INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI
CGIAR INITIATIVE ON Foresight
CGIAR INITIATIVE ON National Policies and Strategies

AGRIFOOD SYSTEM DIAGNOSTICS
COUNTRY SERIES

COUNTRY BRIEF 15 | JULY 2023

Transformation of Rwanda's Agrifood System

Structure and Drivers

Xinshen Diao, Mia Ellis, Gracie Rosenbach, Serge Mugabo, Karl Pauw, David J. Spielman, and James Thurlow

Introduction

Rwanda has made remarkable economic progress during the past two decades, and its annual GDP growth rate reached more than 7 percent during the 2009 to 2019 period (NISR 2021). The rapid economic growth has been pro-poor, and the poverty rate fell from 58.9 percent in 2000/01 to 38.2 percent in 2016/17 (NISR 2018). The country has also emerged as a leader among sub-Saharan African countries in promoting innovation, gender equality, and an enabling business environment for development. The government remains strongly committed to a set of ambitious development goals, as set forth in the 2017–2024 National Strategy for Transformation (NST 1) and the corresponding sector-level strategic plans. While the global COVID-19 pandemic had a severe adverse effect on the economy, causing negative GDP growth in 2020, the country rebounded quickly and registered more than 10 percent growth in 2021 (NISR 2022). The country was only minimally affected by global commodity market disruptions resulting from the Russia-Ukraine war that started in 2022 and the global recession in 2023 (Arndt et al. 2023; Diao and Thurlow 2023). Looking forward, Rwanda's GDP growth is projected to reach 6.7 percent in 2023 and 7.0 percent in 2024 (World Bank 2023), suggesting the economy is returning to its pre-pandemic high-growth trajectory.

Agriculture played an important role in Rwanda's recent economic growth. The sector grew alongside the rest of the economy despite facing challenges of scarcity in available agricultural land, small farm sizes, poor infrastructure, limited access to production inputs and technologies, and repeated climate shocks (Dusingizimana et al. 2022; Adolph et al. 2021; Malabo Montpellier Panel 2021; World Bank and GoR 2020). Agriculture also contributed to growth in off-farm components of the agrifood system (AFS) and helped cushion the economic impact from COVID-19 in 2020 (Pauw et al. 2021; Aragie et al. 2021). In this brief, we unpack Rwanda's historical and projected economic growth trajectory to better understand the role of agriculture as well as the broader AFS in the performance and transformation of its economy.

The AFS is a complex network of actors who are connected by their roles in supplying, consuming, and governing agrifood products and jobs. Just as an economy undergoes transformations as a country develops, agrifood systems are also expected to evolve (Diao, Hazell, and Thurlow 2010; Timmer 1988). Subsistence farming typically dominates agriculture during the earliest stages of development; as agricultural productivity rises, however, farmers start to supply surplus production to markets, thus creating job opportunities for workers in the nonfarm economy both within and outside the agrifood sectors (Haggblade, Hazell, and Dorosh 2007). Rising rural incomes generate demand for more diverse products; this leads to more nonfarm activities such as processing, packaging, transporting, and trading. In the early stages of transformation, the agriculture sector serves as an engine of rural—and even national—economic growth. Eventually, urbanization, the nonfarm economy, and nonagricultural incomes play more dominant roles in propelling agrifood system development, with urban and rural nonfarm consumers creating most of the demand for agricultural outputs via value chains that connect rural areas to towns and cities (Dorosh and Thurlow 2013). The exact nature of this transformation process varies across countries because of the diverse structure of their economies and the unique growth trajectories of their various agrifood and nonfood subsectors.

This brief describes the current and changing structure of Rwanda's AFS and evaluates the potential contribution of different value chains to accelerate agricultural transformation and to make it more inclusive. Though initially reported in Diao et al. (2022), the presentation of results has been further refined to provide additional clarity and insight, and to inform the design of Rwanda's next national strategy for agricultural transformation.[1]

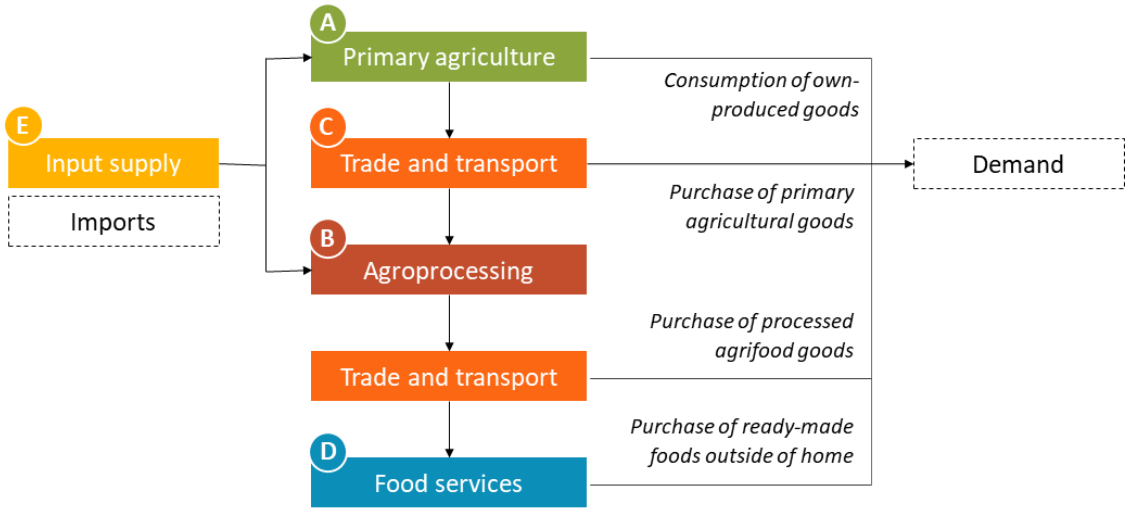
We start by offering a simple conceptual framework of the AFS and apply that framework to compare Rwanda's AFS to that of other countries at different stages of development. Next, we disaggregate Rwanda's AFS across agricultural value chains, considering their different market structures and historical contribution to economic growth and transformation. Finally, we use a forward-looking economy-wide model to assess the diverse contributions that specific value chains can make to each of a set of broad development outcomes. We conclude by summarizing our main findings.

A Simple Conceptual Framework of the Agrifood System

A country's AFS is a complex network of actors who are connected by their differing roles in supplying, using, and governing agrifood products (see Fanzo et al. 2020 for a detailed conceptual description of the AFS). In this brief, rather than examining all components of Rwanda's AFS, we employ a narrower focus. We first measure its size, structure, and historical contribution to economic growth and transformation through a data-driven exercise; second, we use the International Food Policy Research Institute (IFPRI) Rural Investment and Policy Analysis (RIAPA) model (IFPRI 2023) to assess the effectiveness of AFS growth (led by productivity gains in different agricultural value chains) in promoting multiple development outcomes in Rwanda. Our measurement of the AFS is done from a supply-side perspective; that is, we use national accounts and employment statistics to either track or simulate growth and employment changes over time. By disaggregating the AFS into several value chain groups, this analysis offers a unique and useful perspective on the drivers of AFS growth and transformation.

