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Assessing the projected impacts of alternative PSTA5 spending trajectories on the Rwandan economy

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Abstract

Data-driven and evidence-based approaches are critical for shaping public policy, investment, and expenditure decisions, ensuring that development plans are effective and well-informed. The RIAPA model, utilized in this study, has played a key role in informing policy discussions, including the identification of national priorities and strategies, the mid-term assessment of the Rwanda's fourth Strategic Plan for Agriculture Transformation (PSTA 4), and the post-COVID-19 recovery and relief efforts. This policy note employs a Rwanda-specific RIAPA model integrated with an investment module to analyze the expected benefits from agricultural investments outlined in the Fifth Strategic Plan for Agriculture Transformation (PSTA 5) for 2025-2029. Results show that, compared to PSTA 4 spending trends, a moderate spending scenario under PSTA 5 could accelerate agricultural transformation and inclusive growth by 2.8 percentage points. A higher budget scenario, requiring an average annual expenditure of $610 million, is projected to reach an ambitious eight percent agricultural growth target. Faster agricultural growth would further stimulate the off-farm components of the agri-food system, reinforcing agriculture's role as an economic growth engine. By 2029, PSTA 5 could reduce poverty and undernourishment by 1.6 million people, contingent on managing potentially significant climatic and external economic risks.

***Key words**: Economic planning, public expenditure, agricultural transformation, economywide modeling, Rwanda*

1. Introduction

Public support for the agricultural sector has long been viewed as a key mechanism for overcoming constraints in rural development and accelerating agricultural growth (Xu and Findlay 2019, Havemann et al. 2020). However, the effectiveness of this support depends both on the level and how funding is allocated, as the composition of growth plays a crucial role in influencing poverty reduction, employment creation, and improvements in nutrition (Christiaensen and Martin 2018, Pham and Riedel 2019). Benefiting from favorable government policies, Rwanda experienced robust agricultural growth, averaging 5.1% annually between 2010 and 2019, before slowing during the post-COVID period (NISR 2024).

After a period of slow agricultural growth performance, Rwanda is looking towards rediscovering its rapid growth trajectory as the sector continues to play a central role in the structural transformation of the entire economy. To this end, the Government of Rwanda continues to invest in the agricultural sector by building on Strategic Plans for Agriculture Transformation (PSTA's) that began in the early 2000s (MINAGRI 2018). The challenge will be how to prioritize public expenditures across a broad portfolio of policies and programs. An earlier analysis (Aragie et al. 2022), under the mid-term PSTA 4 has assessed PSTA's budget allocation pattern and revealed that agricultural expenditures were, by and large, efficiently allocated in Rwanda. The study estimates that each US dollar of agricultural spending corresponds to a $2.05 gain in GDP during the 2018–2024 period.

As Rwanda seeks to revitalize its agriculture sector and drive rural transformation, the Ministry of Agriculture and Animal Resources (MINAGRI) is developing the PSTA 5 strategy for the 2024/25-2028/2029 period. PSTA 5 proposes an ambitious spending plan and sets outcome targets, including accelerating agricultural growth to approximately 8% (under the full funding scenario) with an average annual growth of over 6%, increasing agricultural export income, diversifying diets, and enhancing labor productivity. The critical question is whether the proposed spending levels will be sufficient to achieve these goals. To address this, it is essential to quantify the potential economic gains by exploring alternative and plausible spending scenarios.

To address this research question, the study employs the Rural Investment and Policy Analysis (RIAPA) economywide model, integrated with the Agricultural Investment Data Analyzer (AIDA) module. This RIAPA-AIDA framework is widely used to assess the economywide impacts of various public expenditure options (Aragie et al. 2024, Aragie et al. 2022, Benfica et al. 2019). It includes microsimulation modules that track changes in poverty and undernourishment at the household level, responding to shifts in growth linked to different agricultural spending trajectories. Through this comprehensive modeling approach, the study connects agricultural and rural development spending to key development outcome indicators.

The remainder of the paper is structured as follows. Section 2 outlines the modeling approach used to evaluate agricultural investments and their impacts, with a focus on the RIAPA-AIDA framework and its microsimulation modules, which assess changes in household poverty and undernourishment. Section 3 details the various PSTA 5 related spending scenarios analyzed in the study. Section 4 presents the results of the model simulations, while Section 5 discusses the findings in more detail. Lastly, Section 6 concludes with some key insights drawn from the analysis.

2. Method of Analysis

2.1. The core CGE model – RIAPA

Computable General Equilibrium (CGE) models are widely utilized for economic policy formulation and analysis (Dixon and Parmenter 1996, Devarajan and Robinson 2010). These models effectively capture the interlinkages between sectors, households, and rural-urban economies, making them well-suited for assessing the economywide effects of various public policies. They enable policymakers to understand the mechanisms and channels through which policy changes or external shocks impact economic flows, ultimately influencing levels of economic growth.

