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Making the healthy choice the easy choice.

Policy levers to increase the availability of moderately processed foods in
low- and middle-income countries



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Cristhina Maria Llerena, Janosch Klemm

Abstract

Modifying food from its raw state for convenience, durability, or palatability is a standard process that can range from fermentation to 3D-printed foods. The overall activity is typically referred to as “food processing”. Moderately or minimally processed foods, which retain most of their raw nutritional value – or increase it – while undergoing minimal processing for improved shelf-life, preservation, or taste, can play an important role in shaping sustainable food systems so that they are profitable from the production side, beneficial from a health and nutrition side, and low-impact from a planetary boundary perspective.

While much of the debate on processing centers on so-called ultra-processed foods, we review the evidence on minimally processed foods and the options public policymakers have to increase their availability through the private sector. We focus on five value chains for four commodities (soy, milk, cashew apple, fruits and vegetables) and structure review findings alongside activities across the value chain (from inputs to consumption) and drivers across the policy landscape. We find that moderately processed foods offer important nutritional and health benefits. Moreover, the development of food processing can positively impact people’s well-being by creating jobs and increasing incomes. We conclude by providing a structured overview of policy tools at policy designers disposal to strengthen government support: facilitating access to credit, providing fiscal incentives and technical assistance—while simultaneously enforcing food regulations and quality standards—can encourage and support private investment in the production and consumption of nutritious, moderately processed foods, thereby increasing their availability, particularly in low- and middle-income countries.

Keywords: Food processing, minimally processed foods, food systems, value chains, fiscal incentives, food regulation, sustainable food systems

JEL codes: Q18, I15, L66, G28

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2. Executive Summary

Sub-Saharan Africa and many other low- and middle-income country (LMIC) contexts face a triple nutrition challenge. **Undernourishment** in Africa has increased since 2015, now affecting 20% of the population, while 61% experience **moderate or severe food insecurity**. **Micronutrient deficiencies** are estimated to affect 62% of children under 5 in the African context and 80% of women of reproductive age (Stevens et al., 2022). At the same time, **adult obesity** is also rising, now at levels around 20% in many countries in Africa (FAO, 2023). Economic growth, rapid urbanization, and globalization are shifting food consumption patterns, replacing traditional diets with more processed products. **Consumers increasingly orient their food choices towards convenience, quality, safety, and variety**, driving expenditure away from primary production toward modified or processed foods (Hashad et al., 2024; Mbogori et al., 2020; Shekar and Popkin, 2020; Yi et al., 2025). This shift leads to the ubiquity of so-called ultra-processed foods.

However, today nearly all foods undergo *some* degree of processing, although exact definitions of what different types of processing entail are debated. Here, we consider **moderately processed foods, which are foods that retain much of their nutritional value with added benefits over the raw product**, such as preservation to reduce the risk of spoilage and foodborne diseases (Augustin et al., 2016; Glatzel et al., 2024).¹ Moderate processing also improves food availability by extending shelf life, reducing food losses and waste, and ensuring year-round access despite seasonal fluctuations in the underlying raw commodity (Ameye and Glatzel, 2025; Augustin et al., 2016; FAO, 1997; Glatzel et al., 2024).

Moderate food processing can make nutritious foods more widely available and affordable, particularly in LMICs. Emerging evidence also suggests that diets rich in minimally or moderately processed foods can play a preventive role in the development and progression of cardiometabolic diseases (De Jesus Santana et al., 2021; Hynes, 2021; Saharia et al., 2016). Current consumption trends show an increase in processed foods, and increasing the availability of moderately processed foods is an important opportunity to address the triple burden of malnutrition in Africa. Processing, more generally, also creates economic opportunities, promotes employment, and can contribute to gender equality within households.

Despite their potential, little systematic evidence is available on the policy mechanisms available or recommended to increase the availability of nutritious, moderately processed foods at different stages of the value chain. To address this gap, this policy brief summarizes the evidence for five value chains in different countries. We provide an overview of **(a) relevant actors across the value chain** in LMICs, **(b) key support measures** available to policymakers, and **(c) examples of policies** to overcome value-chain specific barriers. We focus on examples of moderately processed foods, for which evidence on supporting healthy diets exists: soy chunks in Zambia (Bakhtiari et al., 2019), Tempeh in Indonesia (Romulo and Surya, 2021; Suriani et al., 2021), the dairy value chain in Rwanda (Rabbani et al., 2025; Rumbold et al., 2022), Cashew nuts and apples in Cameroon (Akyereko et al., 2023), and general fruits and vegetables in Kenya (Sullivan et al., 2021). We review documentation on policy mechanisms throughout the specific value chains and summarize them to provide an overview of available policy tools.

¹ Please refer to the accompanying discussion paper for a detailed overview and comparison of different food processing definitions.

3. Introduction

Nowadays, almost all foods undergo some degree of processing (Gou and Zheng, 2025), be it drying, fermenting, preservation, or mixing. There is wide disagreement about what processing exactly means, whether it is a useful concept for classifying foods, if so, at what level processing becomes problematic for human health, and what cut-offs best serve to categorize this. In many cases, food processing results in energy-dense but nutrient-poor convenience foods, typically referred to as “ultra-processed”. However, the potential problematic aspects of these foods can also be captured – and are well-established – at the nutrient level, including sugar, sodium, or trans-fats. And while the benefits of fresh, nutrient-dense foods are undisputed, *some* degree of processing greatly improves the practicality and convenience of day-to-day food choices.

From a policy perspective, this poses a dilemma: Overregulating agrifood processors can yield counterproductive results and choke industry growth, but a complete lack of regulation is likely to be associated with public health consequences manifest in cardiovascular diseases, diabetes, or obesity. Although some policies focus on regulating ultra-processed foods (Scrinis et al., 2025), there is less clarity on which measures support nutritious, moderately processed foods. The question this study therefore aims to answer is which policy instruments are available to incentivize, support, or regulate the private sector to increase the availability of nutritious, moderately processed foods?

To this end, we conduct a literature review and analyze five value chains as case studies (detailed analyses of each value chain in the Appendix document). Based on this, we outline the food classification typology we are following and provide an overview of the structure of the private sector in agrifood systems transformation, including a distinction between low- and middle-income countries (LMICs) and high-income countries (HICs). We then provide a summary of key value chain structures and drivers in the policy landscape. This discussion paper concludes by outlining key recommendations for policymakers in LMICs seeking to engage the private sector to increase the availability of nutritious, moderately processed foods.

4. Moderately processed foods

The United States Department of Agriculture (USDA) defines processed foods as “*any raw agricultural commodity that has been subject to ... procedures that alter the food from its natural state*” (Jones, 2019). Food processing has been a common practice since the origins of humankind. Techniques such as cooking, fermentation, and salt preservation were part of food routines more than two million years ago (Welch and Mitchell, 2000).