[1] These refinements are detailed in the results section of this brief.

Figure 1. A simple conceptual framework of the agrifood system



Source: Thurlow et al. (2023).

Figure 1 provides a simple conceptual framework of the AFS made up of five components, A to E (see Thurlow et al. 2023). *Primary agriculture* (A) comprises the supply and demand of all agricultural products including crops, livestock, fisheries, and forestry products. *Agroprocessing* (B) is part of the manufacturing sector and includes those subsectors that process agriculture-related food or nonfood products. *Trade and transport services* (C) includes those services associated with the transporting, wholesaling, and retailing of agrifood products between farms, firms, and final points of sale. *Food services* (D) includes services such as meals prepared at restaurants, food stalls, or hotels. Finally, *input supply* (E) is the portion of domestically produced intermediate inputs that is used directly in agricultural and agroprocessing production, such as fertilizers and financial services.

Using this conceptual framework, it is possible to measure the size and structure of Rwanda's AFS from a supply-side perspective. Following the definitions of Thurlow et al. (2023), AFS GDP (or AgGDP+) is the sum of the GDP contributions of the five components (A to E), while AFS employment (or AgEMP+) is the total number of jobs across those components. As the economy grows and transforms over time, there will be changes in the relative contributions of the various on-farm and off-farm components of the AFS to total AgGDP+ or AgEMP+. A transforming economy, for example, will typically be characterized by more rapid growth in the off-farm components of the AFS; there will thus be an increased contribution by off-farm components to AgGDP+ and AgEMP+ and a relative decline in the contribution of primary agriculture. By disaggregating AgGDP+ and AgEMP+ by specific agricultural value chains, we can further assess the contribution of each of those value chains to AFS growth and transformation.

Current Structure of Rwanda's Agrifood System

Table 1 presents the structure of Rwanda's AFS in 2019 based on official national accounts data and sectoral employment statistics (NISR 2022a; NISR 2022b; NISR 2012; NISR various years; ILO 2020),

as compiled in a 2019 Social Accounting Matrix (SAM) for Rwanda.[2] National estimates are broken down into estimates for the AFS (that is, AgGDP+ and AgEMP+) and the rest of the economy. The AFS is further broken down into the on-farm (primary agriculture) and off-farm components. The estimates for manufacturing and services (including the trade and transport services subsector) at the bottom of the table include activities in both the AFS and non-AFS sectors, thus providing a perspective on the relative size of the off-farm AFS components within the overall manufacturing and services sectors.

Table 1. Current structure of Rwanda's agrifood system and economy (2019)

	GDP		Employment	
	Value (US$ billion)	Share (%)	Workers (million)	Share (%)
Total economy	**9.5**	**100.0**	**6.3**	**100.0**
Agrifood system	**3.4**	**35.9**	**4.3**	**67.7**
Primary agriculture (A)	**2.4**	**25.7**	**3.9**	**62.3**
Off-farm AFS	**1.0**	**10.2**	**0.3**	**5.4**
Processing (B)	0.5	5.6	0.2	2.6
Trade and transport (C)	0.2	2.2	0.1	2.2
Food services (D)	0.2	1.9	0.0	0.4
Input supply (E)	0.0	0.5	0.0	0.1
Rest of economy	**6.1**	**64.1**	**2.0**	**32.3**
Total manufacturing	0.9	9.1	0.2	3.8
Total services	5.1	53.6	1.7	26.4
Total trade and transport	1.8	18.6	0.8	13.1

Source: Authors' calculation based on the 2019 Social Accounting Matrix (SAM) for Rwanda that was updated from the 2017 SAM for Rwanda (IFPRI et al. 2021).
Note: A to E correspond to the five agrifood system (AFS) components from Figure 1.

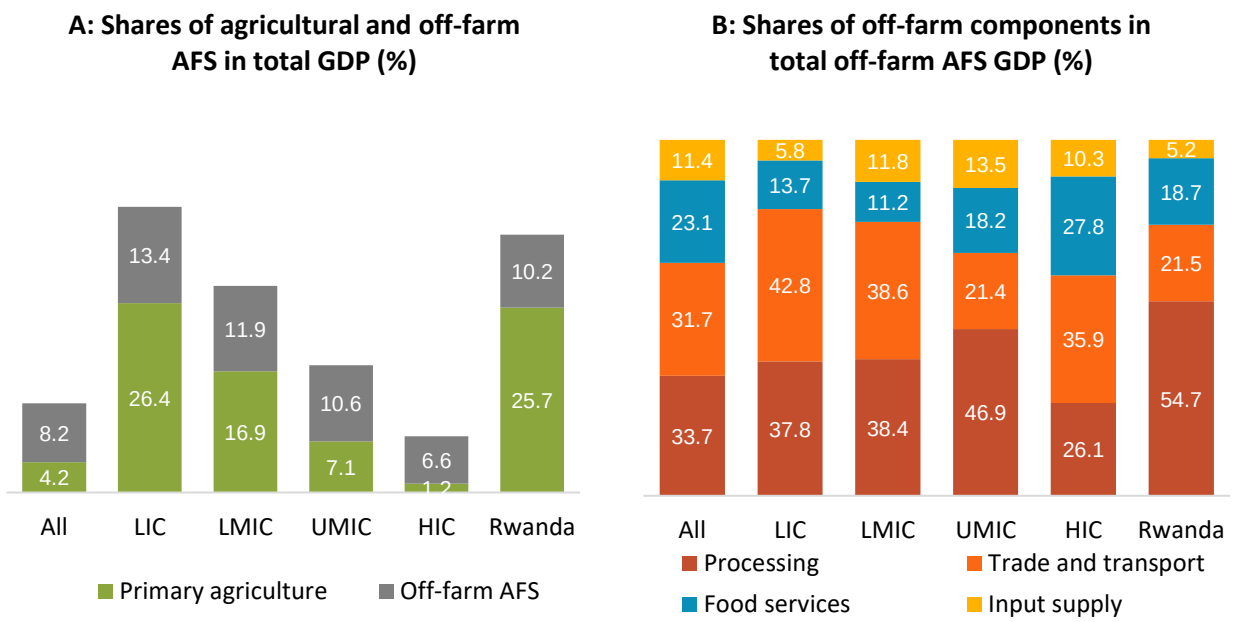
As shown in the table, the AFS accounted for 35.9 percent of Rwanda's national GDP and 67.7 percent of employment in 2019. Primary agriculture alone contributed one-quarter of GDP and nearly two-thirds of employment, while the four off-farm components of the AFS contributed 10.2 percent to GDP and 5.4 percent to employment. The comparison of on- and off-farm GDP and employment shares shows that labor productivity in the off-farm components of the AFS is significantly higher than on the farm. Hence, the movement of farm workers into these off-farm components—a natural process of agricultural transformation—may be beneficial for their household incomes.