Evaluating the connections between economic growth, poverty, and undernourishment is crucial for both national policymakers and development partners. Understanding how these linkages affect multiple development outcomes is particularly important in the context of competing national development ambitions and limited public resources. Further, policymakers often question whether resources allocated can drive the intended impacts across various development parameters. This is especially vital in agricultural and rural development, where public expenditures historically serve as critical drivers of agricultural growth and rural transformation (Tijani et al. 2016, Benfica et al. 2019).

This study employs the RIAPA economywide model, which is calibrated to the 2021 Social Accounting Matrix (SAM) for Rwanda (IFPRI 2022). The model represents the economy through a set of disaggregated sectors, encompassing 30 agricultural sub-sectors, which include 22 individual crops or groups of crops, six livestock production sectors, as well as forestry and fisheries. Additionally, the model incorporates 36 industrial sectors and 12 service sectors, many of which are closely related to agriculture. This includes 20 agro-processing activities within the industrial sector, along with trade and transport activities in the service sector.

The Rwanda model also distinguishes 15 representative households, each of which is an aggregation of a group of households captured in the Fifth Integrated Household Living Conditions Survey (EICV5) (NISR 2018). These households are categorized by rural and urban income quintiles, with rural households further divided into farm and non-farm groups based on their reliance on agriculture as a primary source of income. 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.

2.2. The AIDA module

The investment analysis approach used in this study has been applied in various contexts (Pauw and Thurlow 2015, Benfica et al. 2019), including a previous analysis of Rwanda (Aragie et al. 2022) and is documented in detail in Raouf et al. (2018) and most recently in Aragie et al. (2024). By utilizing the AIDA module within the RIAPA model, productivity growth is calculated for each sector in the economy based on trends in spending on various interventions aimed at enhancing sectoral productivity. The AIDA module integrates spending and investment data obtained from multiple sources—such as household and farm surveys, as well as monitoring and evaluation studies—and assesses the productivity gains from agricultural and rural development interventions. These resulting productivity gains are then linked to the productivity parameters in the RIAPA model across different sectors.

The direct productivity effect from an expenditure package is determined by the investment outcome, which refers to the additional coverage achieved through public investment in a specific technology, service, or infrastructure facility. An example might be an expansion of irrigated farmland that is accomplished with public funding. The investment outcome is determined by the current level of public investment spending and the unit cost per area of farmland.

Impact coefficients, or elasticities, play a crucial role in determining the direct productivity gains from various agricultural investments. These elasticities are evaluated for each type of expenditure, such as the provision of fertilizer, improved seeds, irrigation, or feeder roads. By factoring in the additional coverage achieved through new investments, productivity gains are allocated across different sectors. The combined sector-level productivity improvements are then incorporated into the RIAPA model's productivity parameters, which facilitates the estimation of the overall economic impacts of these investments. This modeling framework allows for a comprehensive assessment of the gains from different interventions and spending options at both the sectoral and economywide levels, providing valuable insights for policy and investment decisions.

2.3. Poverty and undernourishment modules

Whereas measures of changes in economic growth and employment are directly embedded within the core RIAPA–AIDA framework, deriving changes in poverty and undernourishment requires microlevel household data. The RIAPA–AIDA model system thus integrates two household-level microsimulation modules, one for measuring changes in levels of poverty and the other for assessing changes in levels of undernourishment.

Changes in poverty levels result from changes in economic performance, which are driven by different public expenditure choices. Information on changes in poverty levels is obtained by linking a microsimulation module to the CGE model outcome variables; these variables include changes in household income, prices, and consumption, and are designed based on earlier methodologies of Arndt et al. (2012). Changes in real consumption across commodities and services in the RIAPA model are passed down to 15 representative household types that are drawn from nationally representative household surveys. Information on these changes is then used to calculate the new poverty status across all sampled households. EICV5, for example, surveyed over 14,580 Rwandan households that were representative of the country's rural and urban populations which, at the time, were 9.2 million and 2.6 million, respectively. EICV5 also provides information on a wide range of social, demographic, and economic variables, including poverty, inequality, employment, living conditions, education, health, housing conditions, and household consumption.

Similarly, change in undernourishment is calculated by linking key variables from the CGE model with individual households surveyed in EICV5. A person is deemed undernourished when they consume fewer calories than what is required for a healthy life (FAO 2022). Changes in food prices and household incomes derive these new undernourishment outcomes.

