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Cost effective options for inclusive and sustainable development

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This brief is part of IFPRI's series of country studies that utilize the RIAPA modeling system to systematically evaluate and rank agrifood system investment options based on their cost-effectiveness in achieving multiple development objectives. These country studies examine whether the rankings evolve over time and production shocks such as droughts influence their relative cost-effectiveness.

Abstract

In this policy brief, we present findings of a systematic evaluation and ranking of investment options for Kenya's agrifood system based on their cost-effectiveness in achieving multiple development outcomes, including agrifood gross domestic product (GDP) growth, agrifood job creation, poverty reduction, declining undernourishment, and lowering diet deprivation. Additionally, the study assesses their environmental footprint, focusing on water consumption, land use, and emissions. Investments in small and medium enterprise (SME) processors, irrigation, and seed subsidy are shown to be the most cost-effective at driving improvements in social outcomes, like poverty and undernourishment. They are also highly ranked in terms of expanding agrifood GDP and employment. Expansion in extension and advisory services for seeds and agronomy as well as improvements in seed systems also rank high. However, many cost-effective investments have relatively high environmental footprints, which highlights potential tradeoffs. The study further reveals shifts in the cost-effectiveness ranking of investment options overtime and when extreme pro-duction shocks occur.

Keywords: Investment priorities, agrifood system, economic, social, environment, Kenya

Introduction

The agrifood system in Kenya serves as a key engine of economic growth, a major source of employment, and the foundation of livelihoods for millions. However, its core component—low-productivity agriculture—struggles to provide affordable, high-quality food for a rapidly growing population. This stark contrast highlights the urgent need for a sustainable transformation of the entire agrifood system. Achieving such transformation requires substantial technical and financial support, but equally critical are the policy and investment choices that determine the magnitude and durability of development gains (Christiaensen and Martin, 2018; Pham and Riedel, 2019). These choices should therefore be assessed not only in terms of their economic impacts—such as growth and job creation—but also their social outcomes, including poverty reduction, improved nutrition, and enhanced dietary quality. Understanding potential trade-offs among these objectives can guide policymakers in making more efficient and equitable resource allocation decisions. Increasingly, environmental sustainability is also being integrated into these assessments, reflecting a growing recognition that unsustainable production practices drive environmental degradation and climate change—burdens that will fall disproportionately on future generations, particularly among the poor (GLOPAN, 2020).

The effectiveness of policies or investments may be affected by unanticipated shocks, such as global commodity market disruptions, conflict and war, and climate-related events. We focus on the latter, given that climatic shocks have been the most significant exogenous factors affecting the performance of agrifood systems in Kenya (Kabubo-Mariara and Karanja, 2007; Marigi, 2017). Extreme events such as drought and flooding have become increasingly common and are expected to intensify in frequency and severity (Balakrishnan et al., 2024). While there is little doubt that these climatic shocks adversely affect the performance of the agrifood system, and, therefore, the effectiveness of agrifood system policies and investments in general, it is not evident whether climatic shocks would also alter the prioritization of these policies and investments.

In this country brief, we provide data- and model-driven insights to inform policy discussions on the design and prioritization of agrifood system interventions, considering both the current state of the system in Kenya and the emerging risks that threaten its performance, sustainability, and resilience. We systematically evaluate a range of investment options and rank them based on their cost-effectiveness in delivering multiple development outcomes, including agrifood GDP growth, agrifood job creation, poverty reduction, undernourishment reduction, and improvements in diet deprivation. To assess the impacts of these investments on nature capital, we calculate the associated environmental footprints, focusing on water, emission, and land.

We also examine how this investment ranking changes when the system is subjected to climatic shocks that differentially affect crop yields across agricultural sub-sectors. The design of these sensitivity scenarios is informed by observed historical climate shocks. This additional layer of analysis ensures that policy recommendations remain effective not only under normal conditions but also under adverse climatic events, thereby providing a more robust and resilient framework for guiding agricultural investment decisions in Kenya.

Results are generated using IFPRI's Rural Investment and Policy Analysis (RIAPA) modeling system (IFPRI, 2023) which uniquely integrates an investment module that translates identified investments into changes in productivity at the subsector level; a household survey-based microsimulation module that estimates changes in poverty, undernourishment, and diet deprivation; and a newly incorporated environment module that computes environmental footprints, including water, emission, and land. As such, this integrated RIAPA framework provides a comprehensive assessment of investment impacts. The RIAPA modeling system has been widely applied to evaluate the economywide impacts of various public expenditure options across different contexts (Thurlow et al. 2007; Pauw and Thurlow 2015; Benfica et al., 2019; Aragie et al., 2019; Aragie et al., 2024).

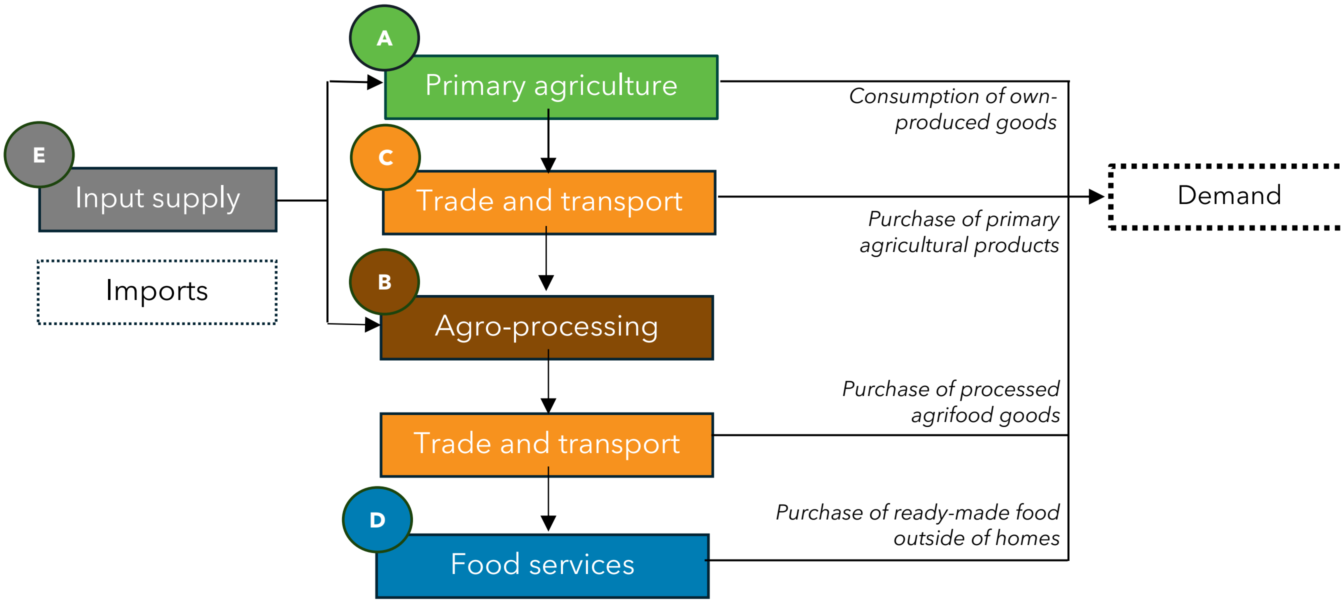
Country Context

Structure of Kneya's agrifood system

A country's agrifood system involves a complex network of actors linked to each other through their roles in producing, distributing, processing, and consuming primary agricultural and agro-processed products. We measure the agrifood system from a supply-side perspective, leveraging national accounts and employment statistics to directly simulate changes in agrifood GDP growth and employment by investment scenarios and over time. By disaggregating the agrifood system into distinct value chain groups and mapping interventions that target improving some of their bottlenecks, this approach provides valuable insights into the key drivers of agrifood system growth and associated environmental impacts in Kenya.

Figure 1 presents a simplified conceptual framework of the agrifood system, consisting of five key components labeled **A** to **E** (see Diao et al., 2023). Primary agriculture (**A**) encompasses the supply and demand for all agricultural products, including crops, livestock, fisheries, and forestry products. Agro-processing (**B**) is part of the manufacturing sector and includes subsectors that process agriculture-related food and non-food products. Meanwhile, trade and transport (**C**) involve demand for services related to transportation, wholesaling, and retailing of agrifood products between farms, firms, and final points of sale. Food services, represented in (**D**), include services such as meals prepared in restaurants, food stalls, or hotels. Finally, input supply (**E**) represents the portion of domestically produced intermediate inputs used directly in agricultural and agro-processing production, such as fertilizers and financial services.