Food processing can offer several advantages, including increasing shelf life, improving sensory appeal, and reducing cooking time (Augustin et al., 2016; Evrendilek, 2018; Glatzel et al., 2024). Nevertheless, modern industrial processing methods are complex and may present potential risks. Some products contain high levels of artificial additives or experience nutritional losses during processing (Correia et al., 2008). This has raised concerns about the effects of food processing on public health, particularly regarding chronic diseases and diet quality (Moubarac et al., 2014).

To address these challenges, multiple food classification systems have been developed based on the degree of processing. These frameworks aim to group foods by level of transformation, from unprocessed to ultra-processed (De Araújo et al., 2022; Jennifer M Poti, 2015), and have been applied

in epidemiological research, dietary guidelines, and the development of food policies (Sadler et al., 2021).

Among the main systems are the classifications developed by the National Institute of Public Health (NIPH) of Mexico in 2007, by the International Agency for Research on Cancer (IARC) in Europe in 2009, and the NOVA system created in Brazil by researchers at the University of São Paulo, which was updated in 2015 (Sadler et al., 2021). NOVA is the most widely used internationally (Marino et al., 2021), although its scientific basis and practicality have been criticized (Gibney, 2019). Other important proposals include systems by the International Food Policy Research Institute (IFPRI) in Guatemala (2011), the International Food Information Council Foundation (IFIC) in the United States (2012), the University of North Carolina (UNC) in 2015 (Jennifer M Poti, 2015), and the SIGA system in 2020 (Sadler et al., 2021). While similar in aim, these classification systems differ in scope, definition, and structure (cf. Table 1). For example, regarding the number of processing groups, IFPRI uses three categories, NOVA four, IFIC five, and UNC up to seven (Jennifer M Poti, 2015), as shown in Table A1 in the Annex.

Due to the complexities of food composition and related health effects, it remains challenging to reach consensus on how to classify different levels of processing (Sadler et al., 2021). In some cases, nutritious foods -such as hummus- have been categorized as ultra-processed (Crino et al., 2018), and other industrialized products, such as infant formula, do not necessarily have poor nutritional profiles (Derbyshire, 2019). De Araújo et al. reported inconsistencies in the classification of foods, especially cereals, milk products, added lipids, sugar, and alcoholic beverages, which directly affect the estimation of the contribution of ultra-processed products to the total diet (De Araújo et al., 2022). Therefore, discrepancies have been identified among classification systems (Bleiweiss-Sande et al., 2019; Sadler et al., 2021).

Despite these limitations, these classification systems offer benefits. They have established a new basis for epidemiological and experimental research, and serve as a reference for developing official reports and dietary guidelines aimed at promoting and protecting public health (Moubarac et al., 2014). They also tend to align with overconsumed dietary components such as added sugars and sodium (Bleiweiss-Sande et al., 2019). Although processing-based classification systems are not fully aligned, this does not invalidate the findings on how diet affects health. Conclusions on processed foods will depend on the conceptual framework (Bleiweiss-Sande et al., 2019) and the criteria used to define what is or is not a processed food.

In the context of modern food processing, consumption is shifting from traditional diets to more processed ones, driven mainly by rising income levels, rapid urbanization, and globalization (Hashad et al., 2024; Shekar and Popkin, 2020). Food processing itself is not an issue — nowadays, nearly all foods undergo some form of processing (Gou and Zheng, 2025). Healthy, moderately processed foods offer several benefits. Techniques such as drying, canning, freezing, fermentation, and vacuum-packing can improve food quality, safety, and accessibility by preserving nutritional content, lowering the risk of spoilage and foodborne illnesses, and extending the shelf life of fresh foods (Ameje and Glatzel, 2025; Augustin et al., 2016; Glatzel et al., 2024). By extending the shelf life, processing helps reduce food loss and waste, supports broader distribution, ensures year-round availability, and mitigates the effects of seasonality (FAO, 1997). These methods make nutritious products more accessible while creating economic opportunities, especially in LMICs (Ameje and Glatzel, 2025).

According to the NOVA classification, unprocessed and minimally processed foods (Group 1) primarily aim to extend the shelf life of fresh foods and make them safe to eat by removing inedible parts or using methods such as drying, fermentation, pasteurization, freezing, and vacuum packaging (Monteiro et al., 2019). Meanwhile, processed foods (Group 3) enhance sensory qualities and make food more palatable. They are produced by adding processed culinary ingredients (Group 2). Standard methods include canning, bottling, salting, smoking, and curing, and some products are canned vegetables, salted or sugared nuts, and smoked meats. These products usually retain the basic identity and most nutrients of the original food (Monteiro et al., 2019).

In the SIGA system, unprocessed foods (A0) are in their natural state, without significant industrial alteration (Davidou et al., 2021, 2020). Minimally processed foods (A1) have undergone mild treatments—such as washing, refrigeration, or freezing—without altering their original matrix, and include items like flour, tomato concentrate, or tofu. Nutritionally balanced processed foods (B1) are processed but retain adequate nutritional balance without excessive salt, sugar, or fat, such as traditional bread, tomato juice, canned peas, or vegetable juice (Davidou et al., 2021, 2020).

Finally, according to Poti et al., unprocessed and minimally processed foods include single-ingredient foods and beverages that have undergone no or very slight modifications that do not alter their inherent properties (Jennifer M Poti, 2015). Processes include portioning, packaging, removal of inedible parts, drying, freezing, or pasteurization. Meanwhile, basic processed foods and beverages remain single foods but are modified for preservation, such as canning, concentrating fruit juice, or precooking grains. Moderately processed foods are divided into two subcategories: those processed for flavor, which are minimally or basic processed foods with added flavoring agents (sweeteners, salt, fats) but still recognizable in their original form—such as salted nuts, fruit in syrup, or vegetables with added salt—and moderately processed grain products, which include whole-grain breads, tortillas, crackers, or breakfast cereals made from whole-grain flour without added sweeteners or fat (Jennifer M Poti, 2015).