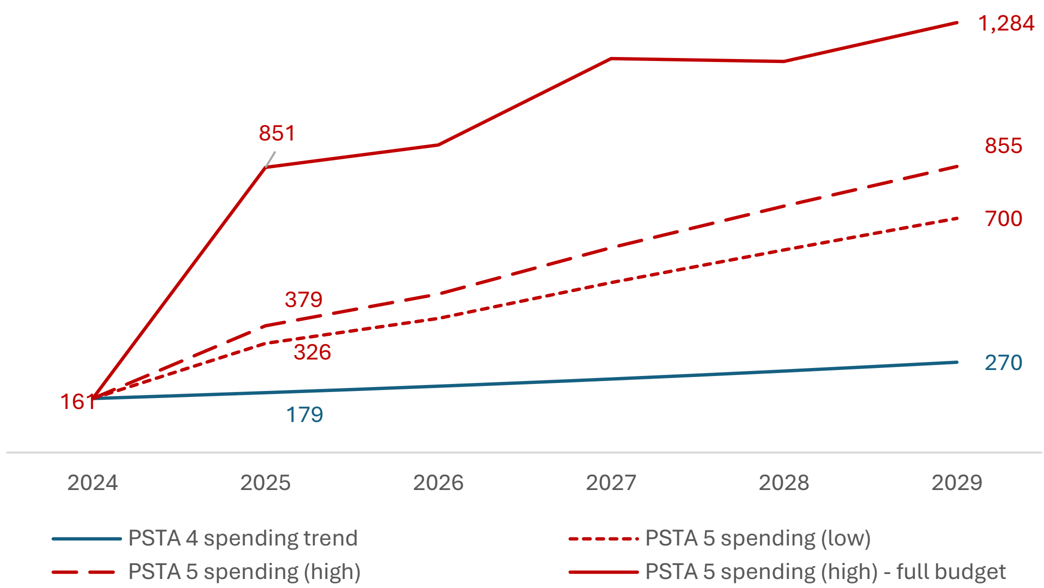
3. Scenario design

The objective of this analysis is to evaluate whether the different spending trajectories considered during the design of PSTA 5 can achieve the program's targets by 2029. To support this objective, we designed two broad sets of public spending trends corresponding to the pre-PSTA 5 and the PSTA 5 period. The *first spending trend* constitutes a "business-as-usual" scenario and corresponds to the expenditure and GDP growth pattern observed during the pre-PSTA 4 period. This expenditure scenario considers expenditure trends in the absence of PSTA 4 level commitment and is determined by removing the PSTA 4 level spending in the simulations. As such, the "business-as-usual" scenario provides a plausible reference for evaluate gains associated with alternative PSTA 5 spending trajectories described in the next set of scenarios.

The second set of spending trends constitutes three separate scenarios corresponding to: (i) a PSTA 5-level spending, (ii) a low level PSTA 5 spending, and (iii) a high level PSTA 5 spending trajectories (Figure 1) in line with the discussions that were put forward during the design of PSTA 5. In this set of scenarios, we introduce shocks to the model through new expenditures and investments, leading it to deviate from the "business-as-usual" scenario. We estimate the returns on individual investments and expenditures across various crop and livestock sectors and assess their contributions to changes in GDP, poverty, and undernourishment. Specifically, we evaluate the effectiveness of different spending trajectories in achieving the intended outcomes.

The first component of the second set of scenarios assumes that PSTA 4 spending trend with a total budget of $1.1 billion, continues until 2029. A second scenario of a significant increase in budget compared to the PSTA 4 trend is represented in "PSTA 5 spending (low)", which assumes a budget level 129% higher than the PSTA 4 levels (a sum of $2.5 billion compared with the $1.1 billion budget under the PSTA 4 trend through 2029). Meanwhile, an optimistic PSTA 5 spending trajectory is also considered, with a total budget three times higher than PSTA 4, amounting to $3.1 billion, as an alternative spending scenario for analysis. With an average annual budget growth rate of 45%, this scenario—referred to as “PSTA 5 spending (high)”— accounts for a portion of the total budget (labeled "PSTA 5 spending (high)-full budget" in Figure 1), as the modeled interventions represent only the quantifiable segments of several spending lines under the PSTA 5 plan. This translates to annual spending of $380 million, increasing to $855 million by 2029. Whereas the “PSTA 5 spending (high)” scenario is modeled in this analysis, the “PSTA 5 spending (high)-full budget” is not considered.

Figure 1. PSTA5 spending scenario (mil. $)



Authors’ calculations

The foundation of assessing the alternative spending trajectories are measures of cost-effectiveness of various on-farm and off-farm investment options. For instance, for a given amount of spending, such as $1 million, we determine how much GDP can be generated and how many individuals can be lifted out of poverty and undernourishment. This process allows us to identify the most cost-effective interventions for promoting inclusive agricultural transformation.

Annex Table 1 presents the interventions evaluated under each of the spending scenarios (see also Aragie et al. 2022). We focus on both on-farm and off-farm interventions aimed at enhancing productivity in the agricultural sector. The on-farm interventions include crop specific seed, fertilizer, and extension services, whereas the off-farm investment areas include those related to rural roads, crop and livestock research and development, and rural electrification, all of which reflects the country’s long-standing emphasis on providing a package of improved inputs and infrastructural development to assist with growing agricultural transformation. When appropriate, for each spending area, we identify separate interventions for different crop groups. We also design separate interventions focusing on livestock extension, which include the joint provision of livestock breeding, health services, feed, and extension support. These interventions are aligned with the PSTA 5 targets aimed at enhancing productivity and production in key livestock value chains, such as poultry, red meat, and dairy. In total, we included 54 unique interventions.