[2] The recent Rwanda supply and use tables (SUT) are used to construct the Rwanda SAM. Rwanda SUT was compiled by NISR and obtained through a joint project between IFPRI and the Ministry of Finance and Economic Planning (MINECOFIN). The Rwanda 2017 SAM was constructed by IFPRI, MINECOFIN, and NISR under the project titled "SAM-CGE Modeling Capacity Building for Evidence-based Policy Analysis and Strategy in Rwanda," which ran from 2017 to 2021 with financial support from the Deutsche Gesellschaft für Internationale Zusammenarbeit Gmb (GIZ). Additional support to the SAM construction and updating was received the European Union, the United States Agency for International Development (USAID), the Bill and Melinda Gates Foundation (BMGF), and the CGIAR Research Program on Policies, Institutions, and Markets (PIM), which is supported by the CGIAR Fund contributors (https://www.cgiar.org/funders/). The Rwanda 2019 SAM was updated from the 2017 SAM. See IFPRI et al. (2021) for details about Rwanda 2017 SAM.

Comparing Rwanda's Agrifood System to Other Countries

The structure and economic contribution of the AFS varies at different stages of a country's development. Figure 2 provides evidence of this by comparing the AFS structures of low-income (LIC), lower-middle-income (LMIC), upper-middle-income (UMIC), and high-income countries (HIC) in 2019. As an LIC, both the on- and off-farm composition of Rwanda's AFS and its contribution to national GDP are comparable to its peer countries but also close to the LMIC group (Panel A). However, within the four off-farm components of the AFS, Rwanda's agroprocessing is relatively larger than what is seen in other LICs, while the agrifood trade and transport component is relatively smaller (Panel B).

Figure 2. Comparing Rwanda's agrifood system to other countries (2019)

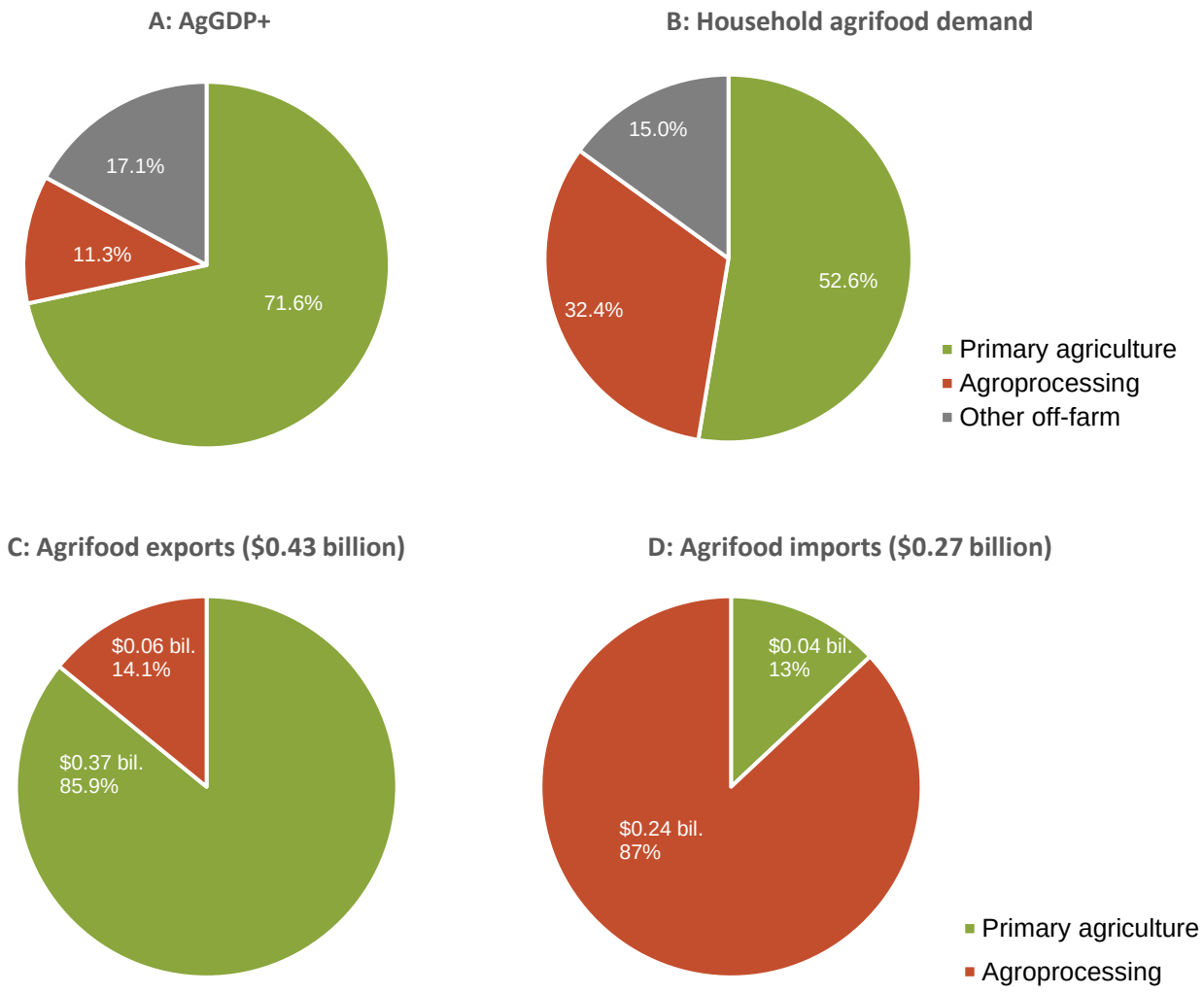


Source: IFPRI's Agrifood System Database (Thurlow et al. 2023) and the 2019 Social Accounting Matrix for Rwanda (IFPRI et al. 2021).
Note: LIC = low-income country; LMIC = lower-middle-income country; UMIC = upper-middle-income country; and HIC = high-income country; AFS = agrifood system.

Unpacking the Demand Side of Rwanda's Agrifood System

Panels A and B of Figure 3 compare the structure of Rwanda's AFS from the supply side, as measured by AgGDP+ (Panel A), against the structure of the AFS from the demand side, as measured by household consumption of agrifood products (Panel B). While 71.6 percent of AgGDP+ is from primary agriculture, primary agricultural commodities account for only 52.6 percent of household demand. In contrast, household demand for processed agrifood products accounts for 32.4 percent of total agrifood demand, even though the associated sector accounts for only 11.3 percent of AgGDP+. The bias toward processed agrifood products is mirrored in the high share of agrifood imports accounted for by processed products, that is, 85.9 percent of agrifood commodity exports are primary agricultural commodities (Panel C), but 87.0 percent of imports are processed goods (Panel D). Rwanda nevertheless maintains a surplus on its total agrifood commodity trade balance, while imports of processed agrifood commodities exceed processed agrifood exports.