Table 1 Food classification systems

Systems	Classification	Subclassification
NOVA	NOVA1 (Unprocessed and minimally processed foods)	
	NOVA2 (Processed culinary ingredients)	
	NOVA3 (Processed food products)	
	NOVA4 (Ultra-processed products)	
SIGA	A. Un-/minimally processed	A0. intact raw initial matrix A1. degraded raw matrix A2. culinary ingredients
	B. Processed	B1. added salt, sugars, fat ≤ official recommendations B2. added salt, sugars, fat > official recommendations
	C. Ultra-processed - loss of matrix/contains purified and /or denatured ingredients (excludes vitamins, minerals, and tolerance of preservatives)	C01. balanced nutritional profile & one industrial ingredient/additive C02. high added fat/sugar/salt C1. unprocessed industrial ingredients and/or limited additives C2. processed industrial ingredients and/or high additives C3. ultra-processed industrial ingredients and/or very high additives
POTI	Less processed (Unprocessed/minimally processed)	

Basic processed	Processed basic ingredients Processed for basic preservation or precooking
Moderately processed	Moderately processed for flavour Moderately processed grain products
Highly processed	Highly processed ingredients Highly processed stand-alone

Source: (Sadler et al., 2021)

In general, we consider minimally and moderately processed foods those that have undergone limited processing—such as cleaning, drying, freezing, fermentation, or the addition of small amounts of culinary ingredients—to improve shelf life, safety, or flavor, while preserving their original identity and nutritional value. Within this context, we selected and analyzed five products classified as minimally or moderately processed foods: pasteurized and powdered dairy (NOVA1; SIGA A1; Poti: Less processed/Basic processed), soy chunks (NOVA3; SIGA A1/B1; Poti: Moderately processed), soy tempeh (NOVA3; SIGA A1/B1; Poti: Moderately processed), cashew apple (NOVA1; SIGA A0; Poti: Less processed) and nut (NOVA1; SIGA A0; Poti: Less processed/Moderately), and frozen or dried fruits and vegetables (NOVA1, SIGA A1; Poti: Less processed).

5. Evidence on food processing and nutrition indicators

Minimally and moderately processed foods provide health and nutritional benefits. Jesús Santana et al. found that diets rich in minimally processed foods (defined as natural products from plants or animals with little or no alteration—such as milled or packaged grains, or with added salt or sugar—such as cheese) can play a preventive role in the development and progression of cardiometabolic diseases by reducing LDL-cholesterol (De Jesus Santana et al., 2021). Similarly, a study by the National Institutes of Health found that individuals on ultra-processed diets consumed more calories and gained more weight than those on minimally processed diets (Hynes, 2021). Furthermore, Saharia et al. found that increased intake of minimally processed leafy green vegetables (as snacks in fresh or dried forms), fruits, and milk before and during pregnancy was associated with a reduced risk of gestational diabetes mellitus (Saharia et al., 2016).

Evidence on selected food products highlights similar health and nutritional advantages. The pasteurization of milk extends shelf life, improving availability in many regions (Rabbani et al., 2025). Pasteurized milk ensures safety by reducing harmful bacteria (LeJeune and Rajala-Schultz, 2009) and thereby contributing to the decline of milk-borne diseases. Cow's milk remains a major source of calcium, iodine, riboflavin, magnesium, and potassium for school-aged children (Rumbold et al., 2022), contributing to their cognitive and physical development.

Soybeans are the base commodity for several minimally processed foods, including Tempeh, Soy chunks, or Tofu. Bakhtiari et al. found that 12 weeks of consumption of textured soy protein (TSP) significantly reduced total cholesterol levels and improved antioxidant capacity (Bakhtiari et al., 2019). It also has positive effects on lipid profiles and markers of glucose metabolism, indicating that its regular inclusion in diets could help mitigate the need for medical interventions by addressing multiple metabolic disorders. Moreover, tempeh enhances the bioavailability of proteins, vitamins, and minerals while reducing anti-nutritional content (Romulo and Surya, 2021). Studies have found tempeh to be effective in improving weight among malnourished children (Suriani et al., 2021), lowering cholesterol levels in hyperlipidemic women (Afifah et al., 2020), and providing anti-aging

effects in peri- and postmenopausal women by improving skin quality, bone density, and uterine health (Khosravi and Razavi, 2021; Sapbamrer et al., 2013).

Cashew apples, which are often discarded due to a lack of awareness of their benefits, are rich in vitamin C, fiber, flavonoids, amino acids, and essential minerals (Das and Arora, 2016; Gawankar et al., 2018; Singh et al., 2019). These nutrients support immunity, cardiovascular and neurological functions, and skin integrity (Akyereko et al., 2023). Cashew apples have also been traditionally used to treat various ailments such as bronchitis, diabetes, arthritis, and oral ulcers, and they have the potential to strengthen the immune system and enhance antioxidant activity (Aslam et al., 2024). Lastly, dried or frozen fruits and vegetables have also shown favorable outcomes. Data indicate that individuals who consume dried fruits generally have lower body mass index, waist circumference, and systolic blood pressure, along with better dietary quality than nonconsumers (Sullivan et al., 2021).

The collective evidence supports that minimally and moderately processed foods can play a critical role in improving diet quality and nutrient adequacy. Their nutritional density, safety profiles, and contributions to health outcomes highlight their potential in public health and nutrition strategies. Promoting their production, accessibility, and consumption should be a fundamental part of nutrition and health policies in LMICs.

6. Private sector in agrifood systems

The private sector plays a central role in transforming agrifood systems. It comprises all types of businesses and enterprises — ranging from smallholder farms to large multinational corporations — operating across the formal and informal sectors (Dubbeling et al., 2016), from production, processing, to retail.

In **the LMIC context**, the agrifood system is characterized by the coexistence of formal and informal sectors. Formal-sector enterprises represent only a relatively small share. A large share of food production and distribution occurs through informal channels, predominantly composed of micro, small, and medium-sized enterprises (Sautier et al., 2006; Yasmeen and Kunin, 2018). These include small-scale farms, street food vendors, market traders, home-based catering services, traditional markets, and street kiosks, which play a major role. In general, the informal sector relies on low levels of technology, and the formal sector operates with more advanced technologies (Da Silva et al., 2009).

The predominance of informality, particularly among smallholders, is linked to structural constraints such as limited access to capital, credit, market information, and food processing technologies; a lack of market connectivity for food products; and the generally low value-added status of most agrifood outputs (Yasmeen and Kunin, 2018). Smallholder farmers and small processors are also weakly integrated into value chains and suffer from limited technological adoption (World Bank & CIAT., 2016). These barriers hinder value addition, innovation, and resilience within the private agrifood sector.

As urban populations expand in LMICs, food processing increasingly connects rural producers with urban consumers, creating forward and backward links along the value chain (Wilkinson and Rocha, 2008). These connections help drive innovation, improve productivity, and raise the overall quality

within agricultural value chains. Food processing can create jobs and income, helping more people access food and contributing to achieving food security goals (FAO, 1997).

In contrast, agrifood systems in **HICs** are heavily industrialized and characterized by significant market concentration (McCullough et al., 2008). These systems have strong coordination, strict quality standards, and high food safety regulations. The sector is dominated by large firms that control major segments of food processing, distribution, and retail – sometimes referred to as “big food”. Over the past four decades, a small number of large firms have come to dominate key segments of the food system in HICs — particularly in seeds, livestock processing, and food retail. For instance, in the United States between 2018 and 2020, just two companies controlled more than half of the planted corn and soybean acreage (Macdonald et al., 2023). This increasing concentration has been driven by technological advancements, evolving market demand, and supply chain restructuring, with mergers playing a significant role.