Figure 1: A simple conceptual framework of the agrifood system



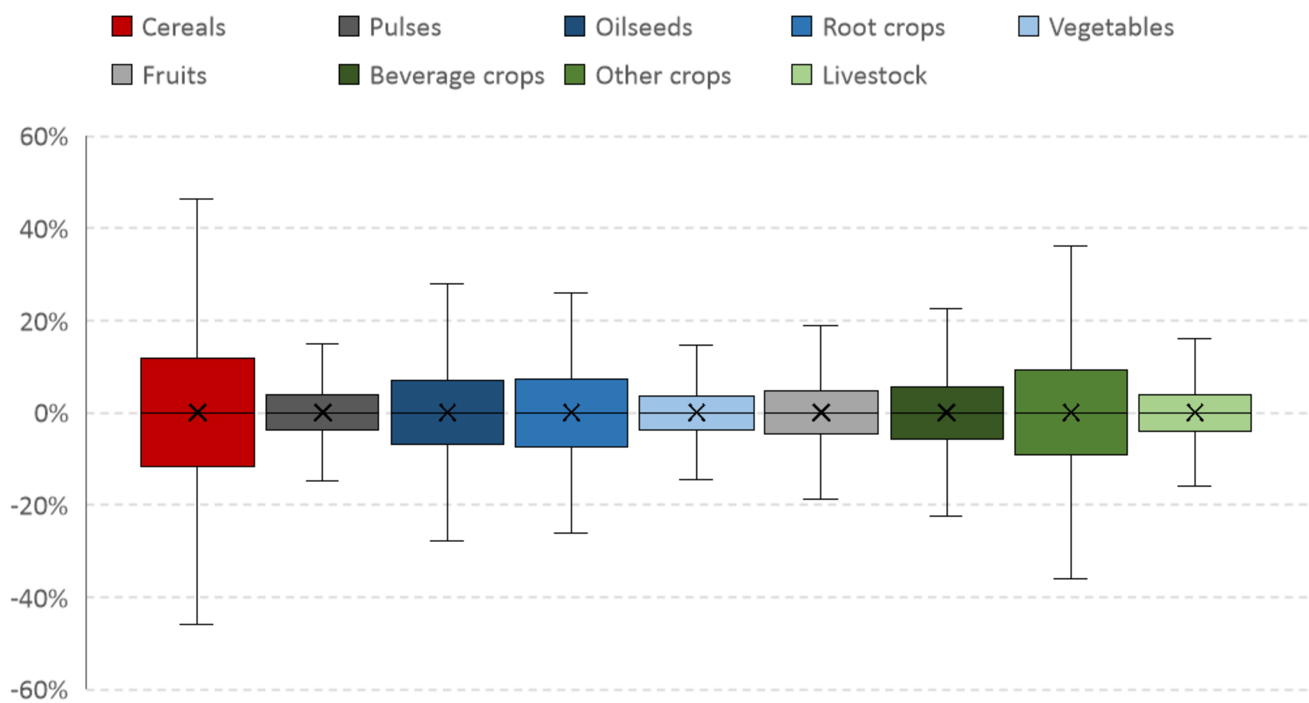
Source: Diao et al. (2023)

The agrifood system in Kenya contributes over 31.1 percent of gross domestic product (GDP) and employs approximately 54.7 percent of the workforce (Diao et al., 2023). Within this system, primary agriculture has been a major driver of growth, expanding at an average annual rate of 2.7 percent over the past two decades and currently accounting for 20.9 percent of GDP (Diao et al., 2023). With appropriate policy reforms, targeted investments, and a stable socio-political environment, the sector holds significant potential to sustain rapid growth and foster broader structural transformation in Kenya. Accelerating economic growth and maintaining high levels of employment have long been central development objectives globally, and Kenya is no exception. However, with a poverty headcount rate of 39.8 percent (based on the national poverty line) in 2022, an undernourishment rate of 35 percent (World Bank, 2025), and persistent concerns about dietary deprivation, the Kenyan government faces formidable challenges. These challenges are compounded by the need to pursue economic development and social progress while simultaneously transitioning toward a green and sustainable economy (RoK, 2025; NT, 2017).

Agricultural production variability in Kenya

Despite its significant contribution to the country's GDP, agriculture remains a critical driver of social and economic outcomes in Kenya. Given the predominance of rainfed production systems, Kenya's agricultural sector has historically been exposed to weather-related production shocks. These shocks adversely affect the efficacy of technologies; for example, several studies have shown that extreme events can lower the expected yield gains from using modern inputs such as fertilizer and seeds (Shah et al., 2024; Kumar and Maiti, 2024). Historical production estimates for Kenya show that yields for root and fruit crops fluctuate more than pulses and livestock (see Figure 2). For instance, production losses during a 1-in-25-year drought event, relative to a "normal" year, could range between 4.8 and 6.9 percent for pulses and livestock and between 25.6 and 28.5 percent for roots and fruits. This variation across sectors highlights different degrees of vulnerability of sectors to climatic shocks. Moreover, there is spatial variation both in the severity of drought conditions and sectoral distribution, both contributing to the national-level variation in yield impacts across products. In our modeling results, we will test the robustness of our investment ranking to climatic shocks using historical 1-in-25-year drought events as indicative of how such shocks will contribute to sectoral yield losses and alter the impact of investments.

Figure 2: Historical production variability for crops and livestock



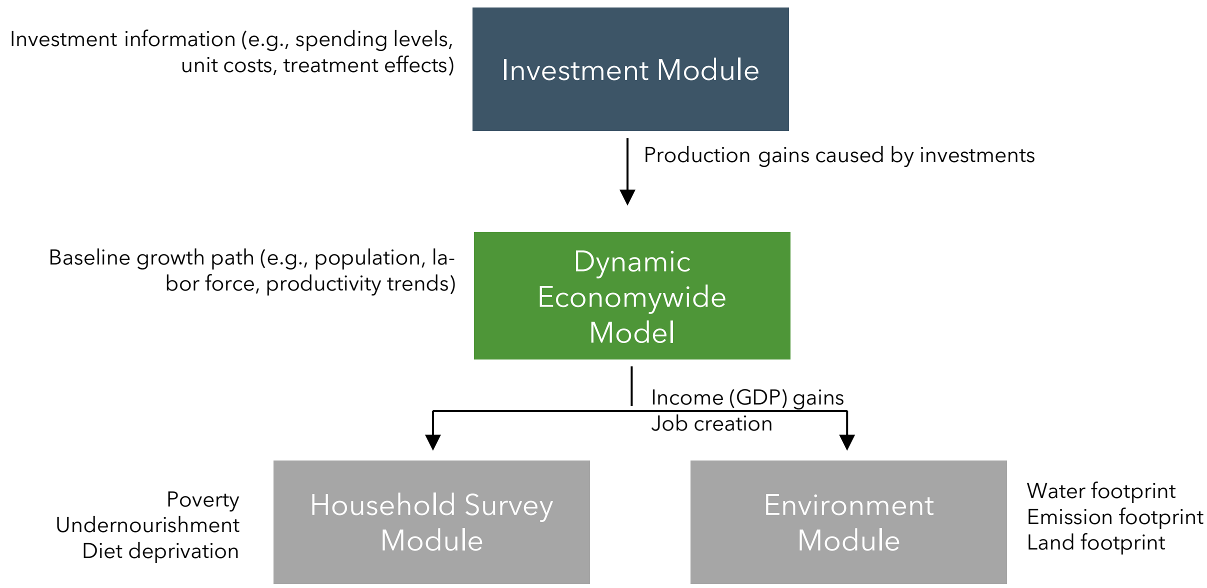
Note: The historical variability values are residual fluctuations from the determined production time series for 1990-2021. Livestock and cereals are the two main contributors of agricultural GDP, with shares of 22.1 and 17.0 percent, respectively. Fruits and beverages follow, contributing 16 percent each to the sector's GDP. Pulses and roots constitute 7.7 and 9.9 percent of agriculture, respectively.

Method of Analysis

Modeling approach

This study estimates the impacts of alternative agrifood system investments on the Kenya economy across key outcome indicators, which are categorized as economic, social, and environmental/resource use. We apply IFPRI's RIAPA modeling system (IFPRI, 2023) which uniquely integrates an investment module that translates identified investments into changes in productivity at the subsector level; a household survey-based microsimulation module that estimates changes in poverty, undernourishment, and diet deprivation; and a newly incorporated environment module that computes environmental footprints, including impacts on water utilization, emissions, and land use (Figure 3). This integrated RIAPA framework thus enables a more comprehensive assessment of investment impacts.

Figure 3: An integrated model for agrifood system investment and outcomes analysis



The economywide model

At the core of the integrated RIAPA framework is IFPRI's standard, recursive-dynamic computable general equilibrium (CGE) model. These models are widely utilized for economic policy formulation and analysis (Dixon and Parmenter, 1996; Devarajan and Robinson, 2010). They capture the interlinkages between sectors, households, and rural-urban economies, making them well-suited for assessing the economywide effects of public policies.

The Kenya model is calibrated to a 2022 Social Accounting Matrix (SAM) for the country. This SAM is an updated version of the 2019 SAM (IFPRI, 2021). The calibrated model represents the economy through a set of disaggregated sectors, encompassing 34 agricultural sub-sectors, which include 25 individual crops or groups of crops, six livestock production sectors, as well as forestry, captured fisheries, and aquaculture. The model also incorporates 40 industrial sectors—including 17 agro-processing activities—and 12 service sectors, which include food-related areas such as trade, transport, and restaurant services. This detailed representation of both the on-farm and off-farm components of the broader agrifood system permits detailed analysis of agrifood value chains, from primary producers to processors and traders to final consumers.

The Kenya model also distinguishes 15 representative households, each of which is an aggregation of a group of households captured in the 2015/16 Kenya Integrated Household Budget Survey (KIHBS) (KNBS, 2017). These households are categorized into rural and urban household groups, with rural households further divided into farm and non-farm groups based on their reliance on agriculture as a primary source of income. Finally, each household group is further disaggregated by per capita expenditure quintiles. In the model, households earn labor income and receive returns on their assets, which include land and capital, as well as domestic or foreign transfers.