Figure 3. Composition of agrifood system GDP, household demand, and trade (2019)



Source: Authors' calculation based on the 2019 Social Accounting Matrix for Rwanda (IFPRI et al. 2021).

Disaggregating the Agrifood System across Value Chains

For a more detailed assessment of structural and historical growth patterns within the AFS, we group Rwanda's agrifood system into 16 value chain groups. (See Table A1 in the Appendix for details on how individual value chains (or subsectors) are mapped to value chain groups.) The 16 value chain groups are further categorized into three subgroups based on their trade orientation. Exportable and importable value chains are defined as those value chains with export-output and import-consumption ratios above the national average, respectively. Trade in both primary and processed agrifood products is considered in the calculation of these trade ratios. The remaining value chains are classified as less-traded value chains.

Table 2 shows the 16 value chain groups, categorized into exportable, importable, and less-traded value chains. The table also reports the contribution of each value chain group to AgGDP+, primary agricultural GDP, and GDP in the off-farm components of the AFS. Consistent with Figure 3, Table 2 shows that Rwanda has a comparative advantage in exports, with an export–output ratio of 8.8 percent,

which is higher than the import–consumption ratio of 6.3 percent. Five of the 16 value chains are classified as exportable value chains because their export–output ratios exceed the national average for AFS value chains. They include not only Rwanda's most important export crops—coffee and tea—that are grouped together, but also a few nontraditional export commodities—beans, Irish potatoes, vegetables, and fruits—that are mainly exported to Rwanda's neighboring countries. Together exportable value chains account for 28 percent of total AFS GDP, while their primary agricultural GDP share of 31.6 percent exceeds their off-farm AFS GDP share (20.1 percent), indicating that most are exported as primary agricultural products.

Table 2. Rwanda's agrifood system composition by trade orientation of value chains (2019)

	Share of GDP (%)			Exports / output (%)	Imports / demand (%)
	AFS (AgGDP+)	Primary agriculture	Off-farm AFS		
Total	**100.0**	**100.0**	**100.0**	**8.8**	**6.2**
Exportable	**28.3**	**31.6**	**20.1**	**31.1**	**1.9**
Beans	4.4	5.6	1.3	22.8	0.8
Irish potatoes	4.0	5.3	0.7	16.9	
Vegetables	3.0	3.7	0.9	28.2	2.0
Fruits	11.9	11.4	13.1	10.6	2.7
Export crops	5.1	5.6	4.1	88.3	
Importable	**16.9**	**11.5**	**30.7**	**1.3**	**15.4**
Maize	2.3	2.6	1.6	1.0	11.1
Rice	2.9	2.2	4.9		10.9
Other cereals	2.2	1.9	2.9	2.1	9.8
Groundnuts	2.7	1.9	4.8	0.4	22.4
Soybeans	0.3	0.4	0.1		23.6
Other crops	5.2	0.9	16.1	2.2	17.4
Fish	1.2	1.5	0.4		27.4
Less tradable	**50.2**	**57.0**	**33.2**	**1.0**	**1.7**
Other roots	17.6	20.9	9.1	0.5	0.6
Cattle and dairy	9.5	8.2	13.0	1.1	3.1
Other livestock	2.2	3.0	0.3		0.5
Forestry	20.9	24.9	10.7	0.3	3.8

Source: Authors' calculation based on the 2019 Social Accounting Matrix for Rwanda (IFPRI et al. 2021).

Seven of the 16 value chains fall in the importable group of value chains. These value chains have relatively large off-farm components, accounting for 30.7 of off-farm AFS GDP, almost three times their primary agricultural GDP contribution (11.5 percent). Thus, these value chains compete with imports both in primary and processed agricultural products. Four of the 16 value chains fall in the less-traded group of value chains, and many of them are large in size. Together they account for 50.2 percent of

AgGDP+. Three of the four less-traded value chains have relatively small off-farm components, and hence the less-traded value chains contribute a disproportionately smaller share to off-farm AFS GDP (33.2 percent) compared to their primary agricultural GDP contribution (57.0 percent). The cattle and dairy value chain is a clear exception; even though the value chain is less exposed to global or regional markets, it is associated with significant value addition (such as meat processing and dairy products). Hence, expansion of some importable value chains and cattle and dairy could be effective at driving agricultural transformation by boosting value addition and off-farm employment in the value chains.

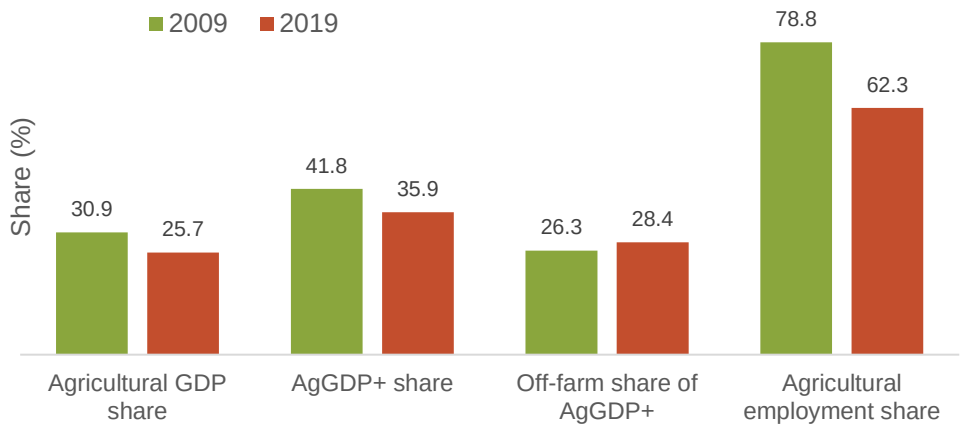
Structural Change and Drivers of Agrifood System GDP Growth

The previous sections have provided a snapshot of the current structure of Rwanda's AFS, the decomposition of the AFS across the 16 value chain groups, and the trade orientation of those value chains. We have demonstrated that Rwanda has some comparative advantage in agrifood exports, while less-traded value chains are dominant in terms of their contribution to AgGDP+ and primary agriculture. However, many of these value chains also are generally less oriented toward value addition in the off-farm components of the AFS (that is, their contribution to off-farm AFS components is small relative to their contribution to primary agriculture, especially compared to importable value chains). Prioritizing growth in some tradable value chains together with the cattle and dairy value chain could therefore be an effective strategy for expanding off-farm value addition and jobs, which contributes positively to AFS transformation.

