on R&D helps to facilitate higher agricultural growth and reducing poverty through pathways such as private investment, wage, productivity, and health.

Subsidies ranked below investments in raising productivity and alleviating poverty at the national level. However, interstate analysis shows relatively higher payoffs from electricity, irrigation, and fertilizer subsidies in the poorer states to achieve agricultural growth. In HIS, irrigation and fertilizer subsidies are ranked second and seventh, respectively—higher than credit subsidies (ninth) or electricity subsidies (eighth). Irrigation and fertilizer subsidies are ranked tenth and second in MIS, and third and seventh in LIS. Electricity subsidies rank fourth in the LIS. Regarding poverty mitigation, input subsidies have a relatively low impact in HIS but a somewhat larger effect in LIS. Poverty reduction from spending on irrigation and credit subsidies is the lowest among spending categories across all three groups of states. Marginal returns from various investments in terms of higher income and poverty reduction tend to be larger in LIS.

Policy Implications

The pattern and composition of public expenditure across 17 Indian states from 1981–1982 to 2013–2014 indicate a significant change in the country's public policy toward agriculture and the rural sector during the 2000s. It marked a reverse of the deceleration in the growth rate of investment in irrigation that spanned the mid-1980s and 1990s along with a dramatic increase in the magnitude of farm input subsidies. Several states have witnessed a remarkable reduction in poverty ratio and have accomplished annual growth between 6 and 8%, much higher than the national level. However, this transformation has not been able to lessen the interstate disparities in various economic and social development outcomes expected from increased public investments. To examine the implications of this trend, a structural equation model, applied to the data from low-, middle- and high-income states, related public expenditure with the development goals of improving agricultural productivity and eliminating poverty in each. This model allowed researchers to investigate the prioritization of government spending on various social and economic categories and the benefits of shifting attention from high-income to low-income states to meet future growth challenges. Accordingly, it ranked the marginal effects of key public investments, input subsidies, and private investment in minor irrigation according to their returns of agricultural income and rural poverty.

From these data and analysis, a broad conclusion may be drawn regarding the differential impacts of government spending across low-, middle-, and high-income states, with little tradeoffs between the efficiency and equity goals of public intervention. Increased agricultural productivity, remunerative farm prices, and nonfarm employment with better wages are found to be the main sources of poverty reduction, though the intensity of impact varies significantly across the states. Although agriculture productivity depends on R&D investment, irrigation, and fertilizer use, nonfarm employment is enhanced by improvements in land productivity, nonfarm income, education, the health and nutrition status of workers, and spending on rural development. Higher payoffs are identified from additional public investments in agricultural R&D, energy, education, health, irrigation, and electricity subsidy, along with private investment in minor irrigation, more so in lower-income eastern states. The marginal impact in highly irrigated states may have reached a ceiling beyond which further investments in irrigation and roads would not yield greater returns in terms of incremental income. Therefore, policymakers should focus on improving their capital use efficiency. The poorer states would benefit from a reallocation of expenditure to priority areas besides government advances in the mission of addressing growth challenges by enhancing technology, facilitating private investment and nonfarm employment, and developing adequate infrastructure.

Acknowledgements We are grateful to the Indian Council of Agricultural Research (ICAR), for extending financial support to undertake this study as part of ICAR-IFPRI workplan. We express our sincere thanks to Dr Trilochan Mohapatra, Secretary, DARE and Director General, ICAR and Dr Shenggen Fan, Director General, IFPRI for their constant support and encouragement during this study. We acknowledge the valuable suggestions received from Dr. Madhur Gautam, Dr. Himanshu and Dr. Indira Rajaraman, on an earlier version of the paper.

Compliance with Ethical Standards

Conflict of Interest We do not have any conflicts of interest.

Annex

See Table 6.