The CGE model is used to produce a baseline that follows historical levels of broader economic and sectoral growth, population and labor force growth, and levels of government spending. This "business-as-usual" scenario runs until 2045. All investment scenarios are compared against this baseline.

As will be seen later, the temporal feature of the model allows us to examine how the effects of various interventions change over time.

The investment module

The investment module is used to synthesize data from several sources to measure, at a detailed sectoral level, the expected productivity gains that can be attributed to a unit of expenditure on each of a range of agricultural transformation investments. The module used in this study is a newly updated version of the framework previously adopted in various contexts (Aragie et al., 2022; Pauw and Thurlow, 2015; Benfica et al., 2019). The previous version of the investment module was elaborated by Aragie et al. (2024). The updated framework separates agrifood system investments in layers depending on whether they are at the knowledge generation stage (upstream: e.g., R&D) or innovation dissemination stage (midstream, e.g., seed system), or at the farmgate level (downstream: e.g., seed application at the farmer level). In this study, the investment module tracks 18 individual interventions, with many targeting up to six distinct groups of agricultural sectors.

The investment module structures agrifood investments and processes data on the costs and impacts of interventions across targeted sectors. Specifically, it integrates investment details—such as spending levels, unit costs, changes in adoption rates, and impact coefficients (or marginal effects)—as inputs and generates corresponding productivity gains as outputs. Whereas unit costs measure costs per area of farmland or head of animal, adoption rates refer to the extent to which new technology is implemented, expressed as a percentage of the target area or number of animals. The productivity gains are then transmitted to the economywide model, which endogenously adjusts the targeted sectors' productivity levels. Through direct and indirect economywide linkages, these adjustments drive changes in income, prices, employment levels, and other key economic indicators.

Unit costs are usually obtained from literature and are retrieved from project planning (such as irrigation master plans) or evaluation documents. Baseline adoption rates and coverage levels are obtained from various sources, including TIAPD (2016). Likewise, impact coefficients—which measure the change in productivity resulting from the adoption of a specific technology or practice—can be estimated using these types of surveys or sourced from existing literature. Alternatively, crop models, which simulate how crops interact with their environment and respond to various factors, can provide usable impact estimates for many crops and interventions. Given these fundamental features of sector-investment combinations, the final productivity gains for each sector will be determined by the level of spending on each intervention. In this brief, an equal amount of hypothetical spending for each intervention area is considered for cost-benefit comparison. An actual budget allocation pattern can also be evaluated using spending data from ministries of agriculture or ministries of finance.

The household survey module

While major economic indicators – changes in economic growth and job creation – are directly calculated from the core economywide model, assessing changes in social and environmental indicators necessitates specialized modules. To this end, the CGE model is linked top-down with household survey-based microsimulation modules measuring changes in poverty, the prevalence of undernourishment, and diet deprivation. Real income changes for different household groups result in diverse effects on these social outcomes.

Changes in poverty are calculated by linking a poverty microsimulation module to the outcome variables of the CGE model—namely, household income, prices, and consumption—following the methodology of Arndt et al. (2012). The changes in real consumption across commodities, observed for the fifteen representative household groups in the RIAPA model, are mapped to the corresponding individual households in the 2015/16 KIHBS (KNBS, 2017). The new poverty status is computed for all sampled households. Likewise, the undernourishment model uses the same set of households and measures the change in the share of the population below a certain minimum dietary energy requirement per capita per day.

The process for estimating changes in diet deprivation is similar to that for poverty in that survey households are linked to their respective representative household groups in the CGE model. In this instance, however, modeled changes in real food consumption across six food groups are used to compute changes in the Reference Diet Deprivation (ReDD) Index (Pauw et al., 2023), which serves as a multidimensional indicator of a household's diet quality. The ReDD Index, which is a deprivation gap measure, quantifies shortfalls in consumption relative to a recommended consumption threshold. A decline in the deprivation gap indicates improvement in overall diet deprivation.

The environment module

The environment module uses information on water, emission, and land intensities of sectors to calculate changes in total water, emission, and land footprints of the economy. These footprints change as the structure or size of the economy changes over time. For instance, the expansion of a water-intensive sector, such as rice, can potentially increase the total water footprint of the cereal sector. However, this shift may also result in resource reallocation—such as the increased availability of cheaper animal feed—which could, in turn, accelerate growth in more emission-intensive sectors like livestock.

The data used to calibrate the environment module come from various sources. Whereas the water footprint data for agricultural sectors come from the Water Footprint Network (Mekonnen and Hoekstra, 2010), this source only reports aggregate water footprints for industrial sectors and municipal water withdrawals. In the absence of sector-specific data, we assume water use is distributed across non-agricultural sectors in proportion to their sectoral output shares. Given our focus on agri-food system investments, this assumption, while crude, has little bearing on our results.

Sectors also differ in terms of their emissions intensities. We use total emission data (in tons of CO_2 equivalent) obtained from FAO (2025) and Climate Watch (2025). FAO (2025) reports total emissions generated in the rice sector, other cereals, and livestock sub-sectors, including milk and meat production. We complement this with global-level estimates of emission per kilogram (CO_2 equivalent) for a comprehensive list of commodities compiled by Poor and Nemecek (2018). Climate Watch (2025) reports emissions generated by major manufacturing and service sectors. The resulting emission coefficients for all sectors included in the Kenya SAM are then scaled using the corresponding sector's output to match total emissions in agriculture, industry, and services.

The land footprint calculation uses the FAO (2025) cropland allocation estimates to calibrate the Kenya CGE model. Kenya had over 5.4 million hectares of land under crop cultivation in 2022, the model base year. In addition to this, we incorporate land use for livestock grazing into the land footprint calculation. FAO (2025) reports over 21.3 million hectares of grazing land in Kenya in 2022. Our modeling analysis assumes total agricultural land expands by one percent per annum. Land use by sector may, however, adjust in line with relative changes in land productivity and output.

Scenario design

This study assesses the impact of twenty different investment areas. We assume a marginal increase of $25 million in spending per year from 2025-2030 for each investment area. The relative effectiveness of each intervention is assessed based on its effect in driving different development outcomes by 2045. To bring future returns to their current equivalent for comparability reasons, we discount the future impacts using a discount rate of 4 percent. Investments are grouped into five broad types of interventions: (i) research and development (or R&D), (ii) extension and advisory services, (iii) markets and food systems, (iv) risk reduction and resilience, and (v) infrastructure. Annex Table 1 includes a detailed list of interventions considered. In short, the interventions include the following:

- R&D investments contribute to the development of improved seed varieties, productive agronomic practices, animal breeds, and animal husbandry.
- Extension and advisory services promote the adoption of improved seeds, agronomic practices, livestock inputs (e.g., feed and vaccines), climate information systems, and climate-smart agricultural practices.
- Markets and food system investments are designed to strengthen seed systems, enhance the productivity of small and medium enterprise (SME) processors and traders through access to finance and training, reduce food loss and waste, improve access to credit, or direct provision of strategic inputs such as improved seeds and fertilizer.
- Risk reduction and resilience interventions support better decision-making by agrifood system actors by developing improved climate forecasting and providing productive safety nets.
- Infrastructure investments raise overall value chain productivity through expanding irrigation schemes or feeder roads that connect farmers to input and product markets.

Calibration of the investment module requires a range of data inputs for each of the eighteen investment areas. These include adoption rates (or coverage rates), which specify the number of farmers that use a specific technology or service or the area of land on which technology is applied, as well as yield gains from utilizing those technologies or services. Baseline rates of technology adoption and service coverage rates were obtained from farm household surveys. Productivity impacts of the respective interventions across the targeted sectors are derived from impact evaluation documents and crop and livestock models. IFPRI's crop model (IFPRI, 2024) is used to estimate yield gains from adopting different farm practices. For Kenya, the model reveals stronger cereal yield effects from irrigation infrastructure, followed by information on planting window and the adoption of improved seeds. These investment module parameters, alongside measures such as value-added and output prices, are important determinants of the returns on investments in different technologies or services.

Investment unit costs measure the financial cost of expanding input coverage (e.g., increasing irrigated land by one hectare). These are primarily sourced from impact evaluation studies, sector development plans, and existing literature. A key enhancement in this version of the investment module, compared to its most recent predecessor described in Aragie et al. (2024), is its ability to track the time lag between investment spending and its eventual impact (e.g., for rural roads or irrigation projects that take a number of years to become operational) as well as the duration of that impact (this accounts for depreciation or time-bound interventions). This distinction is crucial, as some investments yield one-time effects while others generate sustained benefits over multiple years.

The agrifood system in Kenya has historically been exposed to production shocks that can reduce the efficiency of technologies and practices. An alternative situation of a permanent decline in yield gain from a 1-in-25-year drought is also considered to test how the rankings of interventions change by 2045 when the system is faced with large climatic shocks.