In the retail sector, national chains have gained dominance, leading to a sharp rise in overall market concentration. In Europe, large companies (those with more than 250 employees) represent only 0.9% of all food and drink enterprises, yet they account for 52% of industry turnover and contribute nearly 40% of employment (Wilkinson and Rocha, 2008). Retail concentration has also accelerated processing concentration, with two or three firms dominating many final food market segments (Da Silva et al., 2009). Agricultural structures have evolved as well: small farms are disappearing, while large-scale farms have increased in both size and number (OECD, 2023).

Table 2 Structures of the private sector in lower-middle and high-income countries

	Low- and Middle-Income Countries	High-Income Countries
Dominant enterprise type	Small to medium-sized enterprises	Large corporations
Level of formality	High informality	High formality
Technological level	Low to medium, mostly manual	High, automated
Value chain integration	Limited, with bottlenecks	High, with consolidated chains
Access to finance	Restricted	Broad and sophisticated
Market concentration	Low, fragmented across many actors	High, dominated by a few large firms

Source: based on the reviewed literature

Coordination among governments, NGOs, and value chain actors also varies between LMICs and HICs. The high prevalence of diverse, fragmented informal small- and medium-sized enterprises in the private sectors of many LMICs can generate employment and ensure local food availability. They also represent a diversified supplier base, which can enhance supply security in volatile markets by spreading sourcing across regions, lowering the risk of shortages, and reducing vulnerability to localized pest or disease outbreaks. In addition, sourcing locally from smallholders can form part of a company’s corporate social responsibility strategy (Da Silva et al., 2009). However, their high dispersion and limited operational capacity create coordination challenges within value chains. According to Da Silva et al., both traditional export commodities and fresh “non-traditional” products often require specific quality attributes (Da Silva et al., 2009), which demand new forms of economic coordination through contracts and supply chain management (Gereffi et al., 2005). These

requirements pose a considerable challenge when working with small-scale farmers, as they are often perceived to entail higher transaction costs and greater risks due to their fragmented structure. They are also frequently seen as less dependable in fulfilling trade agreements, given limited technical skills and inadequate access to technologies needed to deliver products that meet quality, timing, and consistency requirements (Da Silva et al., 2009).

Moreover, coordinating with multiple smallholders can pose challenges for governments when implementing programs or policies. The highly fragmented nature of small-scale producers makes it difficult to channel support, monitor compliance, and ensure consistent outcomes. Nevertheless, the development of producer associations and cooperatives can serve as a mechanism to improve coordination, aggregate supply, and facilitate government engagement with dispersed farming populations.

By contrast, high-income countries are characterized by intensive vertical integration and oligopolistic market structures; advanced production and safety technologies that enable standardization and scalability; and integrated supply chains that achieve significant operational efficiencies.

Without effective mechanisms for integration, SMEs remain excluded from higher-value market opportunities, which undermines the competitiveness of entire sectors (Da Silva et al., 2009). Therefore, well-designed public policies can act as catalysts to address these coordination barriers, particularly in LMICs.

7. Food-processing sector

Food processing contributes to GDP and adds monetary value to agricultural production. In industrialized countries, such as Germany, the food processing industry generates six times more revenue than the corresponding primary production (Wissenschaftlicher Beirat für Agrarpolitik und Ernährung und gesundheitlichen Verbraucherschutz (WBAE), 2020). This means that processing is one of the most significant value-creating steps in a product's overall value chain. When analyzing the ratio of the value of primary food production to that of manufacturing value added in food production, Hartwich et al. found that in HICs, the value of food processing in some developed countries even surpasses that of primary production. In contrast, in LMICs, this value represents only about 0.3%. Developing the food processing sector could provide substantial value addition and generate significant revenue (Hartwich et al., 2025).

Food processing, as part of the agroindustry, is a key component of economic and social development in LMICs. The growing demand for value-added foods underscores the importance of developing the processing sector to support economic growth (Da Silva et al., 2009). Economically, processing adds value to agricultural products, which translates into boosts for rural economies by increasing incomes, reducing poverty, and creating direct employment -generally with higher wages- in processing activities and indirect employment in related sectors such as transportation (FAO, 1997; Hartwich et al., 2025; Wilkinson and Rocha, 2008). The decentralization of these activities contributes to regional development and reduces rural-urban migration by creating job opportunities in agricultural areas (Dobre et al., 2022). Processing contributes to raising the living standards of rural communities and strengthening the local economy.

7.1. Opportunities

Processing in LMICs presents multiple opportunities. These include improving supply chain efficiency through stronger producer-processor linkages, expanding market access for smallholder farmers, tapping into changing domestic and international demand patterns, and advancing gender equality.

Perishability and variable quality of raw agricultural inputs drive processors to engage directly in primary production or develop long-term supply relations and agreements with farmers. Such relationships improve production efficiency, strengthen the supply chain integration, secure reliable input supply, and encourage the cultivation of crop varieties optimized for processing (Da Silva et al., 2009).

The integration of the value chain can expand market access for smallholder farmers, as processing firms are increasingly open to sourcing from small-scale producers. This trend presents opportunities to integrate these farmers into formal value chains (Santacoloma et al., 2007). Contract farming arrangements, particularly those oriented towards export markets, offer diversification benefits and potential for income generation and job creation among rural populations (Sautier et al., 2006).

Changing consumption patterns also creates lucrative opportunities. Responding to these shifts in demand is highly beneficial. At the local level, urbanization drives food diversification, expanding the demand for processed staples that were once limited to specific regions or ethnic groups. In Central Africa, processed foods such as cassava couscous (*attiéké*) have spread far beyond their original markets due to urban migration and evolving dietary preferences (Sautier et al., 2006). Internationally, there is increasing year-round demand in developed countries for out-of-season fresh vegetables, which LMICs can supply by leveraging their agro-climatic advantages (Da Silva et al., 2009; Sautier et al., 2006). This presents a potentially lucrative opportunity for LMICs through higher-value exports.

Processing also offers distinct opportunities to promote gender equality. By increasing the convenience of healthy foods, such as precooked canned legumes that reduce preparation time, processing reduces time burdens on women. Additionally, it helps maintain nutritional standards for women, children, and households by prolonging shelf life and reducing the reliance on less nutritious food alternatives (Ameye and Glatzel, 2025).