However, the impact of development policy on rural transformation outcomes is not determined solely by the level of public spending. Several analyses, using the methodology applied in this study (Aragie et al. 2024, Benfica et al. 2019, Pauw and Thurlow 2015), including a study on Rwanda's PSTA 4 (Aragie et al. 2022), highlight the importance of the allocation pattern. In this analysis, we adopt a spending distribution across interventions like that observed under PSTA 4 and followed by Aragie et al. (2022). This allocation pattern has been identified as effective in generating stronger outcomes in growth, poverty reduction, employment creation, and diet quality. Annex Table 2 provides details regarding the budget allocation pattern assumed.

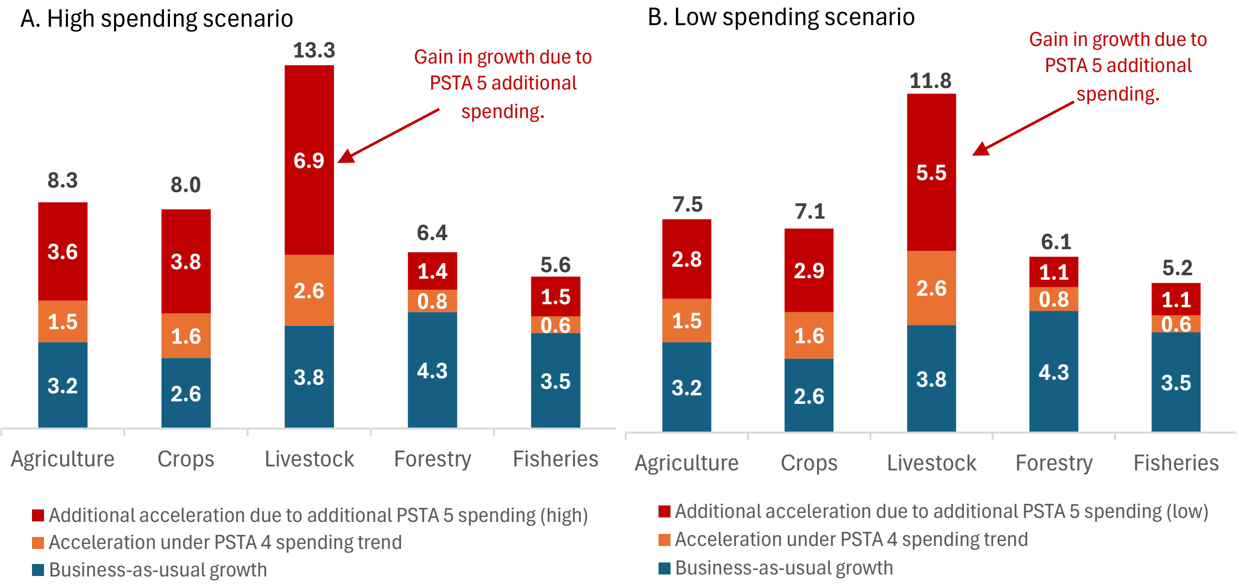
4. Results

4.1. Impact on growth

This section reports the impact of alternative spending trajectories on the various components of Rwanda's economy. Figure 2 shows a moderate agricultural sector growth of 3% per year if agriculture receives a business-as-usual or pre-PSTA 4 budget level. Most of this growth is contributed by the non-crop sector, including livestock. However, maintaining the PSTA 4 budget trajectory would increase this growth performance further by 1.5 percentage points, with livestock demonstrating a robust contribution to this additional growth.

Moderate PSTA 5 level spending (PSTA 5 spending (low)) increases agricultural growth by a further 2.8 percentage points such that sectoral growth averages 7.5% per year during the PSTA 5 period (Panel B). The high PSTA 5 spending scenario achieves the targeted agricultural GDP growth rate of 8% (Panel A), generating a GDP growth 0.8 percentage points higher than what was observed under the moderate spending scenario.

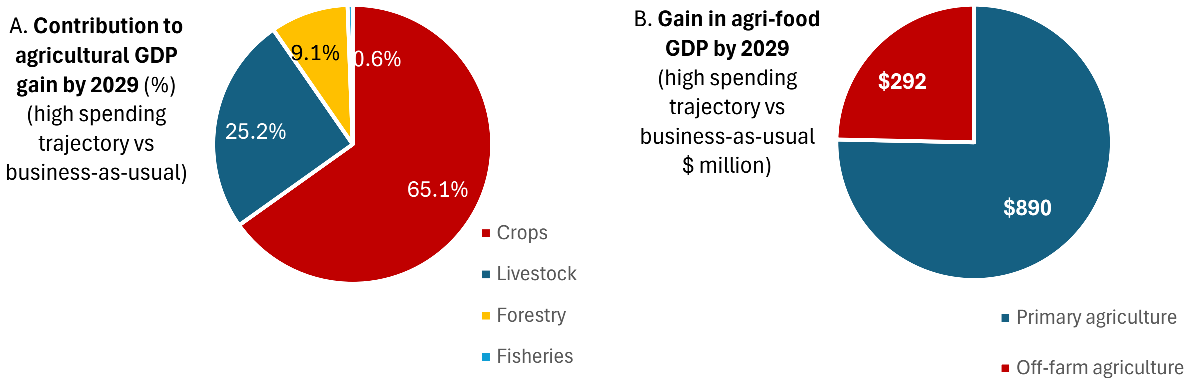
Figure 2. Average annual agricultural GDP growth rates, 2022-2029 (%)