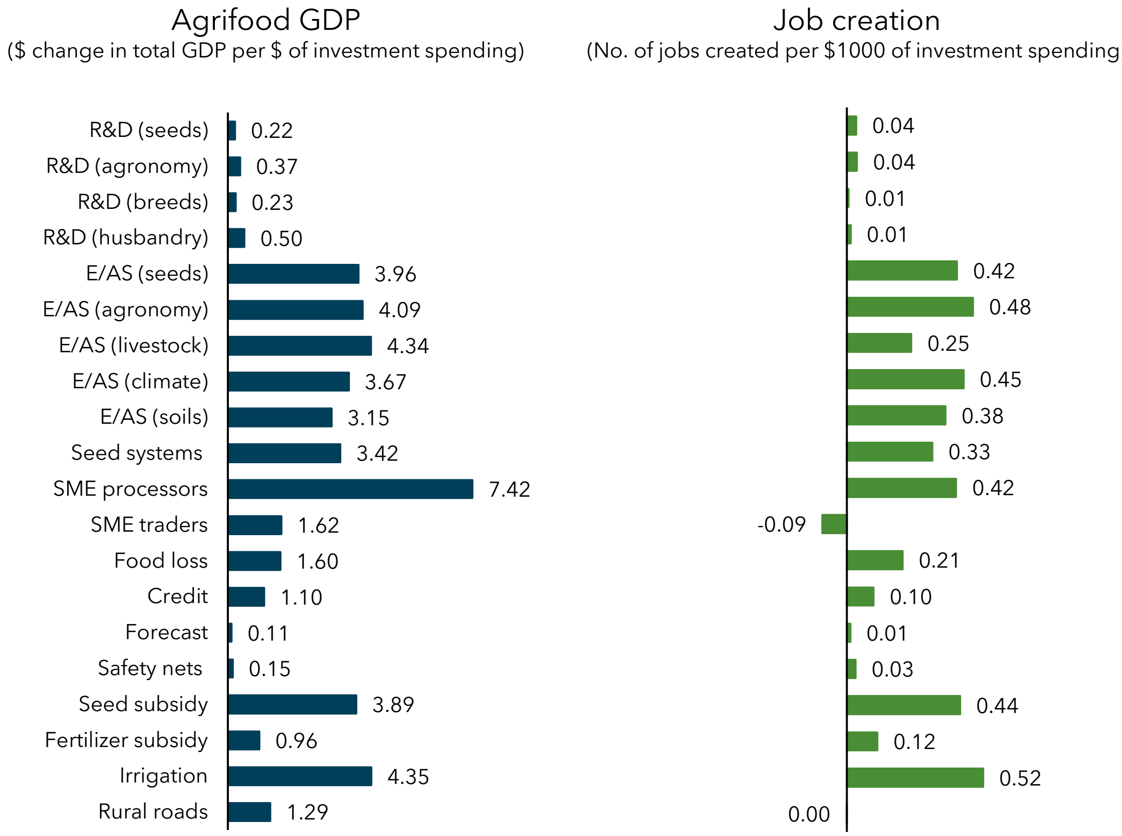
Cost-Effective Investment Options for Inclusive and Sustainable Transformation

Comparing the impacts of investments

We start our comparison of investments based on their impact on two standard economic outcomes: agrifood growth and job creation. These outcome indicators are directly obtained from the economywide model (see Figure 3). Results are reported in Figure 4. These reveal relatively stronger growth effects from investments in SME processors, irrigation, and livestock advisory services. Specifically, each additional dollar spent on SME processors generates an additional $7.42 in agrifood system GDP, compared to around $4.35 for irrigation (Figure 4). Spending on a range of interventions, including advisory services in livestock, agronomy, seeds, and seed subsidy, also yield economywide benefits more than double the cost, suggesting how efficient these investments can be in transforming the agrifood system in Kenya. Most cost-effective investments appear to be targeting sectors with greater contribution to the country's economy.

Job creation remains an important development challenge for most developing countries, including Kenya, especially given the continued rapid increase in the working-age population. Notably, the model results indicate that investments in irrigation and in extension services related to agronomy and climate are the most effective, generating approximately 0.5 additional jobs per $1,000 invested. This effect arises from their strong backward and forward linkages across the economy, despite their overall weaker impact. Extension and advisory services in seeds, support to SME processors, and seed subsidy also emerge as priority areas of investment for job creation. Improved seed systems and advisory services on seed are among the top half on their employment effects.

Figure 4: Comparison of investments based on their cost-effectiveness on economic outcomes

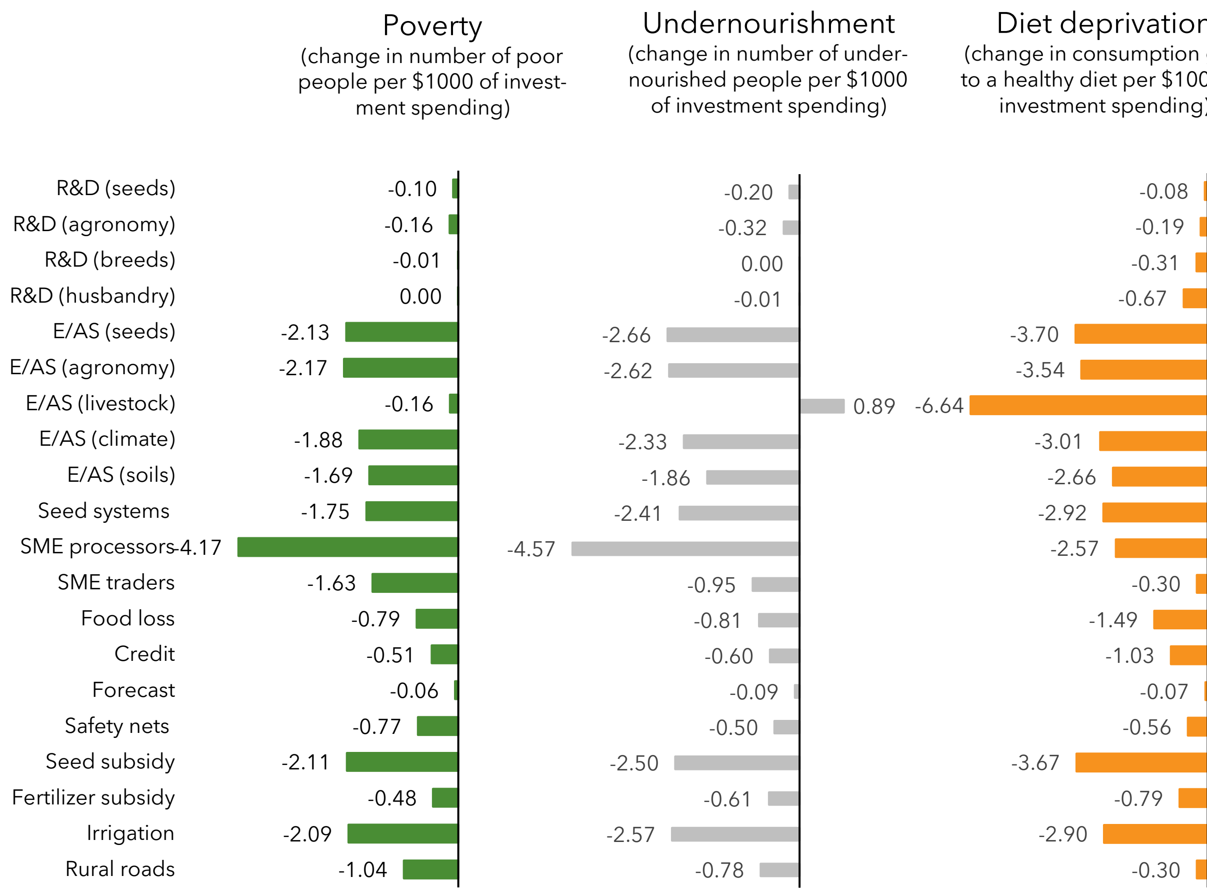


Source: RIAPA modeling system

The three social indicators considered in this study are the poverty headcount, prevalence of undernourishment, and quality of household diets. These are obtained from the various household survey-based microsimulation models incorporated into the RIAPA framework. Results show that investment areas differ in terms of their effectiveness in driving these outcomes (Figure 5). Investing in SME processors and advisory services on agronomy stand at the top in their effects on poverty and undernourishment, partly explained by their strong GDP effects and underlining the role of sectors linked to these investments on the livelihoods of the lower income-quintile households. In addition, investments in extension and advisory services on seeds, support for irrigation development, and seed subsidies are among the top-performing spending options with the strongest impact on poverty reduction.

Regarding effects on undernourishment, advisory services in seeds and climate, and irrigation remain among the most cost-effective interventions, driving significant reductions. Access to seed subsidy and improved seed systems are also impactful. Similar to the poverty and undernourishment outcomes, where certain agrifood system interventions demonstrate strong benefit–cost ratios, several interventions also stand out as the most cost-effective in enhancing diet diversity. Support to extension services in livestock, seeds and agronomy, and climate, and investments in improved seed systems and seed subsidies all have strong impacts on reducing diet deprivation by enhancing productivity and improving access to food products—particularly fruits and vegetables, which are often lacking in household diets.