7.2. Barriers

Food processing faces a complex array of interrelated barriers that hinder its growth, competitiveness, and contribution to rural development in LMICs. Key constraints include limited access to capital and credit, outdated technologies, insufficient infrastructure, and inadequate human capital. Market-related barriers—unequal integration into value chains and difficulties in meeting food safety and quality standards—further exacerbate these constraints. Institutional and policy shortcomings, including weak competition frameworks and bureaucratic inefficiencies, compound the problem. These issues disproportionately affect smallholder farmers and small-scale processors, often resulting in their exclusion from lucrative supply chains (Da Silva et al., 2009; Sautier et al., 2006; Urugo et al., 2024).

Limited access to credit, driven by high borrowing costs or limited collateral, limits investment in modern technologies, processing facilities, purchasing equipment, and capacity-building initiatives.

For instance, in contexts such as Vietnam, insufficient funding is a primary reason entrepreneurs avoid entering the food processing sector, constraining the sector's ability to scale and modernize (Urugo et al., 2024; Yasmeen and Kunin, 2018).

Technological and innovation deficits undermine competitiveness. Many processors rely on outdated machinery and processing methods, constraining efficiency and limiting value addition. In Vietnam, low-value-added output stems mainly from the inadequate application of science and technology in both farming and processing (Yasmeen and Kunin, 2018). As product safety and quality standards become more demanding in global markets, technological lag disadvantages LMIC producers, particularly small-scale farmers, who are unable to comply without targeted support (Da Silva et al., 2009).

Infrastructure weaknesses—including unreliable electricity and clean water supplies, inadequate storage facilities or cold chains, limited information and communication technologies (ICT), and poor transportation networks—create barriers to market access (Da Silva et al., 2009). In Ethiopia, postharvest losses of up to 45% are driven by insufficient storage, limited cold chain capacity, and poor transportation infrastructure, which prevent timely delivery to processing centers and markets (Urugo et al., 2024). Such deficiencies also delay the sector's transition from informal to formal operations, trapping enterprises in low-productivity cycles. Also, they put processors at a competitive disadvantage to their industrialized country competitors. Potentially competitive food processors may be unable to access lucrative markets due to unreliable and costly transportation systems (Da Silva et al., 2009).

The shortage of skilled labor and limited human capital also exacerbates productivity challenges. While multinational companies can import expertise, domestic firms must develop skills internally or depend on costly external providers. The lack of specialized training programs constrains the ability to operate modern processing technologies, innovate, and comply with evolving food safety standards (Da Silva et al., 2009). Skilled labor shortage impedes efficiency and stifles innovation (Urugo et al., 2024). As mentioned by Da Silva et al., "*while access to technology is critical, no technology can be employed unless there is a trained workforce to operate it*" (Da Silva et al., 2009).

Market access and integration into value chains remain uneven, with smallholder farmers and small processors facing structural disadvantages. Limited access to credit, insurance, and specialized inputs, coupled with poor market information, reduces competitiveness and increases transaction costs. High entry barriers—such as compliance with stringent quality standards, contractual requirements, and scale economies—often exclude small producers (Sautier et al., 2006).

Achieving compliance with food safety and quality standards remains a challenge for the agrifood sector in LMICs. Moving from basic to advanced processing requires capital, infrastructure, modern technology, skilled labor, and strong market linkages (Srivastava, 1989)—resources often beyond the reach of small and medium enterprises. For smallholders, stringent private standards pose high entry barriers (Sautier et al., 2006).

Institutional and regulatory constraints also impede growth. Bureaucratic inefficiencies in business registration, the high costs of formalization, contract enforcement, and licensing, and the resulting delays discourage investment and slow formalization. Interventions are required to address these

challenges and unleash the sector's potential (Da Silva et al., 2009). It is essential to establish supportive policies, focusing strategically on streamlining their implementation and fostering a conducive regulatory environment (Urugo et al., 2024).

Food processing in LMICs operates within a landscape of constraints that collectively limit its ability to grow, compete, and drive rural transformation. These challenges are not isolated but mutually reinforcing, often hitting smallholders and small-scale processors the hardest. Addressing them requires integrated strategies that combine targeted investments, inclusive market linkages, skills development, infrastructure upgrades, and streamlined regulatory frameworks. Without such coordinated action, the sector risks entrenching inequality and missing opportunities for value addition, job creation, and poverty reduction; but with it, processing can become a powerful lever for sustainable and inclusive economic growth.

Table 3 Barriers and impacts

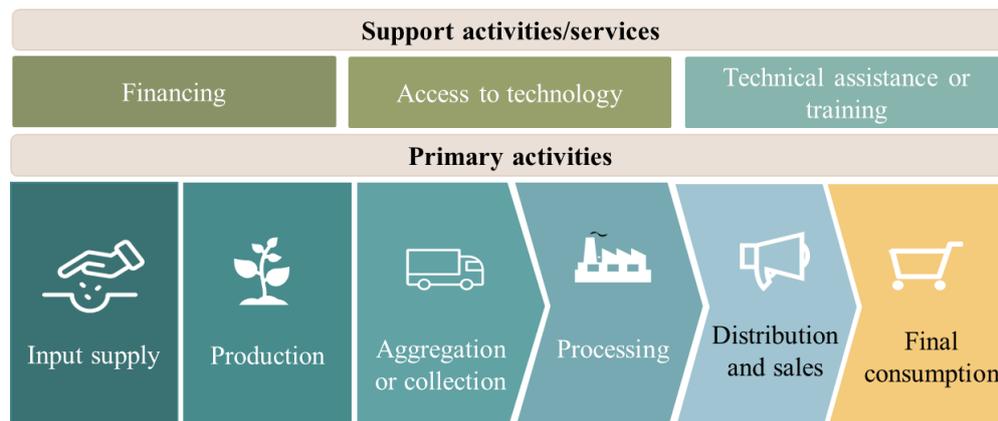
Barrier/challenges	Key Description	Main Impacts
Access to credit	Credit scarcity, high borrowing costs, and a lack of collateral	Limits investment in technology, infrastructure, and training; restricts entry into new businesses
Technological and innovation deficits	Use of outdated machinery, low value-added output, and limited adoption of science and technology	Low production efficiency, inability to meet quality standards
Poor infrastructure	Unreliable electricity and water supply, insufficient storage, costly and inefficient transport	Postharvest losses, reduced market access, trapped in informality
Insufficient human capital	Shortage of skilled labor, limited training	Low productivity, reduced innovation, and compliance capacity
Unequal access to markets and value chains	Structural disadvantages for small producers, lack of market information	Exclusion from lucrative chains, higher transaction costs
Compliance with food safety and quality standards	High compliance costs, technical barriers	Hinders transition to advanced processing and access to premium markets
Institutional and regulatory constraints	Bureaucratic procedures, high cost of formalization, unstable regulatory environment	Slows formalization, discourages investment

Sources: based on the reviewed literature

8. Value chain: summary of country case studies

The benefits derived from nutritious, moderately processed products—and from the broader development of food processing—can be realized through a better understanding of processed food value chains. Such understanding enables more effective policy design and implementation.

