



Evaluation of Agricultural Subsidies and Investments in India: A Systematic Review Towards the Viksit Bharat@2047

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ABSTRACT

This systematic review analyses the evolution, efficiency and trade-offs of agricultural subsidies and investments in India from the inception of green revolution to amrit kaal aligned with the vision of Viksit Bharat@2047. Evaluating 34 studies using PRISMA 2020 framework, it finds that while subsidies have reduced input costs and supported technology adoption, they also led to adverse impacts on environment and fiscal inefficiency benefiting primarily large farmers. In contrast, investments in infrastructure, R and D and extension deliver higher returns. The study highlights the need for a strategic shift toward investment-led growth to enable inclusive, sustainable and climate-resilient agricultural transformation under Viksit Bharat@2047.

Key words: Agricultural subsidies, Amrit kaal, Capital formation, Investments, Systematic review, Viksit Bharat@2047.

Ever since the green revolution emerged in the 1960s the evolution of subsidies and investments had a significant impact on the trajectory of Indian agriculture. Subsidies and public investments represent the two primary instruments of agricultural policy influencing farm-level decisions, input adoption and long-term productivity. In order to lower the cost of vital inputs like fertilizers, electricity, irrigation and finance, subsidies were ongoing expenses that enable farmers especially smallholders to access the essential resources. Investments in contrast were long-term capital expenditures aimed at improving agricultural infrastructure such as markets, irrigation systems, rural roads and public agricultural research and extension programs. Together they form the backbone of public support to the agricultural sector. Over time, India's agricultural expenditure has become increasingly subsidy dominated, with more than 70-75% allocated to subsidies while less than 25% supports long-term capital formation (Gulati and Ganguly, 2010; Bathla and Aggarwal, 2022). In macroeconomic terms agricultural subsidies account for nearly 2% of India's GDP and contribute to 20-25% of farm incomes in several states (Ramaswami, 2019). Yet this mounting economic burden has sparked concerns about efficiency, sustainability and the impact on the environment. Agricultural subsidies and public investments influence development outcomes through the interaction of short-term welfare support and long-term structural growth mechanisms. Utilizing the frameworks established by Fan *et al.* (2008) and Chand and Kumar (2004) subsidies were defined as consumptive expenditures that enhance farmers' liquidity and reduce input costs thereby promoting short-term productivity increases. Conversely investments were cost-effective expenditures that raise the capital basis for the economy through R and D, infrastructure and irrigation lead to long-lasting effects on output and welfare. Empirical evidence showed that although subsidies initially promoted the adoption of green revolution technologies

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and their marginal returns diminished due to input inefficiency, soil nutrient imbalance and fiscal crowding-out of productive investment (Arora, 2013; Bathla and Hussain, 2021). On the other hand, public investments had high benefit-cost ratios which helped to reduce poverty and created jobs non-farming sector (Fan *et al.*, 2008; Bathla *et al.*, 2017; Bisaliah, 2010). Recent studies highlight that targeted public investments improve environmental sustainability and climate resilience (Baig *et al.*, 2023; Bathla and Aggarwal, 2022).

As India enters the amrit kaal period leading to the Vision Viksit Bharat@2047, debates on restructuring agricultural policy instruments have gained renewed importance. In an effort to guarantee financial security, food sovereignty and climate resilience, the Indian government aims to create an agricultural system that was technologically empowered, inclusive and environmentally

sustainable by 2047. In this context to address emerging problems pertaining to fiscal prudence, sustainability and equitable growth, it was imperative to revisit the historical and functional relationship between subsidies, investments and agricultural transformation (Mannepalli, 2022). Achieving the objectives of amrit kaal therefore requires a gradual transition from subsidy-driven support toward investment-led agricultural growth. Vision 2047 aims to transform India into a developed economy through inclusive, sustainable and technology-driven growth. Agriculture which employs about 45% of India's workforce, was core of this vision. thereby, it was projected that the Amrit Kaal period (2022-2047) will be a crucial period for re-establishing agricultural policy frameworks that support climate goals while improving rural livelihoods. Recalibrating the balance between subsidies and investments were therefore essential for improving productivity, sustainability and long-term agricultural transformation. The means by which the budget was now allocated disproportionately favours input subsidies over capital investment limits India's ability to meet its ambitions for transforming its agri-food system. Also to maximize social returns and guarantee intergenerational equity, investments must be aligned with new objectives including value chain integration, digital agriculture, climate resilience and youth entrepreneurship. Beyond irrigation and machinery, future agricultural investments must incorporate climate-smart technologies, bio-input development, renewable energy and sustainable agri-logistics (Bathla and Aggarwal, 2022). The removal of ineffective subsidies and their replacement with direct income assistance or investments that increase productivity have been recommended by a number of high-level committees and reports including those from the RBI and NITI Aayog.