Figure 5: Comparison of investments based on their cost-effectiveness on social outcomes



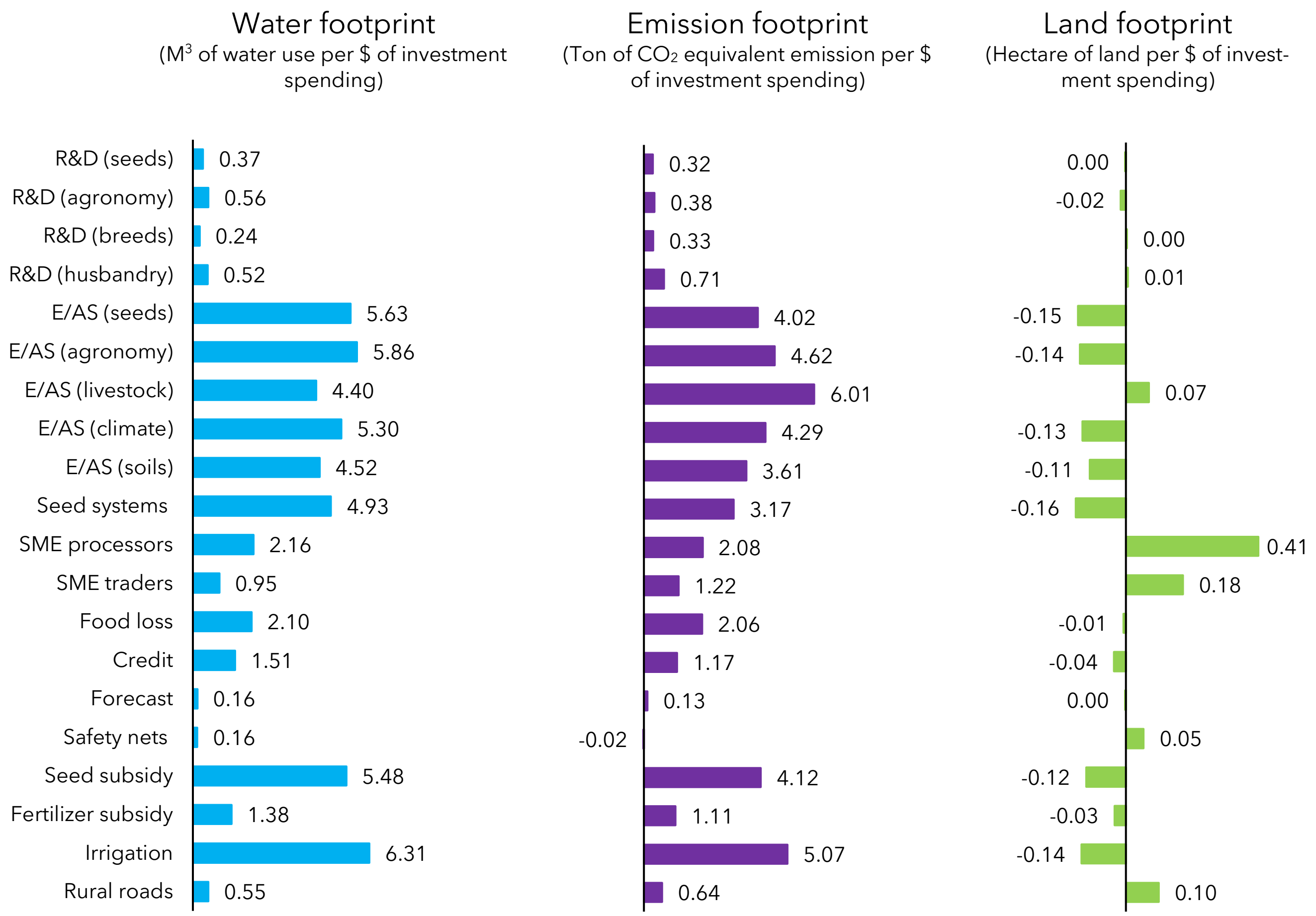
Source: RIAPA modeling system

We also evaluated the various investments based on their resource use or environmental impacts, looking specifically at economywide changes in water use, emissions, and land footprints. The changes in environmental footprints associated with investments will depend on the initial re-source intensity of sectors the interventions target, changes in sectoral activity as a result of the interventions, and any indirect adjustments in the economy outside the targeted sector due to economywide linkage effects and changes in resource reallocation. The basic principle here is that increases in environmental footprint per dollar of spending are undesirable.

Results from the environment module show investments in extension and advisory services for livestock producers and agronomy, irrigation, and SME processors consistently rank among the highest across the three environmental indicators, underscoring the resource intensity of sectors that show significant expansion due to these interventions (Figure 6). Investment in advisory services for livestock is by far the leading cause of emissions per dollar spent in Kenya, followed by irrigation. Livestock and irrigation have strong emission effects since these interventions specifically promote the production of sectors with higher emission footprints in addition to their stronger overall production effects. Figure 6 also highlights a stronger economywide water-use impact resulting from investments in irrigation and extension services related to agronomy, seeds, and livestock. Market-oriented interventions, such as seed subsidies and improved seed systems, likewise exhibit larger water footprint effects.

Land footprint can show movements in both directions depending on the change in economywide demand for land due to these investments. In the case of Kenya, land footprint increases strongly (i.e., more land put under cultivation) when investments in SME processors and traders are considered. These increases in land footprints are likely due to additional opportunities for land-intensive sectors to grow as economic opportunity changes. Increases in land footprint are also observed with investments in rural roads and livestock extension and advisory services. By contrast, improved seed systems, credit access, advisory services focused on agronomy are associated with land-saving effects.

Figure 6: Comparison of investments based on their cost-effectiveness on environmental footprint



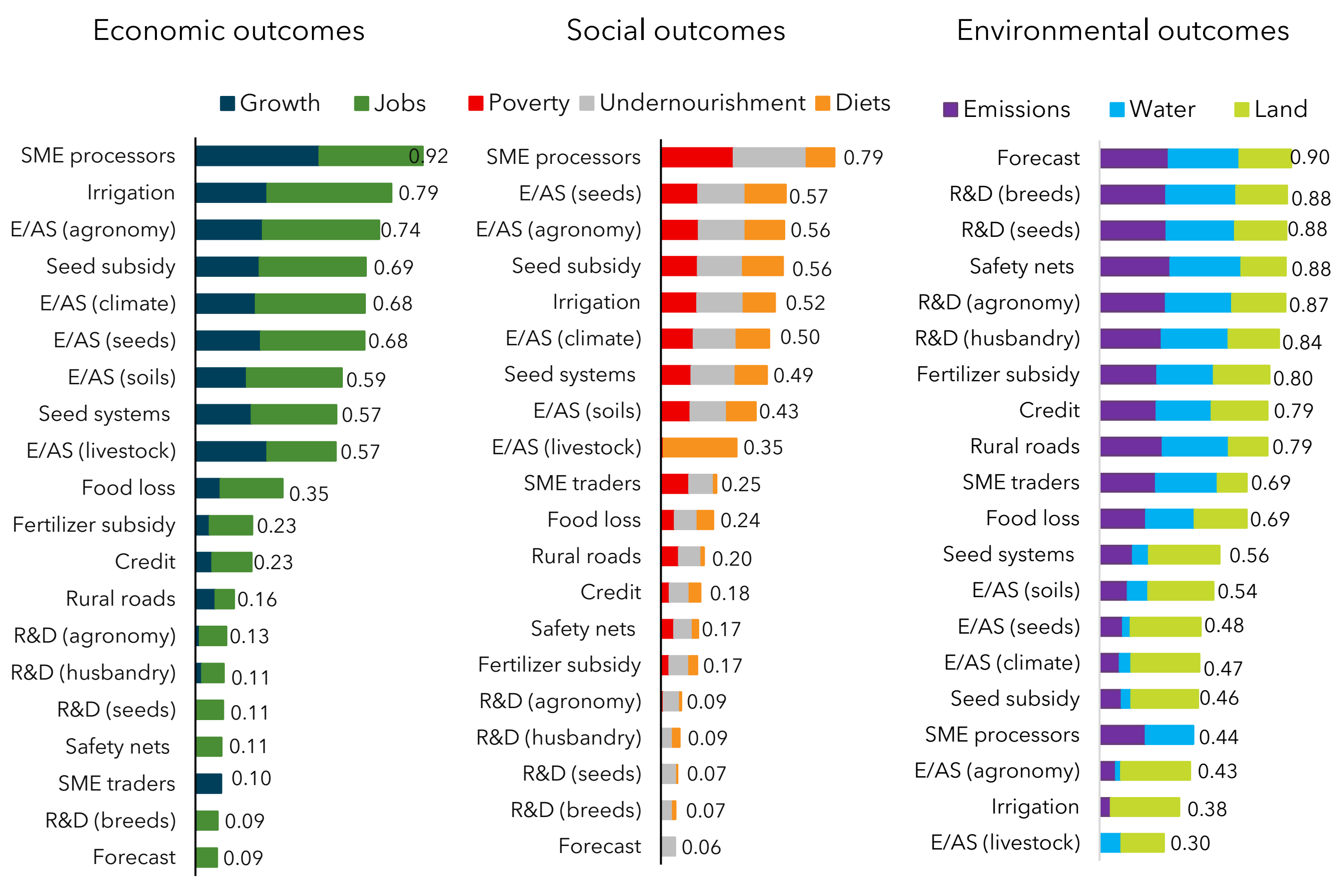
Source: RIAPA modeling system

Composite score of investments by their impact on selected outcome indicators

As presented in the preceding section, investments were ranked by their impacts on a long list of outcomes, grouped into economic, social, and environmental dimensions. We noted from the results that no single intervention was ranked top across all outcomes and that we witnessed potential tradeoffs across these indicators. In this section, we construct composite scores of the interventions by their impact on each group of outcomes. This is done in steps. First, we normalize the intervention scores for each outcome, attaching a value of 1 to the most cost-effective and 0 to the least cost-effective. Second, we then attach equal weights to each outcome in a group. Third, we sum up the weighted scores of the outcomes for each intervention to use it for ranking the interventions based on their overall impact. For example, when creating the composite score for the interventions based on their overall economic outcome, an equal weight – 50 percent each – is attached to growth and job creation, assuming equal preference by policymakers for these outcomes. Finally, for each intervention, we sum the weighted scores for growth and job creation to produce an overall score, which is then used to rank all interventions.