In this section, we assess the performance and structural transformation of Rwanda's AFS in recent years. Labor productivity is typically lowest in primary agriculture, and higher in off-farm activities, such as in agrifood processing, food services, or in sectors outside of the AFS. Economic growth and urbanization are associated with relatively faster growth in these nonagricultural sectors, which could help create higher-paying jobs for both rural and urban households. As such, even smallholder farm households with family members who obtain off-farm employment may benefit from structural transformation.

Figure 4 compares the shares of agricultural GDP and AgGDP+ in Rwanda's national GDP, as well as agricultural employment as a share of total employment between 2009 and 2019. The figure also includes an estimate of the share of the off-farm components in AgGDP+. Agricultural GDP and AgGDP+ shares as well as the agricultural employment share fell significantly between 2009 and 2019, while the off-farm component of AgGDP+ increased. This indicates that Rwanda's AFS has been transforming along with rapid economic growth. However, primary agriculture still dominates the AFS, and it remains more than twice the share of off-farm components of AFS in GDP and 10 times their share in employment.

Figure 4. Agricultural GDP, agrifood system GDP, and employment shares (2009–2019)



Source: Authors' estimates using the 2009 and 2019 Social Accounting Matrixes for Rwanda (IFPRI et al. 2021).

Table 3. Agrifood system GDP growth rates by value chain (2009–2019)

	Average annual GDP growth rate (%)			
	Total AFS	Primary agriculture	Off-farm AFS	Agro-processing
Total AFS	**5.4**	**5.1**	**6.2**	**4.7**
Exportable	**3.9**	**3.4**	**5.9**	**4.1**
Beans	3.8	3.5	7.7	0.0
Irish potatoes	1.9	1.7	5.9	0.0
Vegetables*	6.9	6.5	12.5	0.0
Fruits	3.6	2.8	5.6	4.7
Export crops	5.0	5.0	5.0	-0.8
Importable	**4.4**	**4.8**	**4.1**	**3.0**
Maize	3.4	2.6	7.5	7.3
Rice*	6.2	8.1	4.4	3.1
Other cereals*	10.3	9.3	12.3	11.5
Groundnuts	3.9	5.0	2.8	1.4
Soybeans	3.9	3.7	8.5	0.0
Other crops	2.9	1.7	3.0	2.2
Fish	3.5	3.0	10.0	0.6
Less tradable	**6.4**	**6.2**	**7.1**	**6.2**
Other roots	5.3	5.2	6.1	4.7
Cattle and dairy*	6.8	6.8	6.9	6.0
Other livestock*	9.6	9.6	11.3	0.0
Forestry*	6.9	6.6	8.4	8.0

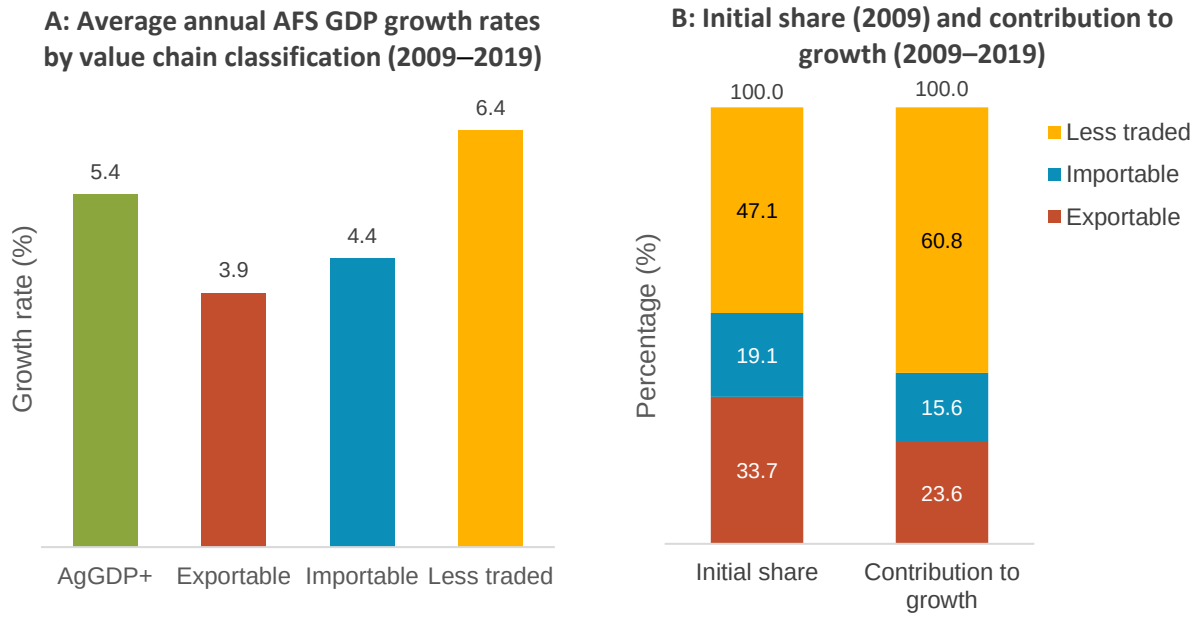
Source: Authors' analysis using the 2009 and 2019 Social Accounting Matrixes for Rwanda (IFPRI et al. 2021).
Note: Value chains that experienced above-average AgGDP+ growth over the period 2009–2019 (that is, higher than 5.4 percent) are marked with an asterisk (*).

Table 3 evaluates the growth performance across AFS value chains over the period from 2009 to 2019. As before, value chains are grouped according to their trade status, that is, exportable, importable, and less traded. Overall, Rwanda's AFS grew rapidly, with an average annual AgGDP+ growth rate of 5.4 percent. The off-farm component of the AFS grew much faster (6.2 percent) than primary agriculture (5.1 percent), though agrifood processing, a subcomponent of the off-farm component of the AFS, grew relatively more slowly at 4.7 percent per year.

Among the 16 value chains, 6 achieved above-average growth during the 2009–2019 period, that is, more than 5.4 percent per year (these are marked with an asterisk in Table 3). Among the exportable value chains, only the vegetable value chain grew faster than the AFS average. Two of the seven importable value chains—rice and other cereals (mainly wheat) —also grew faster than the AFS average, while three of the four less-traded value chains—the two livestock value chains and forestry—achieved above-average growth. In all these rapidly growing value chains, growth in the off-farm components of the AFS was faster than growth in the primary agricultural component. However, in most of these value chains that achieved above-average growth—and in many of the slower-growing value chains, too—the processing components of value chains grew relatively slowly. This is consistent with the broader patterns of growth and structural change in Rwanda's AFS, which shows that growth in the off-farm component of the AFS was much faster than the growth on the farm, but processing agricultural GDP grew more modestly.

Figure 5 summarizes key growth trends from Table 3. On average, only less-traded value chains grew faster (6.4 percent) than the national average growth in AgGDP+ (5.4 percent) (Panel A). With a large initial size and above-average growth, the less-traded value chains contributed the most to AFS growth, at 60.8 percent (Panel B).