Despite the extensive literature on agricultural subsidies and public investments, existing studies largely examine these policy instruments independently. Limited efforts have been made to synthesize their comparative efficiency, developmental trade-offs and long-term implications within a unified analytical framework. Given the conflicting narratives and divergent outcomes with regard to investments and subsidies, an exhaustive review was essential. Despite historical evidence that both instruments were effective in promoting growth and reducing poverty, structural, environmental and technological changes have triggered their relative effectiveness to change over time. This analysis attempts to compile the information, evaluate the trade-offs and identify approaches to maximizing the policy mix based on India's commitment to climate action, sustainable development goals and financial constraints. By carefully evaluating the empirical evidence from the green revolution to Amrit Kaal this study aims to contribute to the evolving policy discussion on agricultural transformation. It also aims to provide ideas for evidence-based policymaking as India moves further to its 2047 vision. Therefore, the present study aims to

systematically review the empirical literature on agricultural subsidies and investments in India to assess their evolution, comparative efficiency and policy implications for achieving sustainable and inclusive agricultural growth under the Viksit Bharat@2047 vision.

In order to evaluate the policy outcomes and development dynamics of capital formation and agricultural subsidies in the Indian agricultural sector this study employed the systematic review approach. A PICO (Population, intervention, comparison and outcome) framework was utilized as a framework for the review assisting in structuring the research question (Santos *et al.*, 2007). The population of interest was the Indian agricultural sector. Multiple agricultural subsidies such as credit, fertilizer, irrigation and other input subsidies were part of the intervention. Capital formation or the public/private investment processes were compared with the subsidies. Enhancement of rural livelihoods, economic growth and agricultural production were the outcomes of interest. Thus the following research question was developed "Among various policy instruments in the Indian agriculture sector, how do agricultural subsidies compare with capital investments in influencing agricultural growth, productivity and sustainability?" In light of India's Vision 2047 and the Amrit Kaal development framework this analytical approach ensures that the evaluation fully documents the development, efficiency and economic impact of subsidies and investments offering a strong basis for policy recommendations.

Systematic reviews require a transparent and replicable procedure for identifying, screening and selecting relevant studies. Therefore, the preferred reporting items for systematic reviews and meta-analyses (PRISMA, 2020) framework was adopted as the methodological guideline for this review. PRISMA provides a structured protocol for documenting literature search strategies, study selection procedures and inclusion or exclusion criteria, thereby improving methodological transparency and reducing selection bias in systematic reviews (Page *et al.*, 2021). The framework organizes the review process into four stages: identification, screening, eligibility assessment and final inclusion of studies. To maintain scientific rigor and transparency the review employed the PRISMA 2020 approach (Page *et al.*, 2021) as shown in Fig 1. The adoption of PRISMA ensures reproducibility and transparency in the review process by clearly documenting each stage of study identification and selection. The PRISMA flow diagram presented in Fig 1 summarizes the systematic literature selection process, including database identification, removal of duplicate records, screening of titles and abstracts, eligibility assessment through full-text review and final inclusion of relevant studies. Scopus and Google Scholar two major academic databases were used to conduct a thorough literature search. The keywords "agricultural subsidies," "capital formation," "investments," and "India" were all part of the search strategy. A total of 193

articles from scopus and 195 from google scholar were obtained from the first retrieval resulting in a pool of 388 studies. After removing duplicate records, 379 individual items were considered for screening. The screening procedure was divided into multiple steps. 317 research articles were eliminated during the title and abstract screening stage because they were not relevant to India, failed to adequately prioritize on specific agricultural subsidies or investments, or lacked any insightful policy or economic analysis. A full-text eligibility assessment was then conducted through 62 reports. 18 of these articles were rejected because they did not fit the predetermined inclusion and exclusion criteria. The three reasons for exclusion were: not focused on the Indian agricultural context ($n = 1$), lacked analysis of agricultural subsidies or investment trends ($n = 11$) and articles did not provide empirical, policy-relevant or analytical depth ($n = 6$). After the full-text screening of 44 eligible studies, a final set of 34 studies was selected based on relevance, analytical