Figure 7 ranks investing in SME processors as the most cost-effective option for jointly expanding agrifood system GDP and employment, with the agrifood growth indicator contributing to most of the change in this combined indicator for economic outcomes. Investing in irrigation and agronomy extension/advisory services are also cost-effective investments—market- and farmer-facing, respectively—both driven by faster growth in agrifood system employment. Amongst R&D investments, agronomy and animal husbandry appear more cost-effective regarding their impact on economic outcomes than improved seeds and animal breeding. Investing in seed systems, seed subsidy, and post-harvest loss reduction are among the more cost-effective market and infrastructural investments.

Figure 7: Composite scores on economic, social, and environmental outcomes by investment area



Source: RIAPA modeling system

Figure 7 further reports composite scores of interventions based on their overall impacts on social outcomes, summarizing their effects on poverty headcount, prevalence of undernourishment, and diet deprivation. The overall impact is constructed by summing together each indicator's normalized score assuming equal weights. The top investment options for economic outcomes also rank at the top in the social outcome scores, albeit in a different order. Specifically, investments in SME processors rank as the most cost-effective option for achieving greater progress in all social outcomes combined. At the same time, extension services on seeds and agronomy, seed subsidy, and irrigation also rank highly, mainly driven by their impact on undernourishment. Extending advisory services on climate and soils, and improved seed systems are also crucial in achieving better social outcomes.

The last panel in Figure 7 reports the composite score of the interventions based on their overall effects on the three environmental indicators, namely water, emission, and land footprint, each receiving equal weight. Interventions with greater GDP effects tend to have undesirable environmental outcomes, demonstrating tradeoffs. Livestock-related investments such as farmer-facing extension services appear most resource-intensive, mainly due to their higher emission and water use per output. Infrastructural investments such as irrigation and market and food system investments such as spending on SME processors and seed subsidy are among the most resource-demanding spending options. By contrast, most upstream R&D interventions—such as those targeting seeds and breeds—as well as climate forecast, and safety nets, exhibit the smallest environmental footprint, primarily due to their limited overall impact on the economy (see Figure 4 above).

Traditionally, policymakers' base policy decisions primarily on economic and social dimensions. To create a composite ranking of the investments, these two dimensions are combined attaching 50 percent weight to each and reported in Figure 8. This clearly illustrates the synergies and tradeoffs across investments as far as these two broader outcomes are concerned. The composite score puts supporting SME processers, investing in irrigation and extension and advisory services on agronomy as well as similar services on improved seeds at the top. All of these top-ranking interventions, based on their composite economic and social scores, are more cost-effective in generating improved economic outcomes. Systemic interventions—such as extending access to seed subsidies and improving seed systems—are also among the most cost-effective strategies for generating broad gains across the agrifood system.

These two dimensions – economic and social – remain important and may still dominate decision-making in many countries. However, a broader agrifood systems approach requires policymakers also to consider the environmental footprint of their policy or investment choices. Figure 8 also reports a comparison of investments' environmental outcomes against their economic and social outcome scores. Interventions with red markers have a high environmental footprint, those with orange markers have a medium-level environmental footprint, and those in green have a lower footprint. This grouping of interventions by their environmental impact is determined by first calculating their Z-scores and then identifying those with the highest and lowest impacts as outliers from the data using a specified standard deviation threshold.

We find that interventions with greater economic and social outcomes tend to be the most resource-consuming, implying some tradeoffs. For instance, advisory in livestock and agronomy and support to SME processors have the strongest impacts on the economic and social outcome indicators, while at the same time causing higher environmental footprints. Meanwhile, most upstream interventions such as R&D in breeds and seeds, and systemic investments such as climate forecast and safety nets rank as the least cost-effective although they generate the least environmental footprint principally because of overall weaker impacts on production. This tradeoff between economic and social impacts, on one hand, and environmental impact, on the other, highlights the need to improve the resource-use efficiency of interventions that yield strong economic and social benefits.

Figure 8: Composite scores on economic and social outcomes by investment area

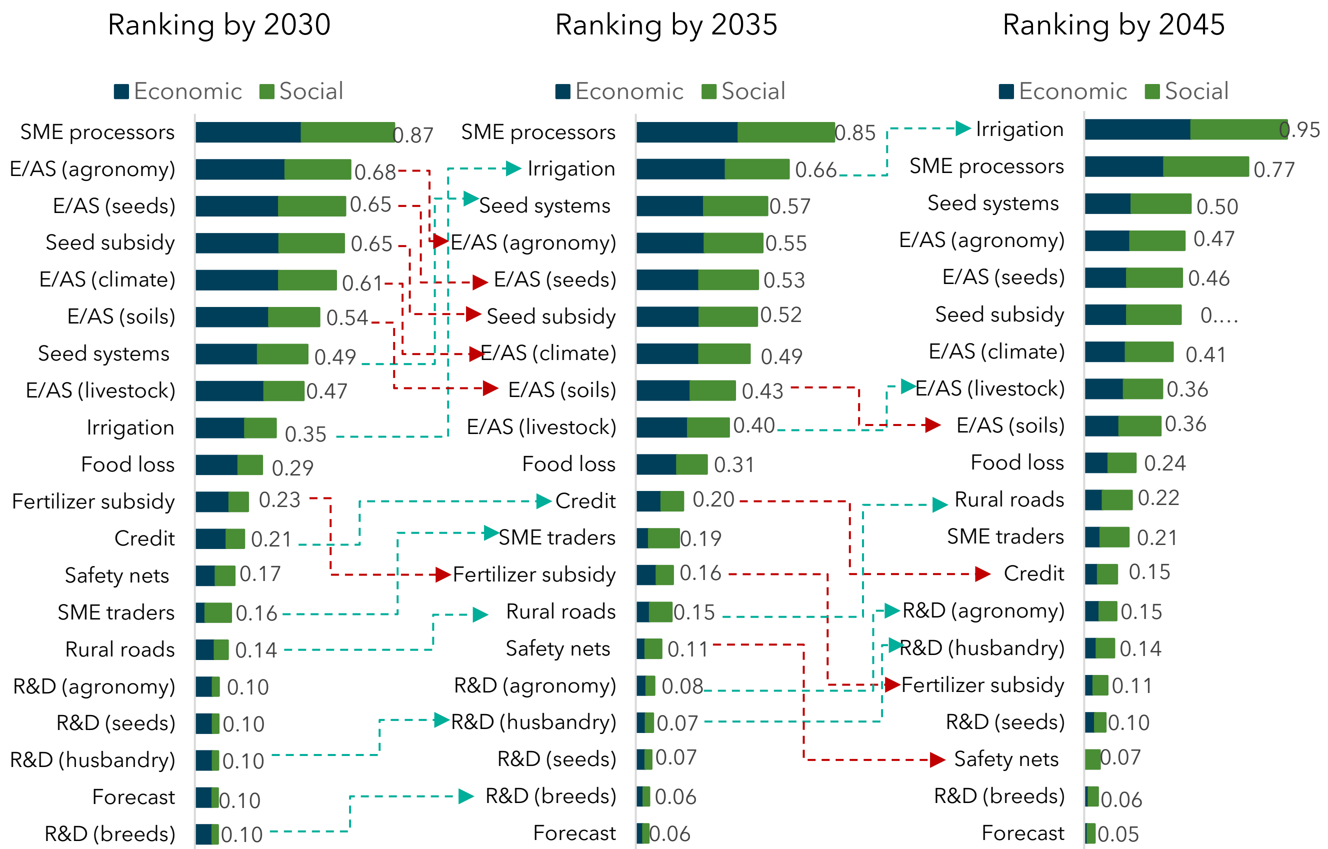
Source: RIAPA modeling system

Do the rankings change over time?

The previous section compares the impact of the 2025-2030 investments at the end of the simulation period, i.e., 2045. Given differences in the lag time between when a particular investment is made and when it starts having an impact on economic and social outcomes, it is of interest to consider whether investment priorities change depending on the time horizon of the policymaker. Notably, most politicians or line ministries in governments may have a shorter time horizon (i.e., matching the typical 4-5 years of the political cycle). In contrast, national planners may have much longer planning horizons (often several decades). The modeling framework adopted in this study accounts for these time delays between when an investment is made and when its effect materializes. This section assesses the magnitude of changes in composite scores by investment area over time. We specifically compared the rankings by 2030, 2035, and 2045 (Figure 9).

Model results indicate that R&D-related investments in animal husbandry, agronomy, and breeding become increasingly more cost-effective over time as their lagged but long-term impacts materialize. Likewise, investments in irrigation and road infrastructures achieve significant improvements in relative cost-effectiveness over time as impacts accumulate. Meanwhile, farmer-facing and recurrent investments—such as extension and advisory services on agronomy, soils, and seeds—gradually lose relative effectiveness as long-term, high-impact investments take over their role in driving economic and social outcomes.