Figure 5. Drivers of Rwanda's AFS GDP growth (2009–2019)



Source: Authors' analysis using IFPRI's 2009 and 2019 Social Accounting Matrixes (SAMs) for Rwanda (IFPRI et al. 2021).

Assessing Growth Outcomes Using IFPRI's RIAPA Model

IFPRI's Rural Investment and Policy Analysis (RIAPA) model is a tool for conducting forward-looking, economywide country-level analysis (IFPRI 2023). RIAPA has been used in a wide variety of contexts to simulate the impacts of policies, investments, or economic shocks. Here we employ RIAPA to assess the effectiveness of productivity-led growth in different agricultural value chain groups in Rwanda to promote multiple development outcomes. The analysis was carried out for 14 value chain groups, which were selected from the original list of 16; other crops and forestry were excluded. We considered five development outcomes:

- A poverty–growth elasticity that measures the percentage-point change in the poverty headcount rate per unit of agricultural GDP growth generated within the targeted value chain;
- A growth multiplier that measures the change in GDP per unit of increase in agricultural GDP in the targeted value chain;
- An employment multiplier that measures the change in the number of jobs created per unit of increase in agricultural GDP in the targeted value chain;
- A diet-quality indicator that measures the percentage change in a diet quality index per unit of agricultural GDP growth generated within the targeted value chain; and
- A hunger–growth elasticity that measures the percentage-point change in the rate of undernourishment per unit of agricultural GDP growth generated within the targeted value chain.

The simulations entail raising on-farm productivity separately in each targeted value chain and comparing development outcomes across the value chains. While this exogenous productivity shock is imposed only in the primary agriculture component of each value chain, there are spillover effects into that value chain's off-farm components as well into other agricultural value chains or sectors outside the AFS. These spillovers are captured by the economywide model and provide an indication of the transformation effect that agricultural productivity growth in the value chain has within the AFS and the broader economy. There are also structural differences across value chains. For example, value chains have unique links to other sectors as suppliers or users of intermediate inputs, or they have unique links to rural or urban households in different income groups because of the types of workers they employ or the consumption preferences of households for the agrifood products produced by those value chains.

As such, each value chain growth scenario is expected to have a unique impact on the development outcomes. Moreover, not all value chains will be equally effective at improving outcomes. In some cases, there may even be trade-offs because of competition for resources across value chains. With the aid of the RIAPA model, these complex effects can be unpacked, thus providing information to governments or development partners that can be used to prioritize across different value chains, subject of course to the development outcomes they value most highly.

Figure 6 shows the scores each value chain achieves across the five development outcome indicators.[3] We arbitrarily rank the value chains by their poverty score. Value chains clearly differ significantly in terms of their effectiveness in improving different development outcomes. The other cereals (mainly wheat and sorghum) value chain, for example, has strong poverty effects and is most effective at reducing hunger, but it is much less effective in increasing jobs. The rice value chain, in contrast, has a

[3] Figure 6 shows results in terms of actual scores for each value chain. Although this figure differs from the normalized scores shown in Figure 9 of Diao et al. (2022), Figure 6 remains consistent with Table 4 in Diao et al. (2022). Also note that the poverty and hunger outcome indicators are reported in negative terms, that is, as reductions in poverty and hunger, for purposes of clarity only.

growth multiplier of 3.35, the second-highest of all the value chains, which means that for every US$1.00 increase in GDP in the rice value chain driven by rising productivity, an additional US$3.35 is generated in total GDP, that is, US$2.35 is generated either in the off-farm components of the rice value chain or in other value chains or sectors of the economy. The rice value chain also scores high on the hunger outcome but ranks much lower on the diet quality and job creation outcome.

These results highlight the possible trade-offs that might emerge when prioritizing individual value chains, as no single value chain is the most effective at achieving every development objective. Promoting a few value chains jointly will not only diversify agricultural growth; it can also help to simultaneously achieve multiple development objectives.

A composite score across different outcome indicators is created in order to narrow down the number of value chains that might be prioritized. Because of a high correlation between poverty and hunger impacts across value chains, the hunger score is omitted from the composite score.[4] Also, since the different outcome indicators have different underlying units, the individual outcomes are normalized so that they are comparable while still retaining their ranking within the outcome category. Normalization entails assigning a score of 1 to the value chain that is most effective within an outcome category and a score of 0 to the least effective value chain. All value chains with adverse effects on an outcome are also assigned a score of 0. This includes value chains with a growth multiplier of less than one (vegetables, Irish potatoes, other livestock, and export crops (coffee and tea)) or those with negative diet effects (other roots). The remaining value chains receive a score between 1 and 0 that is proportionate to their original score relative to the highest-ranked value chain. The individual normalized scores for the outcomes are then combined into a composite score for each value chain. The default approach assumes that each of the four outcome indicators is equally important, so an equal weight is assigned to each score; however, if policymakers consider a particular development outcome to be more or less important than the other outcomes, the weights assigned to each particular outcome score can be adjusted accordingly.

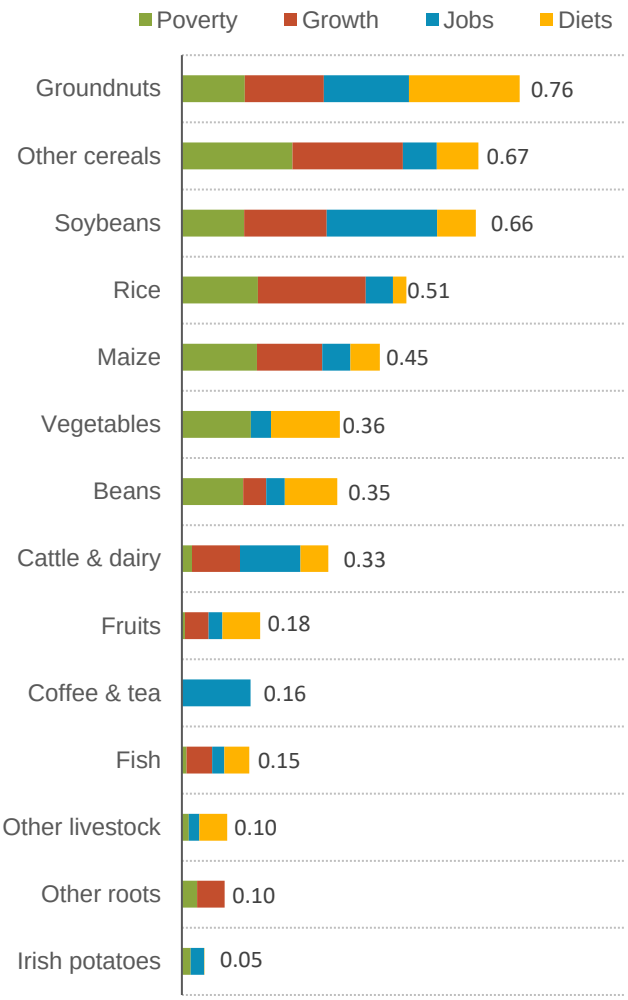
Figure 7 presents the composite scores using equal weights across the four development outcome indicators (that is, excluding hunger). Each component in the bars shows the relative contribution of a particular outcome indicator in the final score. The groundnuts, other cereals, soybeans, and rice value chains are ranked highest. For all these four value chains, each of the four outcome components makes some contributions to the composite score. For groundnuts, the highest-ranked value chain, the contribution of diet outcome is far more important than in other high-ranking value chains. By contrast, in the second-ranked other cereals value chain, it is the growth component that makes the most important contribution. Similarly, productivity growth in the rice value chain would only contribute minimally to diet quality improvement and job creation, even though it could have important impacts on the other two development outcome areas. While a ranking of their impacts on multiple development outcomes based on composite scores allows us to identify and prioritize value chains, trade-offs clearly exist as to which outcomes are most significantly affected by productivity-led growth in each value chain.