Figure 1 Processing value chain



Source: Based on the reviewed literature of the five selected value chains

The food processing value chain can be summarized in six stages: input supply, production, aggregation or collection, processing, distribution and sales, and consumption. Input supply includes the provision of seeds, fertilizers, or veterinary services, whose availability, quality, and cost influence overall productivity. Production includes planting and harvesting the crop and determines the quality, volume, and seasonal availability of goods, which are shaped by farming practices and environmental factors. Aggregation or collection consolidates products from multiple producers for processing or marketing. Processing adds value by transforming raw materials into safer, more durable, or more convenient products. This may range from basic activities such as grading and packaging to more industrialized operations. Distribution and sales channel products to consumers through markets, retailers, wholesalers, or kiosks, while consumption takes place domestically or through exports, driven by consumer preferences, purchasing power, and nutritional awareness.

Throughout this process, support services—such as financing, access to technology, training, certification, and technical assistance—enhance the capacity of value chain actors to improve productivity, adapt to market changes, and meet quality standards. These transversal support activities can be decisive, particularly for small producers aiming to integrate and compete in national or global value chains. As presented earlier, several challenges persist across the food processing value chain in LMICs, including limited access to credit, outdated technologies, and weak infrastructure. These constraints are especially burdensome for smallholder producers and processors, who make up much of the sector and often operate informally. Nevertheless, many countries have implemented and continue to develop policies, programs, and projects to strengthen the value chains of moderately processed foods.

The following section summarizes key country-level insights in the value chain and policy-actions implemented or recommended, with a full analysis available per supply chain available in the Appendix to this document.

Figure 2 Soy chunks value chain flowchart

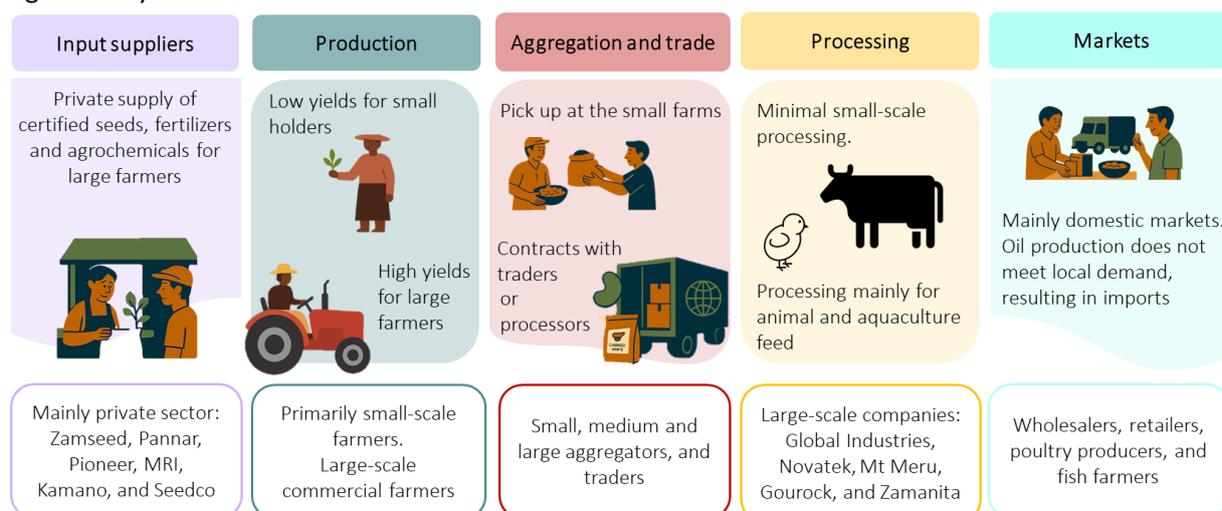


Table 4 Policies implemented or recommended for soy chunks value chain in Zambia

Input	Production	Aggregation or collection	Food processing	Distribution and sales (marketing)	Consumption
<ul style="list-style-type: none"> • Ensure the quality of certified seeds. 	<ul style="list-style-type: none"> • Invest in public goods and services to support production. • Adopt a cluster approach in soybean-producing areas. • Provide access to credit through guarantee funds or tailored credit lines. • Strengthen agricultural research and apply agricultural practices. • Encourage sustainable farming and collaborative productivity initiatives. 	<ul style="list-style-type: none"> • Modernize transport infrastructure, including railways. • Expand access to financial and digital services. • Establish community-managed collection centers. • Regulate the role of intermediaries. 	<ul style="list-style-type: none"> • Adopt a cluster approach in soybean-producing areas and develop small-scale processing plants within farming communities. • Provide access to mechanization technologies. • Strengthening linkages between farmers and processors to ensure supply. • Promote diversification of soybean-processed products. 	<ul style="list-style-type: none"> • Avoid and advocate against (sudden) export bans. 	<ul style="list-style-type: none"> • Expand domestic demand by promoting soybean-based foods as part of healthy diets.

Source: based on the reviewed literature

Figure 3 Tempeh value chain flowchart

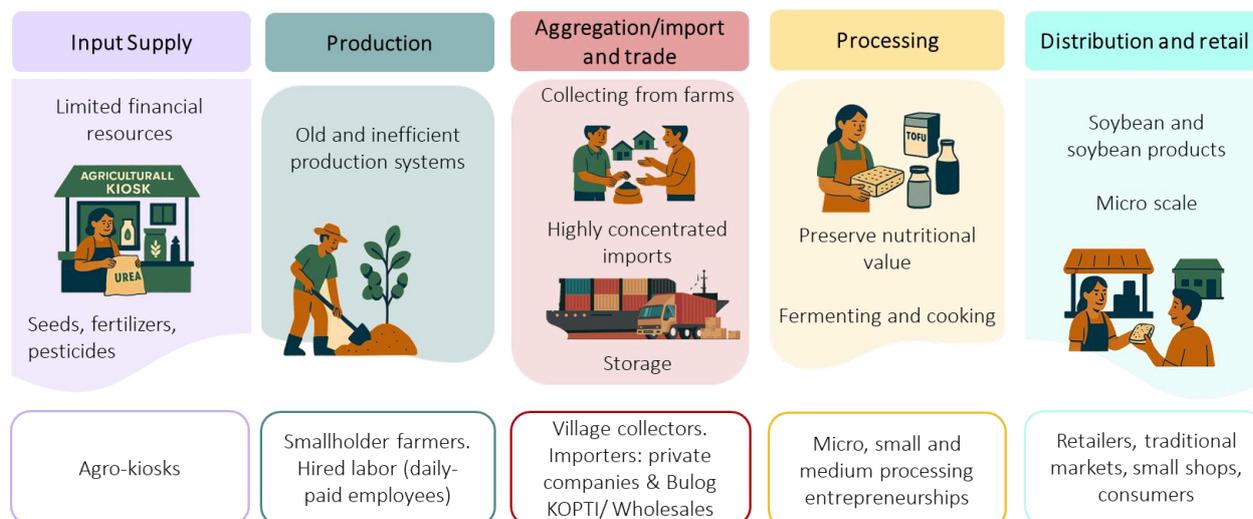


Table 5 Policies implemented or recommended by policy makers for tempeh value chain in Indonesia