Figure 9: Changes in rankings over time



Source: RIAPA modeling system

Stress-testing of investments

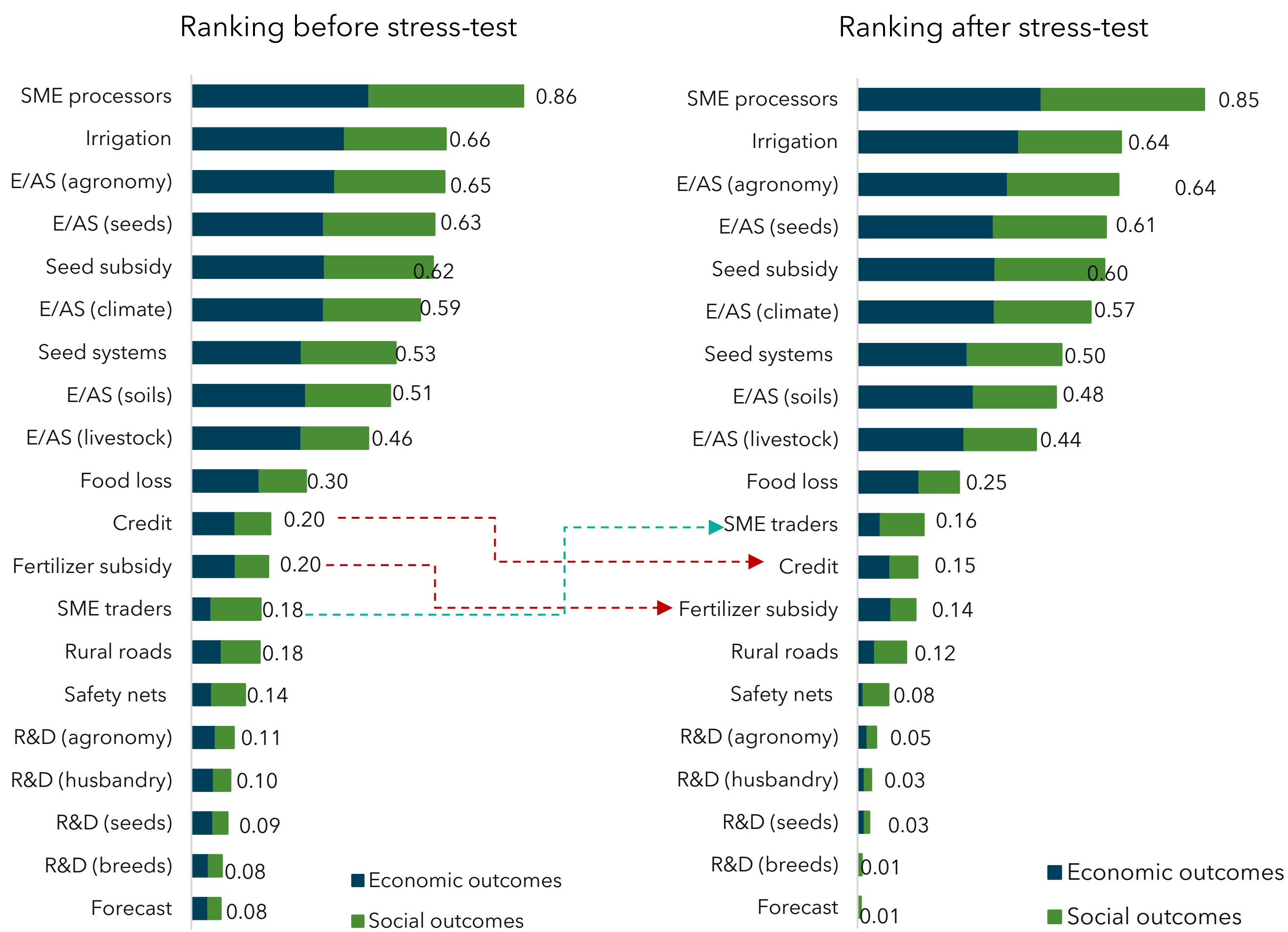
This section reports on how investment rankings might change when a 1-in-25-year drought shock slashes the yield gains throughout the simulation period (2025-2045).[1] Of course, climatic shocks are unanticipated events, and so these simulations should not necessarily influence policymakers' decisions, but they do shed light on the robustness of the ranking results. The Kenya case demonstrates minor changes in rankings (Figure 10). The top cost-effective investments—such as support to SMEs,

[1] A drought shock causes a temporary but significant drop in yield, which can reduce productivity over an extended period if it becomes frequent, by affecting resource quality. However, we proxy the yield effect of the drought shock through a shift in yield gain throughout the simulation period since it is difficult to determine the year when the shock may occur. We noted that the timing of the weather shock affects the relative effectiveness of the investments. Since the permanent yield effect is considered for each investment option, the results generated from this analysis remain insightful.

irrigation, advisory services on agronomy and seeds, and increased access to seed subsidy—retain their high benefit-cost rankings even after accounting for the production risks previously discussed. This is because targeted sectors like livestock have historically shown the least yield variability in response to climate change or have only been indirectly and minimally affected by on-farm production losses (see Figure 2).

Meanwhile, we observe a slight change in the rankings of the bottom half of the interventions. Particularly, the relative cost-effectiveness of micro credit to farmers and fertilizer subsidy declines moderately due to a disproportional effect of the simulated 1-in-25-year production shock on targeted sectors. By contrast, support to SME traders shows improvements in cost-effectiveness, demonstrating a strong improvement in relative impact by diversifying the economy and facilitating trade when extreme shocks are likely.

Figure 10: Rankings of interventions after stress-testing



Source: RIAPA modeling system

Unpacking priorities by sub-sector

In the previous sub-sections, we present the cost-benefit rankings of interventions that also target various sub-sectors. For example, food loss reduction measures can focus on cereals, cash crops, or root crops. In this section, we consider a dual approach and provide a much deeper analysis of the ranking of interventions based on the sectors they target. The investment-sector combinations are compared using their normalized composite scores using their effects on economic and social indicators (Table 1).

The blue-shaded cells in Table 1 identify value chains or sectors where the impacts of a given intervention exceed the overall average impact score of the cross-cutting investment. For instance, the composite score for R&D in agronomy is relatively low – at 0.04 – when the intervention's impact is evaluated across all targeted sectors. However, its impact is slightly above the average for cash crops, at 0.05. Meanwhile, the green-shaded cells denote sector–investment combinations ranked among the top five in terms of potential impact. These indicate priority areas where targeted investment could substantially enhance the overall performance of the cross-cutting intervention. As such, although R&D in agronomy for cash crops shows above-average impact relative to the cross-sector score, it does not fall within the top five crop-specific intervention areas. Conversely, extension and advisory services in improved seeds related to cash crops not only exceed the average impact score of such services in improved seeds but also are among the top five investment priorities for greater agrifood system performance. Furthermore, Table 1 suggests that concentrating extension services in agronomic practices and climate-smart agriculture, on the one hand, and irrigation infrastructure coverage, on the other, for cash crops would significantly enhance the overall effectiveness of investments in the agrifood system. Support to SME processors, seed system, and advisory services to climate information also remain the top cross-cutting (non-crop-specific) interventions in terms of their impact on social and economic outcomes.

Table 1: Composite scores by investment area and crop sector

			Cross-cutting	Cereals	Root crops	Pulses and oilseeds	Horti-culture	Other cash crops
R&D	1	R&D (improved seeds)	0.04	0.04	0.03	0.03	0.03	0.05
	2	R&D (agronomy)	0.04	0.04	0.03	0.03	0.04	0.05
	3	R&D (animal breeds)	0.03					
	4	R&D (animal husbandry)	0.04					
Extension / advisory services	5	E/AS (improved seeds)	0.17	0.10	0.08	0.15	0.25	0.72
	6	E/AS (agronomic practices)	0.17	0.11	0.09	0.10	0.28	0.83
	7	E/AS (livestock)	0.13					
	8	E/AS (climate information)	**0.15**					
	9	E/AS (climate smart agriculture)	0.14	0.09	0.08	0.07	0.23	0.67
Markets and food systems	10	Seed systems	**0.15**					
	11	SME processors (finance, training)	**0.24**					
	12	SME traders (finance, training)	0.07					
	13	Food loss and waste	0.08	0.05	0.06	0.06	0.14	0.40
	14	Credit access (financial inclusion)	0.06					
	15	Seed subsidy (direct input provision)	0.17	0.09	0.08	0.15	0.25	0.74
	16	Fertilizer subsidy (direct provision)	0.06	0.05	0.04	0.04	0.09	0.23
Risk reduction and resilience	17	Seasonal forecast (early warning)	0.03					
	18	Productive safety nets	0.05					
Infrastructure	19	Irrigation infrastructure	0.17	0.11	0.10	0.05	0.28	0.92
	20	Rural roads	0.06					

Source: RIAPA modeling system

Summary

Kenya's agrifood system is an important source of livelihood for households, an engine of economic growth, and a key sector of employment, particularly in rural areas. Despite encouraging progress, Kenya has an urgent need to transform its agrifood system sustainably. This requires increased levels of technical and financial support to agriculture and allied sectors. Policymakers can benefit greatly from data- and model-driven insights on the impacts of agrifood system investments on economic, social, and environmental outcomes, including for different planning horizons and under conditions of uncertainty and risk. In this country brief, we report results from a systematic evaluation of a range of agrifood system investment options. We rank investment choices based on their cost-effectiveness in delivering multiple development outcomes, including agrifood GDP growth, agrifood job creation, poverty reduction, undernourishment reduction, and improvements in diet deprivation. We also considered the environmental implications of these investments, focusing on water, emissions, and land footprints.