[4] The exclusion of the hunger outcome indicator due to its high correlation with poverty is the main difference between this version of the diagnostic and the previous version reported in Diao et al. (2022). Note that this change does not affect the ranking of most value chains reported below. In fact, the five top-ranking value chains remain, with only groundnuts and other cereals switching their rankings among the top five.

Figure 6. Impact of value chain growth on development outcomes

Source: RIAPA model results.
Note: Panel A shows the percentage point changes in poverty rate that are associated with a 1 percent increase in agricultural GDP; Panel B shows the percentage point changes in hunger rate that are associated with a 1 percent increase in agricultural GDP; Panel C shows the changes in total GDP (in US$ millions) that are associated with a US$1.0 million increase in agricultural GDP from the targeted value chain; Panel D is the change in total economywide employment (in thousand persons) that is associated with a US$1.0 million increase in agricultural GDP from the targeted value chain; and Panel E is the percentage improvement in diet quality that is associated with a 1 percent increase in agricultural GDP. The figure is ordered by the poverty rate outcome.

Figure 7. Composite score of development outcomes: Equal weights



Source: RIAPA model results.
Note: The composite score is a simple average (equally weighted) of the scores for each of the four outcome categories; the figure is ordered according to the highest composite score.

Summary

Rwanda's economy grew rapidly at more than 7 percent annually in the two decades prior to the COVID-19 pandemic. Although the agrifood system (AFS) did not grow as fast, it still achieved a respectable annual growth rate of 5.4 percent. Since more than two-thirds of the labor force in Rwanda is engaged in the AFS, this growth was important for household income growth and poverty reduction—national poverty declined by 20 percentage points from 58.9 percent in 2000/01 to 38.2 percent in 2016/17 (NISR 2018). The rapid growth has been accompanied by economic structural change and Rwanda's AFS has been transforming. The growth rate for the off-farm component of the AFS was much higher than the growth rate on the farm—6.2 and 5.1 percent, respectively— and the off-farm share of the AFS increased from 26.3 to 28.4 percent between 2009 and 2019. While both the agricultural GDP and agricultural employment shares declined significantly over this period, agriculture remains a relatively large sector in Rwanda.

The growth in Rwanda's AFS that occurred between 2009 and 2019 was mainly contributed by less-traded value chains (more than 60 percent). The large contribution from the group of less-traded value chains is explained both by its large initial size and above-average growth rate.

The RIAPA model-based comparison of future sources of growth shows that there is no single value chain group that is the most effective in achieving all desired development outcomes, that is, declining poverty, declining hunger, economic growth, job growth, and improved diets. The groundnuts, other cereals, soybeans, and rice value chains rank highly in their composite outcome scores for poverty, GDP, jobs, and diets. Some of these value chains already displayed above-average growth rates in the preceding decade. Promoting these value chains together offers an effective and broad-based way to achieve these development outcomes.

About the Authors

Xinshen Diao and **Karl Pauw** are Senior Research Fellows, **James Thurlow** is the Director, and **Mia Ellis** is a Research Analyst in IFPRI's Foresight and Policy Modeling Unit; **Gracie Rosenbach** was, at the time this study was conducted, Program Manager of IFPRI's Rwanda Strategy Support Program; **Serge Mugabo** is a Research Analyst of the program based in Kigali, Rwanda; **David Spielman** is Director of IFPRI's Innovation Policy and Scaling Unit, based in Washington, DC, and was formerly the head of IFPRI's Rwanda Strategy Support Program.

References

Adolph, B., S. Barrett, A. Guarín, G. Nicolini, F. Assefa, B. Tizazu, D. Fikreyesus, B. Nebsu, J. Mungoo, A. Kimani, F. Narambuye, S. Sirikare, and S. Natukunda. 2021. *Agri-food Systems that Work for People and Planet: Challenges and Opportunities from Ethiopia, Kenya, Rwanda and Uganda*. London: International Institute for Environment and Development (IIED). https://pubs.iied.org/20196g

Aragie, E., X. Diao, S. Robinson, G. Rosenbach, D.J. Spielman, and J. Thurlow. 2021. *Assessing the Economywide Impacts of COVID-19 on Rwanda's Economy, Agri-food System, and Poverty: A Social Accounting Matrix (SAM) Multiplier Approach*. Rwanda Strategy Support Program Working Paper no. 1. IFPRI, Kigali/Washington, DC.

Arndt, C., X. Diao, P. Dorosh, K. Pauw, and J. Thurlow. 2023. "The Ukraine War's Impacts on Global Poverty and Food Insecurity." *Global Food Security* 36:100680.

Diao, X., P. Hazell, and J. Thurlow. 2010. "The Role of Agriculture in African Development." *World Development* 38 (10): 1375–1383.

Diao, X., and J. Thurlow. 2023. *Impacts of Global Shocks on Poverty, Hunger, and Diets.* Agrilinks Webinar, February 9, 2023. https://agrilinks.org/events/impacts-global-shocks-poverty-hunger-and-diets

Diao, X., M. Ellis, S. Mugabo, K. Pauw, G. Rosenbach, D.J. Spielman, and J. Thurlow. 2022. *Rwanda's Agrifood System: Structure and Drivers of Transformation*. Rwanda SSP Working Paper 6. Washington, DC: IFPRI.

Dorosh, P., and J. Thurlow. 2013. "Agriculture and Small Towns in Africa." *Agricultural Economics* 44: 435–445.

Dusingizimana, P., J. Kazungu, A. Lalui, P. Milani, J. Munanura, A. Nsabimana, J.K. Sindi, D.J. Spielman, and M. Umugwaneza. 2022. *Rwanda's Food Systems Transformation: A Diagnostic of the Public Policy Landscape Shaping the Transformation Process.* Rwanda Strategy Support Program Working Paper no. 4. IFPRI, Kigali/Washington, DC.