Input	Production	Aggregation or collection	Food processing	Distribution and sales (marketing)	Consumption
<ul style="list-style-type: none"> Strengthen the seed system and accelerate the adoption of improved, pest-resistant varieties. Access to credit. 	<ul style="list-style-type: none"> Implement production support programs, including input subsidies, productivity enhancement, and agricultural extension. Provide farmers with access to credit and technical training. 	<ul style="list-style-type: none"> Implement fiscal and infrastructure incentives to strengthen the value chain, including subsidies and improvements in transport and storage facilities. 	<ul style="list-style-type: none"> Provide direct subsidies to tofu and tempeh producers. 	<ul style="list-style-type: none"> Use the state soybean agency to stabilize import prices. 	

Source: based on the reviewed literature

Figure 4 Dairy value chain flowchart

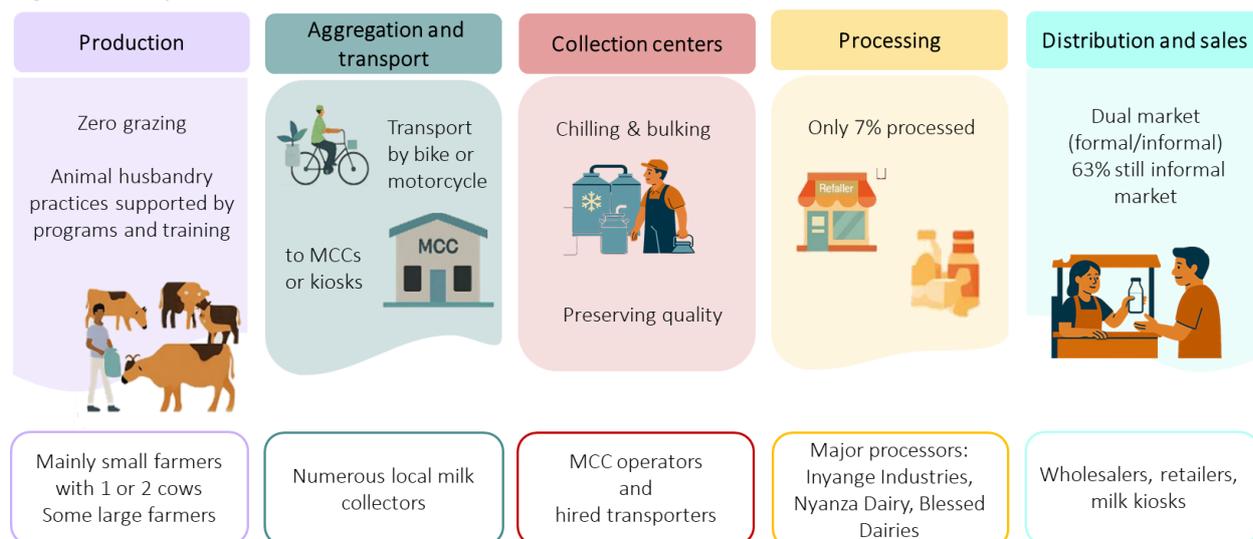


Table 6 Policies implemented or recommended by policy makers for dairy value chain in Rwanda

Input	Production	Aggregation or collection	Food processing	Distribution and sales (marketing)	Consumption
<ul style="list-style-type: none"> Invest in input supplies to improve quality, including insemination equipment, advanced laboratory tools, and vaccine storage facilities. Implement mass vaccination campaigns. 	<ul style="list-style-type: none"> Improve the quality of dairy products from small-scale farmers for domestic and regional markets. Provide access to insurance for farmers. Enhance animal health services. Promote formalization. 	<ul style="list-style-type: none"> Upgrade milk collection centers to increase volumes and improve quality control. Analyze production costs and raise milk prices to encourage formal supply. Promote formalization. 	<ul style="list-style-type: none"> Support investments to construct a new milk powder processing plant. 	<ul style="list-style-type: none"> Promote formalization. 	<ul style="list-style-type: none"> Procure milk in school feeding programmes.