Model results indicate that investments in SME processors, extension and advisory services in seeds and agronomy, and seed subsidy are the most cost-effective means of improving social outcomes, such as reducing poverty and undernourishment. These investments also rank highly in terms of expanding agrifood GDP and employment. Extension and advisory services in climate and livestock are similarly high-impact, farmer-facing interventions. Additionally, the study identifies investments in markets and food systems—particularly those targeting seed systems, food loss reduction, and micro credit to farmers—as cost-effective strategies for promoting inclusive agrifood transformation. However, many investments that are cost-effective have relatively high environmental footprints, highlighting the tradeoffs between development outcomes and the environment. The analysis reveals only slight changes in the ranking of agrifood system investments under climatic shocks, which suggests the ranking is robust.

Several general policy messages can be drawn from this analysis. Firstly, not only have we demonstrated that integrating data- and model-driven insights into policy and investment prioritization decisions is feasible, but it is also important to do so given synergies and tradeoffs across these investments on development outcomes. Secondly, considering the environmental implications of policy and investment decisions is critical to ensure that the adverse effects of climate change or environmental degradation do not fall disproportionately on future generations of poor people. Our analysis highlights the importance of designing appropriate climate adaptation and mitigation policies to help increase the productivity and resource use efficiency of sectors identified as drivers of socioeconomic progress.

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References

Aragie, E., Benfica, R., Pauw, K., Randriamamonjy, J. and Thurlow, J. 2024. Assessing Investment Priorities for Driving Inclusive Agricultural Transformation: An Application to Tanzania. *Development Policy Review*, 42(6): e12812.

Aragie, E., M. Artavia, K. Pauw. 2019. "Strategic public spending: Scenarios and lessons for Ghana." IFPRI Discussion Paper 1852. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.133332

Arndt, C., M. Hussain, E. Jones, V. Nhate, F. Tarp, and J. Thurlow. 2012. Explaining the evolution of poverty: The case of Mozambique. *American Journal of Agricultural Economics*, 9 (94): 854-872.

Balakrishnan, AK., Otieno, S., Dzombo, M., Plaxico, L., Ukoh, E., Obara, LM., Brown, H., Musyimi, C., Lincoln, C., Yang, L.S., Witte, S.S., Winter, S.C. 2024. Socio-ecological impacts of extreme weather events in two informal settlements in Nairobi, Kenya. *Front Public Health,* 3;12:1389054. doi: 10.3389/fpubh.2024.1389054.

Benfica, R., Cunguara, B. and Thurlow, J. 2019. Linking agricultural investments to growth and poverty: An economywide approach applied to Mozambique. *Agricultural Systems*, 172, 91–100.

Climate Watch. 2025. Historical GHG Emissions. https://www.climatewatchdata.org/ghg-emissions?end_year=2021&start_year=1990

Christiaensen, L., and W. Martin. 2018. Agriculture, structural transformation and poverty reduction: Eight new insights. *World Development*, 109: 413-416.

Diao, X., Pauw, K., Smart, J., Ellis, M. and Thurlow, J. 2023. Transformation of Kenya's agrifood system structure and drivers. Agrifood System Diagnostics Country Series 6. https://doi.org/10.2499/p15738coll2.136802.

FAO. 2025. FAOSTAT. Food and Agricultural Organization of the United Nations. https://www.fao.org/faostat/en/#data

GLOPAN (Global Panel on Agriculture and Food Systems for Nutrition) 2020. Future food systems: for people, our planet, and prosperity. London, UK. https://www.glopan.org/wp-content/uploads/2020/09/Foresight-2.0_Future-Food-Systems_For-people-our-planet-and-prosperity.pdf.

IFPRI (International Food Policy Research Institute). 2024. Global Spatially-Disaggregated Crop Production Statistics Data for 2020 Version 1.0.0. https://doi.org/10.7910/DVN/SWPENT. Harvard Dataverse. Version 3.

IFPRI (International Food Policy Research Institute). 2023. RIAPA Data and Modeling System. Washington, DC. https://www.ifpri.org/project/riapa-model

IFPRI (International Food Policy Research Institute). 2021. 2019 Social Accounting Matrix for Kenya. Washington, DC: IFPRI [dataset]. https://doi.org/10.7910/DVN/ALUXSI. Harvard Dataverse. Version 1.

Kabubo-Mariara, J. and Karanja, F.K. 2007. The economic impact of climate change on Kenyan crop agriculture: A Ricardian approach.

Global and Planetary Change, 57(3–4): 319-330. https://doi.org/10.1016/j.gloplacha.2007.01.002.

Kumar, N. and Maiti, D. 2024. Long-run macroeconomic impact of climate change on total factor productivity — Evidence from emerging economies. *Structural Change and Economic Dynamics*, 68: 204-223.

Marigi, S. 2017. Climate Change Vulnerability and Impacts Analysis in Kenya. *American Journal of Climate Change*, 6(1). https://doi.org/10.4236/ajcc.2017.61004.

Mekonnen, M.M. and Hoekstra, A.Y. (2010) The green, blue and grey water footprint of farm animals and animal products. Value of Water Research Report Series No. 48, UNESCO-IHE, Delft, the Netherlands. http://www.waterfootprint.org/Reports/Report47-WaterFootprintCrops-Vol1.pdf

NT (The National Treasury). 2017. The Kenya National Green Climate Fund (GCF) Strategy. Nairobi, Kenya: Government Press. https://files.acquia.undp.org/public/migration/ke/Kenya-GCF-Coordination-Strategy_Report.pdf

Pauw, K., O. Ecker, J. Thurlow, and A.R. Comstock. 2023. Measuring changes in diet deprivation: New indicators and methods. *Food Policy*, 117, Article #102471.

Pauw, K., J. Thurlow. 2015. Prioritizing Rural Investments in Africa: A Hybrid Evaluation Approach Applied to Uganda. *European Journal of Development Research,* 27(3): 407–424. https://doi.org/10.1057/ejdr.2015.24.

Pham, T. H., and J. Riedel. 2019. Impacts of the sectoral composition of growth on poverty reduction in Vietnam. *Journal of Economics and Development*, 21 (2): 213-222.

RoK (Republic of Kenya). 2025. Kenya's Second Nationally Determined Contribution (2031-2035). Nairobi, Kenya: Ministry of Environment Climate Change and Forestry. https://unfccc.int/sites/default/files/2025-05/KENYAS%20SECOND%20NATIONALLY%20DETERMINED%20CONTRIBUTION%202031_2035.pdf

Shah, UH., Lu, Y., Liu, J., Rehman, A. and Yasmeen, R. 2024. The impact of climate change and production technology heterogeneity on China's agricultural total factor productivity and production efficiency. *Science of The Total Environment*, 907: 168027.

TIAPD (Tegemeo Institute of Agricultural Policy and Development). 2016. Agricultural Information Sources and their effects on farm productivity in Kenya. https://tegemeo.egerton.ac.ke/images/_tegemeo_institute/downloads/publications/working_papers/wp62.pdf

Thurlow, J., J. Kiringai, M. Gautam. 2007. Rural Investments to Accelerate Growth and Poverty Reduction in Kenya. IFPRI Discussion Paper 00723 (October 2007). Washington DC: International Food Policy Research Institute. https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/40627/filename/40628.pdf.

World Bank. 2025. World Development Indicators. World Bank. https://databank.worldbank.org/source/world-development-indicators

KNBS. 2017. 2015/16 Kenya Integrated Household Budget Survey. Nairobi, Kenya: Kenya National Bureau of Statistics.

Annex Table 1: List of investment scenarios considered

Broad category	Number	Scenario	Description
Research and development (R&D)	1	R&D (improved seeds)	R&D into improved seed development
	2	R&D (agronomic practices)	R&D into improved agronomic practices
	3	R&D (animal breeds)	R&D into improving breeds
	4	R&D (animal husbandry)	R&D into improved husbandry practices
Extension / advisory services	5	E/AS (improved seeds)	Advising improved seed use
	6	E/AS (agronomic practices)	Advising improved agronomic practices
	7	E/AS (livestock)	Advising improved livestock handling
	8	E/AS (climate information)	Providing climate information system
	9	E/AS (climate smart agriculture)	Advising on climate smart practices
Markets and food systems	10	Seed systems	Extended seed system
	11	SME processors (finance + training)	Finance and training for SME processors
	12	SME traders (finance + training)	Finance and farming for SME traders
	13	Food loss and waste	Food storage and transport
	14	Credit access (financial inclusion)	Micro-credit access for farmers
	15	Seed subsidy (direct input provision)	Provision of improved inputs to farmers
	16	Fertilizer subsidy (direct input provision)	Provision of chemical fertilizer to farmers
Risk reduction and resilience	17	Seasonal forecast (early warning)	Seasonal weather forecast
	18	Safety nets	Productive safety nets for the poor
Infrastructure	19	Irrigation infrastructure	Small and medium scale irrigation
	20	Rural roads	Unpaved feeder roads

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