Table 6 Exogenous and endogenous variables used in the SEM and sources of data

RAIN	Annual rainfall index (Fertilizer Association of India)
GDPGNA	Annual rate of growth in nonagriculture gross domestic product (GDP) or nonagriculture income per capita (Government of India–National Accounts Statistics [GOI-NAS])
World price	World food price index, 2005 = 100, includes cereal, vegetable oils, meat, seafood, sugar, bananas, and oranges price indices (International Financial Statistics)
Population	Rural population (GOI-Census of India)
Health status (IMR)	Proxied by infant mortality rate in rural areas (Sample Registration System, Registrar General, India)
TT	Terms of trade based on 3-year moving average; estimated taking state domestic product (SDP) agriculture current/constant price divided by SDP nonagriculture current/constant price (2004–2005 GOI-NAS)
Poverty	Rural population falling below poverty line (based on headcount ratio from Planning Commission)
AY	Agricultural income, GDP per NSA (GOI-NAS and GOI–Agricultural Statistics at a Glance)
NAWage	Rural wage rate (Government of India–National Sample Survey [GOI-NSS])
NFEmpl	Percentage of nonfarm employment in total rural employment (GOI-NSS)
Agri. R&D	Public expenditure on agriculture R&D, soil conservation, crop and animal husbandry (GOI–Finance Accounts)
Labor	Agriculture labor, all age group as per UPSS [Usual Principal and Subsidiary Status] (GOI-NSS)
IRRI	Percentage of cropped area irrigated by public and private sources (GOI–Agricultural Statistics at a Glance)
ELECT	Electricity consumption in agriculture per hectare (Annual Reports of State Electricity Board and GOI–Agricultural Statistics at a Glance)
EDU	No. of years of schooling of rural workers bifurcated as per educational categories and then divided by total population (estimated using GOI-NSS)
FERT	Fertilizer consumption per hectare (Fertilizer Statistics of India)
ROAD	Road density measured in km per 1000 km^2 (GOI–Statistical Abstract of India)
Land	Gross cropped area (Fertilizer Statistics of India)
NFSM	Dummy for National Food Security Mission (NFSM) from 2006
RWAGE	Nonagricultural wage rate (GOI-NSS)
MGNREGS	Dummy for MGNREGS [Mahatma Gandhi National Rural Employment Guarantee Scheme] from 2006
Rur. Dev. Exp.: public expenditure on rural development (GOI–Finance Accounts)	
Vill. Ind. Exp.	Public expenditure on village industry (GOI–Finance Accounts)

Table 6 (continued)

Fertilizer sub	Fertilizer subsidy estimated using unit rate based on all-India estimates and then apportioned across states based on consumption (Fertilizer Statistics of India)
Electricity sub	Electricity (power) subsidy based on unit cost of supply minus agricultural tariff × use of electricity in agriculture (Annual report of SEB)
Credit sub	Credit subsidy (only interest) based on loan outstanding of Primary Agricultural Credit Societies, Regional Rural Banks, and Commercial Banks based on difference in lending rate of agricultural and nonagricultural sectors (National Federation of State Cooperative Banks)
Irrigation sub	Irrigation subsidy based on operation & maintenance expenditure − receipts + interest income/receipts; second estimate is taken in this study = irrigation subsidy + 1% of cumulative capital expenditure (exclude exp. on flood control) (GOI–Finance Accounts)
Irrigation Exp.	Public expenditure on minor, medium, and major irrigation and command area development (GOI–Finance Accounts)
Energy Exp.	Public expenditure on rural energy; bifurcated as per consumption in agriculture (GOI–Finance Accounts)
Road-transport Exp.	Public expenditure on rural roads, transport, and bridges. Division as per the share of rural population in total (GOI–Finance Accounts)
Education Exp.	Public expenditure on education, sports, art, and culture (GOI–Finance Accounts)
Health-nutrition Exp.	Public expenditure on medical and public health and social and welfare nutrition (GOI–Finance Accounts)

Public spending on each category comprises revenue and capital expenditure. The latter is measured as a stock variable based on accumulated expenditure at the end of 1981 (i.e., the base year in the study). Annual depreciation is taken to be 10%. The public expenditure series, SDP, and other datasets given in nominal prices are converted into real prices at 2004–2005 base using income deflators from India's EPW Research Foundation. Wage rates are converted into real prices using the consumer price index published by the Ministry of Consumer Affairs

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