depth, methodological rigor and direct policy relevance to agricultural subsidies and investments in India. The final selection prioritized studies that provided empirical analysis, policy relevance and methodological robustness in examining the role of subsidies or capital formation in Indian agriculture. The inclusion criteria were strictly limited to peer-reviewed journal articles, policy reports and working papers written in english that directly addressed themes related to capital formation, public/private investment, or subsidies in Indian agriculture. Both qualitative and quantitative research methods were acceptable. Exclusion criteria removed opinion articles, content lacking peer review, studies not pertinent to the agriculture sector and those lacking full-text access.

The 34 reviewed studies were organized into ten major thematic areas including sectoral outcomes of agricultural investments, determinants of capital formation and subsidy-investment trade-offs as shown in Table 1. A summary of the major findings, specific studies, the

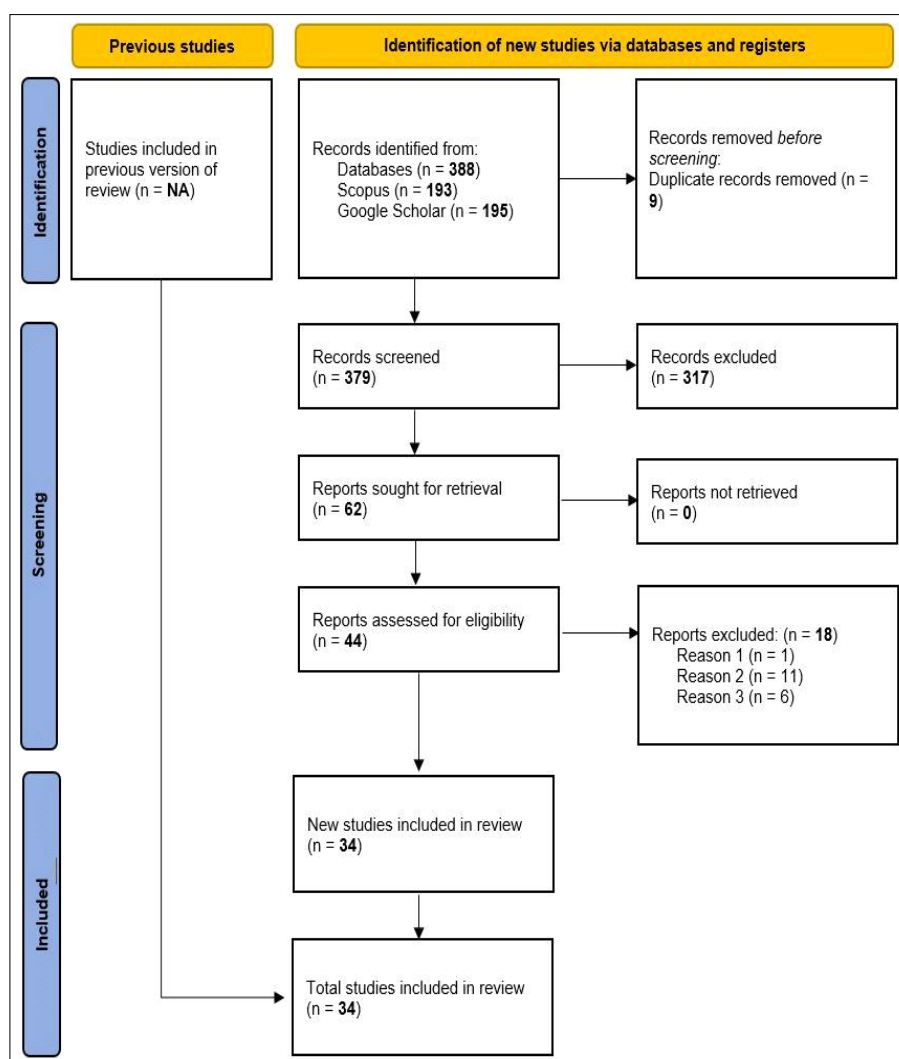


Fig 1: PRISMA framework for the systematic review.

Table 1: Structured summary of selected studies for systematic review.