Authors' calculations

As can be implied by the additional growth rates in Figure 2, at the sub-sector level and influenced by the relative size of each sector, different sub-sectors contribute to the gain in growth differently. For example, despite a smaller increase in growth in the crop sector compared to livestock, crops generate 65% of the gain under PSTA 5 spending scenarios (Figure 3). Contributing to 36% of agricultural GDP, livestock contributes to the accelerated growth performance by generating 25% of the additional growth.

Figure 3. Contributions to agricultural and agri-food system GDP gain by 2029

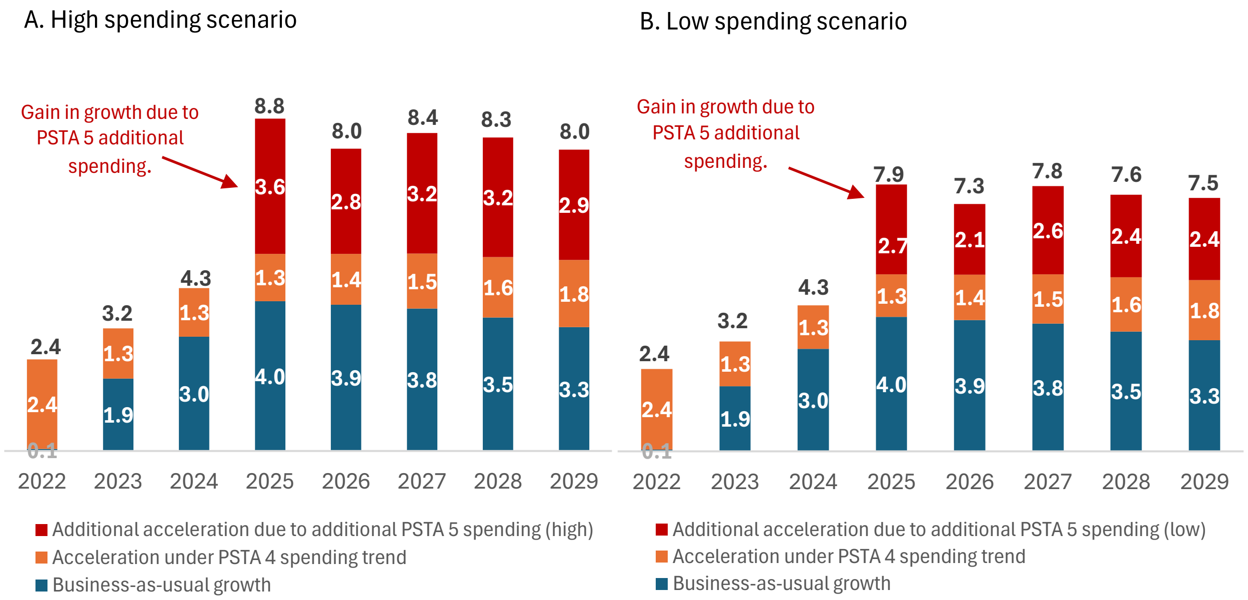


Authors' calculations

The PSTA 5 spending scenarios examined have strong linkage effects on the wider agri-food system, including downstream processing, trade and transport services, food services, and input supply, all of which extend beyond primary agriculture. As such, the agri-food system GDP expands by over 4 percentage points annually from 2025 to 2029 under the PSTA 5 spending (high) scenario (Figure 4, Panel A). One-third of this growth (i.e., about 1.4 percentage points) can be achieved under the PSTA 4 spending trajectory. Also note that agri-food system GDP grows rapidly during the early period due to a rapid increase in the sector budget compared to the pre-PSTA 5 period, before growth stabilizes at about 8 percent per year by the end of the plan period.

The optimistic PSTA 5 spending scenario expands the agri-food system GDP by about $1.2 billion compared with the 'business-as-usual' scenario (Figure 3). Importantly, over $290 million (or 27%) of the total increase in GDP is generated outside primary agriculture. This suggests a $1 in off-farm agri-food GDP for every $3.0 GDP generated in primary agriculture, showing a robust interlinkage between the primary and off-farm components of the economy.