Fanzo, J., L. Haddad, R. McLaren, Q. Marshall, C. Davis, A. Herforth, A. Jones, T. Beal, D. Tschirley, A. Bellows, L. Miachon, Y. Gu, M. Bloem, and A. Kapuria. 2020. "The Food Systems Dashboard Is a New Tool to Inform Better Food Policy." *Nature Food* 1 (5): 243–246. https://doi.org/10.1038/s43016-020-0077-y

Haggblade, S., P. Hazell, and P. Dorosh. 2007. "Sectoral Growth Linkages Between Agriculture and the Rural Nonfarm Economy." In *Transforming the Rural Nonfarm Economy: Opportunities and Threats in the Developing World*, eds. S. Haggblade, P. Hazell, and T. Reardon. Washington, DC: Johns Hopkins University Press.

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

IFPRI, MINECOFIN (Ministry of Finance and Economic Planning of Rwanda), and National Institute of Statistics of Rwanda (NISR). 2021. A 2017 Social Accounting Matrix (SAM) for Rwanda. Draft Report. Kigali/Washington, DC: IFPRI/MINECOFIN/NISR.

ILO (International Labour Organization). 2020. *Modeled Estimates of the Labor Market*. Geneva.

Malabo Montpellier Panel. 2021. “Case Study: Rwanda.” In *Connecting the Dots: Policy Innovations for Food Systems Transformation in Africa*. Dakar: Akademiya2063. https://www.mamopanel.org/resources/reports-and-briefings/case-study-rwand-connecting-dots-policy-innovation/

NISR (National Institute of Statistics of Rwanda). 2022a. GDP National Accounts, 2021. Kigali. https://pip.worldbank.org/country-profiles/RWA

_____. 2022b. The Fifth Population and Housing Census - 2022. Kigali.

_____. 2021. GDP National Accounts, 2020. Kigali. https://pip.worldbank.org/country-profiles/RWA

_____. 2018. The Fifth Integrated Household Living Conditions Survey (EICV5). Microdata. Kigali.

_____. 2012. The Fourth Population and Housing Census - 2012. Kigali.

_____. Various years. Labor Force Survey. Data tables. Kigali.

Pauw, K., J. Smart, and J. Thurlow. 2021. *The Short-Run Economic Costs of COVID-19 in Developing Countries in 2020: A Synthesis of Results from a Multi-country Modeling Exercise*. Project Note (June 2021), Washington, DC: IFPRI.

Thurlow, J., B. Holtemeyer, X. Diao, K. Pauw, and J. Randriamamonjy. 2023. Measuring Agrifood Systems: New Indicators and Global Estimates. Mimeo. Washington, DC:IFPRI.

Timmer, C.P. 1988. “The Agricultural Transformation.” In *Handbook of Development Economics*, Vol. 1, eds. H. Chenery and T.N. Srinivasan, 276–328. Amsterdam: Elsevier Science Publishers.

World Bank and Government of Rwanda. 2020. *Future Drivers of Growth in Rwanda: Innovation, Integration, Agglomeration, and Competition*. Washington, DC: World Bank.

World Bank. 2023. *Global Economic Prospects, January 2023*. Washington, DC. http://hdl.handle.net/10986/38030

Appendix

Table A1. Value chain groups and their corresponding agricultural subsectors

Value chain groups and their share of AgGDP+	Individual value chains (or agricultural subsectors) in the group and their share of the group's agricultural GDP
Maize (2.3%)	Maize 100%
Rice (2.9%)	Rice 100%
Other cereals (2.2%)	Sorghum & millet 93.5% | Wheat & barley 3.5% | Other cereals 3.1%
Groundnuts (2.7%)	Groundnuts 100%
Soybeans (0.3%)	Soybeans 100%
Beans (4.4%)	Beans 100%
Irish potatoes (4.0%)	Irish potatoes 100%
Other roots (17.6%)	Cassava 49.7% | Sweet potatoes 23.4% | Cooking bananas 14.3% | Cooking bananas 12.4%
Vegetables (3.0%)	Leafy green vegetables 27.9% | Other vegetables 72.1%
Fruits (11.9%)	Nuts 2.4% | Sweet bananas 57.8% | Other fruits 37.8%
Export crops (5.1%)	Coffee 61.1% | Tea 37.4% |Cut flowers 1.5%
Other crops (5.2%)	Sugarcane 82.0% | Tobacco 6.3% | Other crops 11.7%
Cattle & raw milk (9.5%)	Cattle meat 45.6% | Raw milk 54.4%
Other livestock (2.2%)	Poultry meat 27.8% | Eggs 18.8% | Small ruminants 35.8% | Other livestock 17.6%
Fish (1.2%)	Aquaculture 15.5% | Capture fisheries 84.5%
Forestry (20.9%)	Forestry 100%

Source: Authors' calculation based on the 2019 Social Accounting Matrix for Rwanda (IFPRI et al. 2021).

This work is part of the CGIAR Research Initiatives on Foresight and National Policies and Strategies. We thank all funders who supported this research through their contributions to the CGIAR Trust Fund. This publication was also made possible through support provided by the Office of Policy, Analysis and Engagement, Bureau for Resilience and Food Security, U.S. Agency for International Development, under the Policy, Evidence, Analytics, Research and Learning (PEARL) Award# 720RFS22IO00003. The research was also jointly funded by the Bill and Melinda Gates Foundation (BMGF). Additional financial support was provided by the International Growth Centre (IGC) and the European Union through their funding to the Strategy Support Program in Rwanda, a joint initiative of the Ministry of Agriculture and Animal Resources (MINAGRI) and IFPRI. Financial support for developing and updating the Rwanda SAM and CGE model used in this paper was provided by the Deutsche Gesellschaft für Internationale Zusammenarbeit Gmb (GIZ). We thank Didier Tabaro and Eric Mutabazi at MINECOFIN, Anna Twum at IGC, and Chantal Ingabire, Octave Semwaga, Peter Ntaganda, Bertrand Dushimayezu, and Sosthene Ndikumana at MINAGRI for their comments on the working paper version of the brief; and the participants at an IFPRI Rwanda policy seminar held on June 22, 2022, with support from the IGC and European Union. The brief has not been Independently peer reviewed. Any opinions expressed here belong to the author(s) and are not necessarily representative of or endorsed by the Government of Rwanda, IFPRI, CGIAR, USAID, or any of the organizations listed above.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

A world free of hunger and malnutrition

IFPRI is a CGIAR Research Center

1201 Eye Street, NW, Washington, DC 20005 USA | T. +1-202-862-5600 | F. +1-202-862-5606 | Email: ifpri@cgiar.org | www.ifpri.org | www.ifpri.info