Variable	Research question	Study references	Methodology/data source	Summary of findings
Subsidies and investment linkages	How do subsidies affect public and private investments in agriculture?	Chand and Kumar, 2004; Fan <i>et al.</i> , 2008; Bisaliah, 2010; Gulati and Ganguly, 2010; Kannan, 2012; Bathla and Hussain, 2021; Zafar and Tarique, 2023.	Time-series econometrics, CGE models, secondary data (NABARD, MoA, etc.)	Subsidies may crowd out productive capital formation if not targeted; private investment responds better to infrastructural support than direct subsidies.
Composition and efficiency of subsidies	What is the economic impact of different forms of subsidies (input, credit, etc.)?	Fan <i>et al.</i> , 2008; Kannan, 2011; Arora, 2013; Misra <i>et al.</i> , 2016; Bathla <i>et al.</i> , 2021	Panel data analysis, policy simulations	Input subsidies often have diminishing marginal returns; credit subsidies enhance productivity when targeted toward smallholders.
Subsidies, investments and yield	How do combined effects of subsidies and investments influence yield outcomes?	Baig <i>et al.</i> , 2023.	ARDL regression with spatial data	Positive interaction between irrigation investment and fertilizer subsidies improved food grain yields in selected Indian states.
Determinants of capital formation	What factors drive capital formation in agriculture?	Dhawan and Yadav, 1997; Chand, 2001; Chand and Kumar, 2004; Bisaliah, 2010; Saini and Kumar, 2020; Bathla and Aggarwal, 2022; Akber <i>et al.</i> , 2022; Jamaludheen <i>et al.</i> , 2022.	Dynamic panel models, decomposition techniques	Public investment in irrigation, roads and credit institutions were significant drivers; interest subvention had limited effect on capital deepening.
Investments and agricultural growth	Do public investments reduce poverty and enhance agricultural production?	Fan <i>et al.</i> , 2008; Baba <i>et al.</i> , 2010; Dastagiri, 2010; Ramakumar, 2012; Wiggins and Brooks, 2012; Bathla <i>et al.</i> , 2017.	Cross-country and state-level econometric studies	Investments in R&D, irrigation and roads showed stronger linkages with poverty reduction and yield growth than subsidies alone.
Investments and employment	What is the role of agricultural investments in enhancing non-farm rural employment?	Fan <i>et al.</i> , 2008; Baba <i>et al.</i> , 2010.	Panel regression, rural household survey data	Public investments in rural infrastructure had spill-over effects in generating non-farm employment opportunities.
Investments and fiscal constraints	How do fiscal deficits influence agricultural investment priorities?	Alagh, 2011.	Descriptive macroeconomic analysis	Fiscal consolidation led to stagnation in public agricultural investment during early 2000s; shift towards food and fertilizer subsidies observed.
Investment-output elasticity	What is the elasticity of production with respect to agricultural investments?	Chand and Kumar, 2004; Akber and Paltasingh, 2021.	Time-series econometrics.	Investments have significantly higher production elasticity than subsidies; higher returns observed in long-term infrastructural investments.

Table 1: Continue..

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Role of rural banking in investment	Does rural banking infrastructure influence capital formation in agriculture?	Kaushal and Ghosh, 2016.	Regression on banking and investment indicators	Expansion of rural credit and banking institutions positively correlated with gross capital formation in agriculture.
Public and private investment dynamics	What is the relative role of public and private investments in agriculture?	Alagh, 2011; Akber and Paltasingh, 2019; Akber <i>et al.</i> , 2020; Bathla and Aggarwal, 2022; Akber <i>et al.</i> , 2022.	Macro-trends analysis, econometric modeling	Public investment crowds in private investment especially in irrigation, storage and markets; consistent decline in public share since 1990s noted.

methodological approach (qualitative, quantitative or mixed) and the guiding research questions has been included in each theme. This framework makes it possible to compare the ways in which various research streams address the policy discussion surrounding agricultural investments and subsidies in India. A comprehensive evaluation of developmental trade-offs and investment efficiency was facilitated by thematic understanding which also draws attention to areas of agreement and disagreement. Table 2 illustrates the way India's agricultural investment and subsidy structure changed over time, starting with the Green Revolution to the amrit kaal. This table which demonstrates changes in public-private investment priorities, subsidy intensity and policy orientation. The new agricultural strategies introduction in the 1960s, the fiscal contractions of the liberalization era in the 1990s and the most recent digital and climate-smart interventions implemented under the Amrit Kaal vision were important turning points. The table shows how changes in political economy and developmental ideologies have affected the subsidy-investment balance. It supports the claim that a shift towards strategic capital formation and investment-led support was necessary for inclusive and sustainable agricultural growth.