Figure 4. Average annual agri-food system GDP growth rates 2022-2029(%)



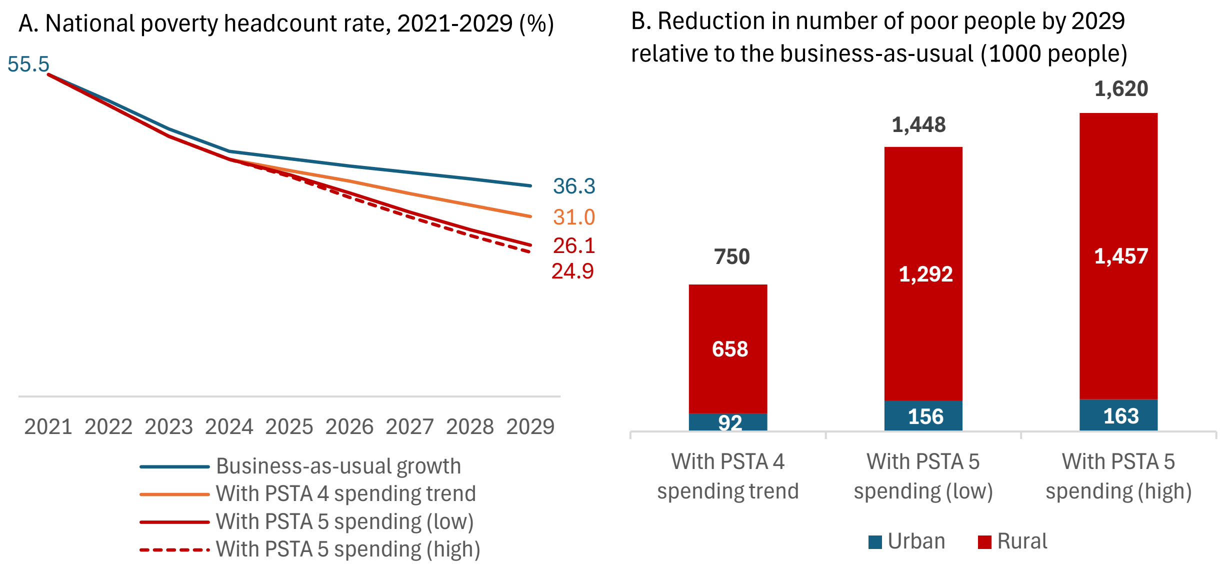
Authors' calculations. **Note**: PSTA 5 spending scenarios begin from 2025.

4.2. Impact on poverty

Public support for the agricultural sector has long been recognized as a key driver of poverty reduction (Keynes 1936, Tijani et al. 2016). Under the current growth trajectory, poverty is expected to decline gradually, as GDP growth outpaces population growth, leading to rising per capita incomes (Figure 5; see Annex Figure 1 on the change in the number of the poorer population). However, the pace of poverty reduction is slower compared to what could be achieved under the PSTA 5 spending trajectories. The national poverty rate ($1.90 line) would fall by an additional 5-11 percentage points under the low and high PSTA 5 spending trajectories, when compared to the 31percentage poverty rate projected under the PSTA 4 level spending. This indicates that the high spending PSTA 5 option can help reduce poverty by up to one-third.

In terms of the number of poor, the high PSTA 5 spending trajectory could lift over 1.6 million Rwandans above the poverty line by 2029, driven by faster agri-food system growth and lower prices. Most of this reduction occurs in rural areas, with about 163,000 urban residents also moving out of poverty.