Role and evolution of agricultural subsidies

Public investments and input subsidies serve as critical policy instruments to foster the growth of the agricultural sector. During the green revolution period, subsidies for credit, irrigation and fertilizers played a crucial role in promoting the adoption of high-yielding technologies benefit-cost ratios often exceeded 5:1 (Fan *et al.*, 2008). Despite this throughout time the magnitude of subsidies had increased dramatically and noted that this had affected public spending (Kannan, 2012). In order to achieve food self-sufficiency and reduce dependence on imports, subsidies were essential when combined with government investments in infrastructure and research. However, the long-term trend shows a growing dominance of subsidies in agricultural expenditure. Subsidies have risen in magnitude and reach over time displacing capital expenditures further and faster. According to empirical data only one-fourth of all public resources allocated to agriculture goes to long-term public investments with approximately three-fourths flowing toward subsidies (Gulati and Ganguly, 2010). On top of that subsidies often fail to reach smallholder and marginal farmers equitably with well-off cultivators benefiting the most (Bathla *et al.*, 2021). Importantly discussions concerning the sustainability of the current subsidy systems have been sparked by the adverse environmental impacts of excess use of inputs especially groundwater depletion, soil nutrient imbalance and diminishing input-use efficiency (Bathla and Hussain, 2021; Arora, 2013). Also the state and central budgets were experiencing fiscal stress due to the growing subsidy bills which reduces the amount of resources available for productive investment (Zafar and Tarique, 2023).

Linkages between subsidies and agricultural growth rate

The relationship between agricultural growth and subsidies had been the focus of numerous studies. Chand and Kumar (2004) found that for every rupee spent on subsidies the agricultural GDP rises by ` 3.1. Similarly Zafar and Tarique (2023) found that agricultural productivity increases by 0.35% over time for every 1% rise in per hectare input subsidy spending. These findings indicated that subsidies can generate short-term improvements in agricultural productivity. When compared to other policy instruments like investments, the extent of the returns were still minimal.

Effects of subsidy allocation on productivity outcomes

In the absence of any form of compensation mechanism, agricultural output would decrease by 11.95%, according to Bathla *et al.* (2021) analysis of the possible effects of removing fertilizer and power subsidies. The analysis also revealed notable inter-state differences, with West Bengal expected to endure the largest output decline (13.94%) and Himachal Pradesh the lowest (2.47%). The results also demonstrated that larger farmers and wealthier states often benefited greater from subsidies than marginal and smallholder farmers in less developed areas. These disparities highlight concerns regarding the equity and efficiency of existing subsidy policies. Credit was essential for promoting technology adoption and agricultural investment. While evidence indicated that merely expanding access to credit through interest subsidies does not result in increased crop yields (Kannan, 2011). Rather, investments in infrastructure, irrigation and extension services must be made in addition to increased agricultural finance. Misra *et al.* (2016) also showed that the intensity of agricultural credit with a one-year lag had a significant impact on agricultural productivity. This suggested that farmers may adopt a greater variety of fixed and variable inputs as well as new technologies to increase production as the intensity of financing access improves. As per these findings credit can be a significant enabler but its effects on productivity would be strongest when combined with broader investment-led activities.

Interactions between food grain yield, subsidies and investments

There had been mixed results regarding the relationship between investments, subsidies and food grain yield. Research indicated that while over dependence on subsidies, cultivated area expansion and agricultural employment might have detrimental long-term impacts, gross capital formation and consumption of fertilizer had the positive effect on food grain output (Baig *et al.*, 2023). Based on the coefficient analysis the study found that food grain production increased by 0.2% for every 1% rise in fertilizer consumption and by 0.2% for every 1% increase in gross capital formation. On the other hand, the coefficient for agricultural subsidies shown an adverse relationship

Table 2: Timeline of evolution in subsidies and investments in the agriculture sector of India.

Time period	Major policy initiatives/shifts	Subsidy focus	Investment focus	Key outcomes
1960s and 70s	Green revolution	High (Fertilizer, irrigation)	Moderate (Public irrigation, HYV seed programs)	Focus on self-sufficiency; input-heavy support.
1980s	Expansion of rural credit and subsidies	Expanded (Electricity, credit, fertilizer)	Limited capital investments	Shift towards populist subsidies; low asset creation.
1990s	Economic liberalization	High but re-evaluated	Reduced public investment	Subsidies crowding out investment; stagnating capital formation.
2000-2007	Targeted investment schemes (RKVY, NFSM)	Still high	Rising trend (RKVY started)	Re-alignment towards productive investments.
2008-2014	MSP-led growth and debt waivers	Very high	Moderate public and private investments	Debt-led subsidies peaked; low capital formation elasticity.
2015-2020	Doubling Farmers' Income agenda	Rationalization attempts (DBT pilots)	Renewed focus on irrigation, infra (PMKSY)	Mixed results; infrastructure push renewed.
2020-2024	Post-COVID and Amrit Kaal push	Still large (urea, PM-KISAN)	Vibrant villages, agri infra fund etc.	Moderate correction towards growth-oriented support.

with the productivity of food grains indicating that subsidies may not always result in long-term increases in productivity. A 1% increase in agricultural employment was associated to a 0.01% reduction in productivity suggesting that labour-intensive agriculture employment also appears to reduce production. This finding also reflects the low marginal productivity of labour in Indian agriculture and that shifting workers from the sector to another could increase wages and improve the nation's overall economic efficiency (Baig *et al.*, 2023).

Efficiency analysis: Comparative outcomes of subsidies and investments

The analysis of government funding allocation revealed a notable imbalance. Public investments accounted for only one-fourth of the resources allotted to public investments; the other three-fourths were used for subsidies, primarily for electricity, irrigation and fertilizers (Gulati and Ganguly, 2010). This disparity was significant since research indicated that public investments yielded higher than the subsidies in terms of growth in agriculture. Zafar and Tarique (2023) state that, even though input subsidies can increase private investment by an average of 2.49% for every 1% increase in spending, reallocating 1% of subsidy spending toward capital investments could eventually increase agricultural GDP by 1.82-2.73%. Similarly, Chand and Kumar (2004) found that a rupee spent on subsidies causes a net decrease in agricultural GDP of ₹2.83-₹4.23 but a rupee invested in public sector capital formation provides ₹35.21 to GDP over its lifetime. The argument was further supported by historical analysis of marginal benefit-cost ratios. During the 1960s and 1970s power and credit subsidies produced returns 12-19 times the costs they incurred while expenditures in roads and education produced benefit-cost ratios of 15-20. However by the 1980s and 1990s the returns on irrigation and power subsidies had drastically decreased to less than two rupees for every rupee invested, whilst investments in rural roads, education and agricultural research and development continued to yield returns of 400-500% (Fan *et al.*, 2008). In agriculture sector public investments especially in rural roads, irrigation, research and extension, provide better long-term economic and social benefits than subsidies (Fan *et al.*, 2008; Chand and Kumar, 2004; Bathla and Aggarwal, 2022). While subsidies give lower returns and can even result in a net GDP deficit when they substitute investments one rupee invested on capital formation in agriculture was estimated to generate Rs. 35.21 in GDP during its lifespan (Chand and Kumar, 2004). The reduction of rural poverty, non-farm employment and agricultural GDP have all been positively correlated with public investments which also had a considerable crowding-in effect on private investments (Akber and Paltasingh, 2021; Baba *et al.*, 2010). For example the marginal effects of spending on rural development indicated that in some regions every additional Rs. 1 lakh spent on rural areas can help lift more than

178 people out of poverty (Baba *et al.*, 2010). Similarly, infrastructure investments assist to absorb surplus agricultural labor and promote rural economic diversification through their strong multiplier effects on non-farm employment (Bathla *et al.*, 2017). Depending on the design of the policy and its targeting efficiency the interaction of subsidies with these factors can either promote or hinder long-term capital formation. This trend suggested that public investments generated stronger and more sustained impacts on agricultural growth than subsidies.