Figure 5. Change in rate and level of poverty

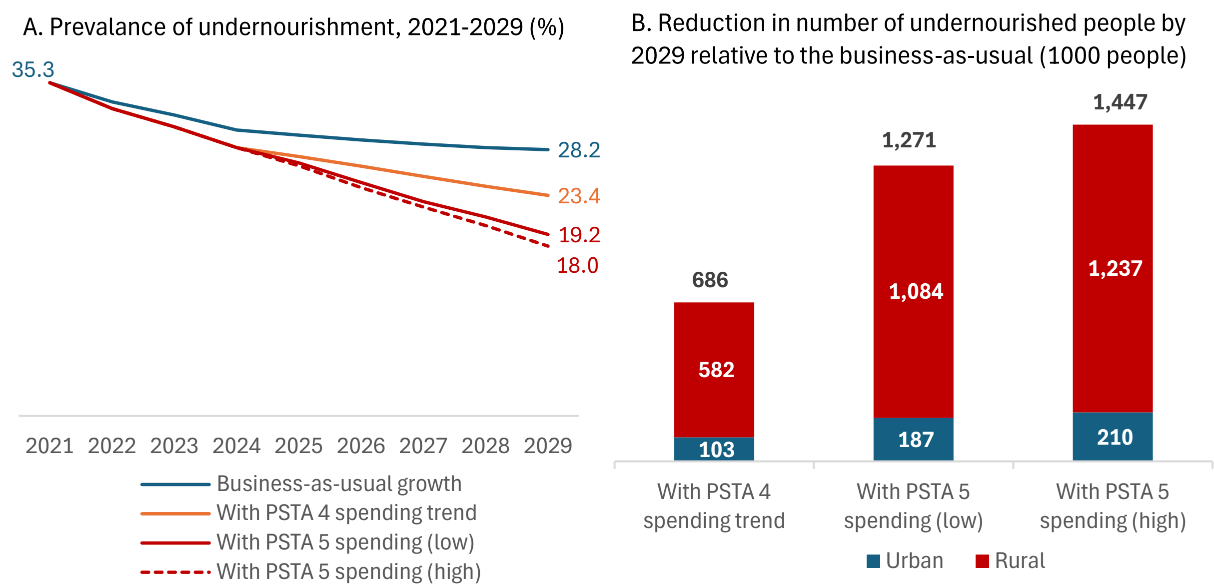


Authors' Calculations

4.3. Impact on undernourishment

The model results depicted in Figure 6 (see Annex Figure 2 on the change in the number of undernourished population) indicate that the prevalence of undernourishment in Rwanda could decrease from the current 35% under a slower growth trajectory (Panel A) associated with the pre-PSTA 4 spending path. Maintaining the PSTA 4 spending trajectory could further reduce undernourishment by 5 percentage points by 2029. However, the PSTA 5 plan proves even more effective, potentially lowering it by an additional 4.2 - 5.4 percentage points by 2029 under the low and high spending trajectories. This reduction would mean up to 1.5 million fewer Rwandans (0.8 million fewer compared to the PSTA 4 trajectory) consuming less than the minimum required calories per day by the end of the PSTA 5 period (Panel B). Notably, compared to poverty reduction, 85 percent of the hunger reduction would occur in rural areas, while urban areas would still see up to 210,000 fewer undernourished people.

Figure 6. Change in rate and level of undernourishment



Authors' Calculations

5. Conclusion

Data-driven and evidence-based approaches are essential for guiding public policy, investment, and expenditure decisions, ensuring that development plans are informed, efficient, and effective. In Rwanda, policymakers have increasingly relied on rigorous research to shape their development strategies and policy planning. The RIAPA model, utilized in this study, has played a key role in informing policy discussions, including the identification of national priorities and strategies (Diao et al. 2015), the mid-term assessment of PSTA 4 (Aragie et al. 2022), and the post-COVID-19 recovery and relief efforts (Aragie et al. 2024a).

Using a tailored version of the RIAPA model for Rwanda, this paper explores the projected economic benefits, poverty reduction, and improved nutrition resulting from the agricultural expenditures outlined in the PSTA 5 for the 2025-2029 period. The model results indicate that PSTA 5 will significantly accelerate inclusive agricultural transformation in Rwanda. Under the moderate budget projection (PSTA 5 spending (low) scenario), agricultural growth is expected to increase by an additional 2.8 percentage points compared to the growth achievable under the PSTA 4 spending trend. The high budget scenario, requiring an average annual expenditure of $610 million—rising from $380 million in 2025 to $855 million by 2029—would be necessary to achieve an ambitious growth of 8% in agriculture.

As agricultural growth accelerates, it stimulates further expansion in the off-farm components of the agri-food system, highlighting agriculture's role as a key driver of growth for the broader economy. This interconnected growth underscores agriculture's central position as an engine for overall economic development.

The accelerated economic growth associated with PSTA 5 spending is projected to significantly reduce poverty and undernourishment in Rwanda. By 2029, there could be 1.6 million fewer poor and undernourished people compared to a business-as-usual scenario. When compared to the budget trajectory of its predecessor, PSTA 4, the PSTA 5 plan has the potential to further reduce poverty and undernourishment by up to 0.8 million people by the end of the plan period. However, the success of PSTA5 is contingent on managing climatic and external economic risks, which have played a critical role in shaping Rwanda's recent growth trajectory. Emphasis should be placed on enhancing the economy's resilience to these shocks.