Determinants of public and private capital formation in agriculture

Several institutional and economic factors impact capital formation in agriculture. According to Chand (2001) public sector capital formation, institutional credit availability and agricultural and technological terms of trade were important factors influencing the establishment of private capital. The quantity and composition of public investment at the regional level were greatly influenced by factors including central grant-in-aid, farm subsidies, population growth, state agricultural GDP and rural literacy (Bisaliah, 2010). Public investments in agriculture and irrigation were also impacted by market borrowings, revenue deficits, irrigation intensity and per capita income (Bathla and Aggarwal, 2022). According to Dhawan and Yadav (1997) one third of net state borrowings was generated by savings in state revenue budgets while approximately 40% flows toward fixed capital formation in agriculture. Research suggested that private investment responds favourably to public support in the form of subsidies and favourable terms of trade, especially in the eastern states and that public spending on input subsidies were almost twice as high as agricultural capital formation (Bathla and Aggarwal, 2022). Indicators of public infrastructure such as road density had a big impact on private investment. Based to regression analysis these factors account for up to 85% of the volatility in private agricultural investment (Bathla and Aggarwal, 2022). Investment behaviour was additionally affected by farm size. Per-hectare investment tends to decrease as farm size increases but overall farm investment per farm increases (Bathla and Hussain, 2021). While public spending on research, education and public canal networks tends to crowd out private investment, irrigation subsidies greatly stimulate private on-farm investment (Akber *et al.*, 2022). Future food demand, favourable trade situations and institutional funding were the additional variables. Larger farms were characterized by machinery and implements while small and marginal farms invest primarily on livestock (Saini and Kumar, 2020). Disparities in productive asset investments between states were brought to light by Jamaludheen (2022). Agricultural households in Haryana spent more than twelve times as much (₹13,694) on productive assets as those in Jharkhand which spent less than one tenth of the national average (₹1,013). Even after accounting for factors including

household size, landholding, credit and crop revenue, families headed by individuals with less schooling were less likely to invest, indicating that education was also influenced investment decisions (Jamaludheen, 2022). These results demonstrate that a variety of structural, economic and sociodemographic factors that affect capital formation and the effective policies must take a comprehensive approach to addressing these determinants.

Impact of agricultural investments on rural poverty reduction

Studies constantly demonstrated that agricultural investments reduce poverty more effectively than subsidies. Rural poverty was greatly reduced by increased agricultural productivity and revenue brought about by public investment in rural infrastructure, education, agricultural R and D and energy (Fan *et al.*, 2008; Baba *et al.*, 2010; Dastagiri, 2010; Wiggins and Brooks, 2012; Ramakumar, 2012; Bathla *et al.*, 2017). Baba *et al.* (2010) found that 178 underprivileged individuals in Himachal Pradesh could be lifted over the poverty line with an extra ₹ 1 lakh in government spending for rural development. According to Bathla *et al.* (2017) investments in health and education also increase labor productivity and non-farm employment prospects which raises wages and incomes in rural areas. Subsidies have a substantially less proportionate impact on eradicating poverty. According to Fan *et al.* (2008) public investments in roads, education and agricultural research and development had a greater impact on poverty reduction than loans, irrigation and fertilizer subsidies combined. These results highlight the likelihood that much more significant results in reducing poverty could be obtained by redirecting financial resources from subsidies to focused investments.

Linkages between investments and non-farm employment generation

Non-farm employment was additionally significantly supported by public investment especially in rural areas. A significant number of employment outside of agriculture were generated by investments in check dam construction, irrigation projects, soil and water conservation and other rural development initiatives. 104 people outside the farm sector might be directly employed with an extra ₹ 1 lakh invested in irrigation infrastructure (Baba *et al.*, 2010). In addition to creating jobs outside of agriculture these investments also improve agricultural GDP growth which in turn increased the demand for labour in rural areas. By improving income stability and diversifying rural livelihoods, public investments reduce dependence on agriculture and promote wider rural economic growth. The multiplier effects of capital formation over subsidies were shown by this dual effect of increasing agriculture production and generating non-farm employment.

Role of investments in agricultural GDP growth

The growth of agricultural GDP was positively and significantly impacted by both public and private investments in

agriculture. Akber and Paltasingh (2021) found that there was a significant 0.216-0.211% improvement in agricultural GDP growth for every 1% increase in public investment growth. Similarly a 1% increase in public canal intensity growth leads to a 0.34-0.48% increase in agricultural GDP growth. Growth in private investments had a greater significant impact and coefficients ranging from 0.36 to 0.42. These results emphasize the importance of both public and private investments in the growth of the agriculture sector. According to Chand and Kumar (2004) the impact of capital investments spans longer than a year. The short-term yield of agricultural output was ₹ 0.61 for every one-rupee increased in agricultural capital stock. Due to the long shelf life of capital assets this effect compounds over time increasing the returns on investment. Lower levels of hunger and increased labor productivity were also linked to high capital intensity (capital deepening) in agriculture especially in developing countries (Bisaliah, 2010).

Influence of banking sector on capital formation in agriculture

The growth of the financial sector was strongly related to capital formation in agriculture. In India, Kaushal and Ghosh (2016) showed a long-term association between banking and capital production as well as a short-term, unidirectional causal relationship between capital formation and the growth of the financial services sector. By channelling household resources into long-term, profitable investments, increasing capital efficiency and encouraging entrepreneurship banks play a critical role. These financial links highlight how crucial it was to improve rural credit delivery networks in order to improve capital formation and productivity.

Fiscal policy implications of agricultural investments

Fiscal deficits and public investments had a complex relationship. Evidences indicated that public investments in agriculture were less likely to result in unsustainable deficits since they increase economic output as well as efficiency even while deficit financing could eliminate private investment (Alagh, 2011). Public investments typically have lower incremental capital-output ratios (ICORs) which suggested stronger returns on investment and favourable externalities for the economy as a whole. This supports the argument that capital investments in agriculture should take priority over continuing spending involving subsidies.

Complementarity between public and private investments in agriculture

Although the degree of complementarity varies over time and by sector, public and private investments in agriculture were often complementary (Alagh, 2011; Akber *et al.*, 2020; Akber and Aggarwal, 2022). It was also found that public investments frequently crowd in private investment in the short and long term. However, in the long term the elasticity of private investments was larger and statistically more

significant than that of public investment indicating that the private sector was more sensitive to shifts in its own investment environment (Akber and Paltasingh, 2019). Farmers were sometimes obliged to raise private investment to counteract the negative consequences of a decrease in public investment, however the types of investments differ. While private investments were more concentrated on machinery, irrigation and production inputs, public investments tend to focus on infrastructure, education and research. When formulating policy this imbalance needs to be carefully taken into account because relying too much on private investment would not result in widespread outcomes for rural development (Bisaliah, 2010). The findings constantly depicted that whereas subsidies help stabilize farmer incomes and encourage the use of inputs, their over use had resulted in limited productivity enhancements, financial strain and environmental deterioration. On the other hand, both public and private investments promote long-term agricultural growth, lower poverty, create jobs apart from agriculture and have a favourable impact on the overall economy. Results for rural development and agricultural GDP could be greatly improved by shifting part subsidy expenditure towards capital formation. These observations were in alignment with Amrit Kaal's and India@2047's aspirations which emphasize resilience, inclusion and sustainability as the fundamental principles of agricultural transformation. Collectively, the reviewed studies suggest a consistent pattern in which long-term agricultural investments generate higher productivity gains and poverty reduction effects compared to input subsidies, highlighting the importance of rebalancing public expenditure priorities.

CONCLUSION AND POLICY RECOMMENDATIONS

The review finds that India's transition into Amrit Kaal requires a shift from subsidy-driven support to investment-led growth, as persistent reliance on input subsidies has weakened capital formation, resource-use efficiency and climate resilience. A calibrated subsidy-investment mix aligned with sustainability, innovation and inclusivity is critical for achieving India@2047 goals. Policy priorities include: Reform inefficient input subsidies into environmental incentives through renewable-linked support; Reorient public expenditure toward productive capital formation in irrigation, infrastructure and value chains; Invest in agri-tech and digital infrastructure for precision and market integration; Regionally differentiated investment strategies for agro-ecological efficiency; Institutionalize fiscal monitoring mechanisms like subsidy-investment dashboards; Encourage private investment via risk-reduction instruments including credit, insurance and land reforms; and Enhance institutional capacity and extension systems for inclusive, farmer-centric services. By correcting policy asymmetries and prioritizing strategic investments India can transform its agricultural sector into

a climate-resilient, high-income and innovation-led growth engine thus fulfilling the bold ambitions of Amrit Kaal and India@2047.

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Informed consent

N.A.

Conflict of interest

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