6. Reference

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7. Annex

Annex Table 1. Scenarios and related agricultural production sectors

No.	Policy/spending scenarios	Simulated crops/livestock production
1	Fertilizer only	Maize, rice, Irish potatoes, beans, soybeans, vegetables, sugarcane, other cereals, other roots, tubers, and bananas (RTBs), coffee and tea, other crops
2	Seeds only	Maize, rice, Irish potatoes, beans, soybeans, vegetables, sugarcane, other cereals, other RTBs, coffee and tea, other crops
3	Fertilizer and seeds	Maize, rice, Irish potatoes, beans, soybeans, vegetables, sugarcane, other cereals, other RTBs, coffee and tea, other crops
4	Extension—crops	Maize, rice, Irish potatoes, beans, soybeans, vegetables, sugar, other cereals, other RTBs, coffee and tea, other crops
5	Fertilizer and seed with extension	Maize, rice, Irish potatoes, beans, soybeans, vegetables, sugarcane, other cereals, other RTBs, coffee and tea, other crops
6	Irrigation—marshland development	Maize, rice, Irish potatoes, vegetables, sugarcane, other cereals, other crops
7	Irrigation—hillside	Maize, vegetables, other cereals, other RTBs, beans, other crops
8	Irrigation—small-scale	Maize, soybean, vegetables, other cereals, other RTBs, beans, other crops
9	Terracing—progressive	Maize, Irish potatoes, beans, vegetables, other cereals, other RTBs, other crops
10	Terracing—radical	Maize, Irish potatoes, beans, vegetables, other cereals, other RTBs, other crops
11	Crop R&D	All crops
12	Livestock R&D	All livestock production
13	Feeder roads	All primary agriculture and agriculture-related nonagricultural activities
14	Education	All primary agriculture and agriculture-related nonagricultural activities
15	Electricity	All primary agriculture and agriculture-related nonagricultural activities
16	Artificial insemination and animal breeding	All livestock production
17	Animal health (vaccines, antibiotics)	All livestock production
18	Extension—livestock	All livestock production
19	Postharvest loss reduction	Maize, Irish potatoes
20	Policies to reduce import barriers and promote exports	Exports and import-substitutable crops/livestock
21	Policies to improve the enabling environment and increase responsiveness of institutions	All investment/policy areas above

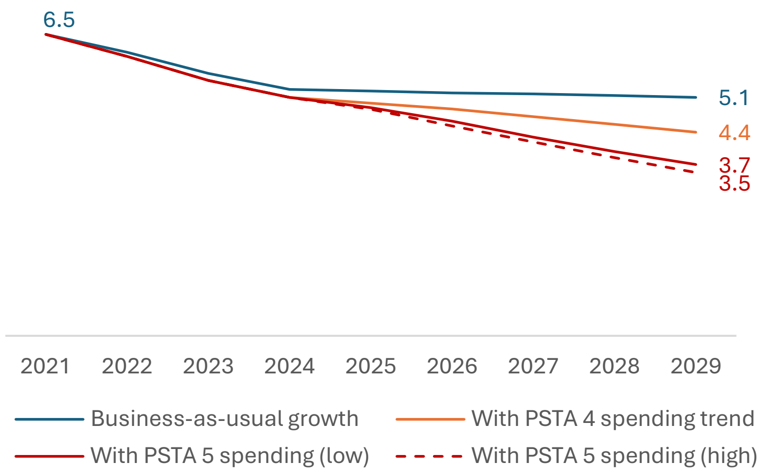
Source: Aragie et al. (2022)

Annex Table 2. Assumed distribution of agricultural spending for PSTA5 impact analysis

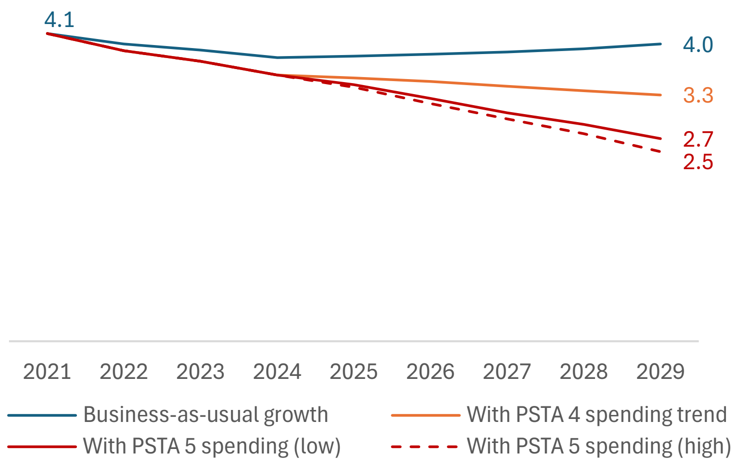
By spending classification		By investment classification	
Crop R&D	3.2%	Agriculture R&D	8.7%
Livestock R&D	5.6%	Marshland irrigation	7.1%
Feeder roads	8.3%	Hillside irrigation	4.9%
Education	21.8%	Small-scale irrigation	5.9%
Electricity	7.0%	Progressive terracing	12.2%
Coffee & tea, combined	0.8%	Radical terracing	15.6%
Maize, combined	11.0%	Coffee & tea	0.8%
Marshland irri w Fertilizer, seeds & ext. (rice)	2.7%	Livestock	7.6%
Potato, combined	2.3%	Nonagricultural	37.1%
Soybeans, combined	1.7%		**100.0%**
Vegetables, combined	4.0%		
Marshland irri w Fertilizer, seeds & ext. (sugar)	0.7%		
Other cereals, combined	2.8%		
Other rtbs, combined	8.0%		
Beans, combined	8.5%		
Other crops, combined	4.0%		
Livestock extension, health & breeding	7.6%		
	100.0%		

Source: Aragie et al. (2022)

Annex Figure 1. Poor Population 2021-2029 (millions of people)



Annex Figure 2. Under nourished Population 2021-2029 (millions of people)



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