Source: based on the reviewed literature

Figure 5 Cashew value chain flowchart

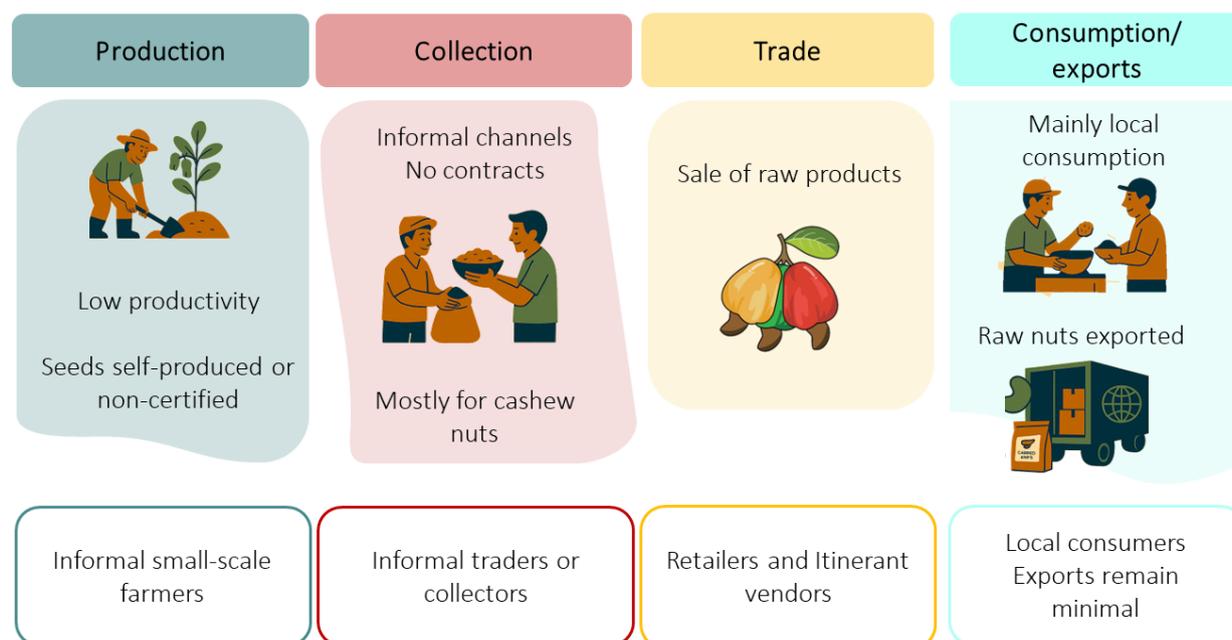


Table 7 Policies implemented or recommended for cashew value chain in Cameroon

Input	Production	Aggregation or collection	Food processing	Distribution and sales (marketing)	Consumption
<ul style="list-style-type: none"> • Provide high-yield seed. 	<ul style="list-style-type: none"> • Invest in agricultural equipment (modernize agricultural mechanization). • Organize actors into associations and cooperatives. 	<ul style="list-style-type: none"> • Organize actors into associations and cooperatives. 	<ul style="list-style-type: none"> • Encourage local processing of cashew nuts and apples to minimize waste. • Provide incentives for investment in processing plants with public and private support. 	<ul style="list-style-type: none"> • Promote the export of high-quality cashew nuts to international markets. 	

Source: based on the reviewed literature

Figure 6 Fruits and vegetables value chain flowchart

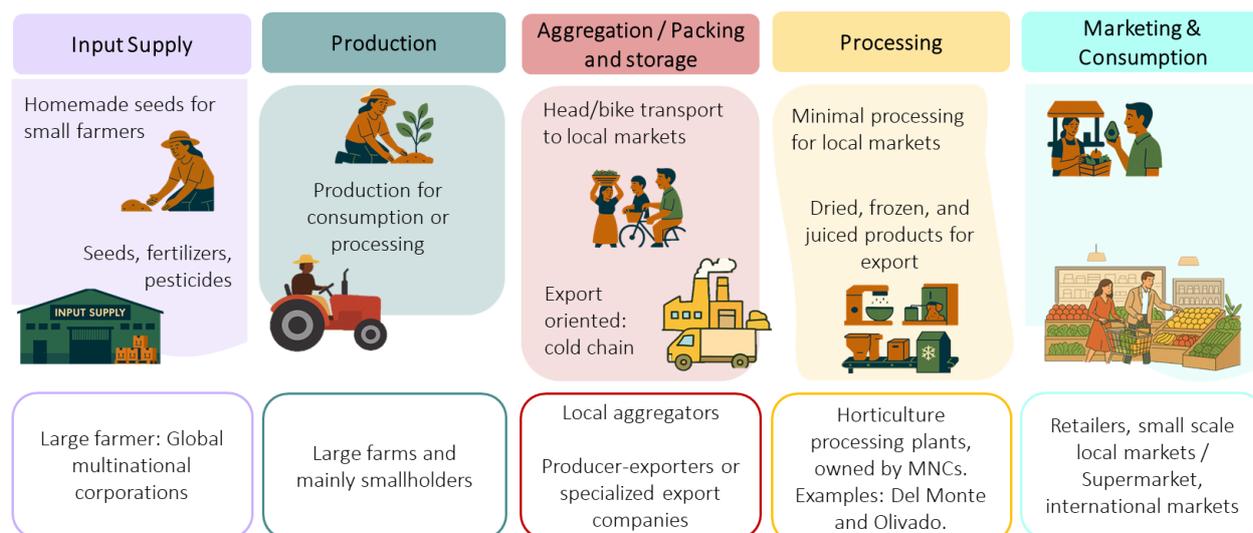


Table 8 Policies implemented or recommended by policy makers for fruits and vegetables in Kenya

Input	Production	Aggregation or collection	Food processing	Distribution and sales (marketing)	Consumption
	<ul style="list-style-type: none"> Invest in infrastructure and irrigation, while promoting the adoption of climate-smart technologies and agricultural practices. Transform the agricultural subsidy scheme by introducing an electronic voucher system that allows farmers to select inputs from private distributors. Provide digital solutions for credit and market access. Link supported farmers to producer organizations. 	<ul style="list-style-type: none"> Promote greater social and youth inclusion. 	<ul style="list-style-type: none"> Provide knowledge and management tools, value chain development services, and support for waste management. Increase market participation and value addition for smallholders. Promote linkages with agribusinesses and SMEs. 	<ul style="list-style-type: none"> Promote the establishment of a commodity exchange to facilitate fairer prices and reduce supply chain inefficiencies. 	<ul style="list-style-type: none"> Encourage healthier diets through public health campaigns

Source: based on the reviewed literature

9. Policy incentives, support, regulation, and practices

Food consumption is shifting toward more processed options (Hashad et al., 2024; Mbogori et al., 2020; Shekar and Popkin, 2020; Yi et al., 2025). At the same time, in Africa, undernourishment and adult obesity have both increased (FAO, 2023). Promoting the production of nutritious, moderately processed foods aligns with these evolving consumption trends and offers an opportunity to address the double burden of malnutrition in Africa. Food processing can enhance the availability of nutritious foods.

Promoting the processing of nutritious foods requires a balanced combination of supportive measures, incentives, and regulations. In this process, governments—particularly in LMICs—play a fundamental role. According to Schneider et al., governance shapes the transformation of food systems by acting through multiple channels that have cross-cutting effects (Schneider et al., 2025). In other words, governance serves as a tool for action that can expand the availability of moderately processed foods and improve the overall quality of the food environment. However, most countries in Sub-Saharan Africa and Central Asia lack the economic and regulatory instruments needed to enhance the quality of their food environments (Schneider et al., 2025). Based on our review of five value chains, we present support measures, incentives, and regulations to increase the availability of moderately processed foods.

Support Measures

The support measures focus on strengthening key enablers, including infrastructure improvements, training and technical assistance, the development of integrated industrial parks or shared hubs, enhanced access to finance, and the promotion of formalization and market access.

Infrastructure. Governments can play a decisive role by developing systems that ensure market functioning (Da Silva et al., 2009). This includes improving roads, ports, telecommunications, electricity, sanitation, clean water, refrigeration, and the cold chain, as well as collection centers and storage facilities needed to transport and distribute perishable products while preserving their quality (Yasmeen and Kunin, 2018). Cold-chain facilities or collection centers can be subsidized by the government or implemented through public–private partnerships. These facilities may be operated by public entities or rented and shared with smallholders to ensure broad access. Governments can also provide tax incentives or subsidies to private companies that build cold-chain or collection infrastructure. A robust infrastructure for connectivity links producers and consumers domestically and internationally, enabling greater market integration. The impact on international competitiveness is direct: inadequate infrastructure severely limits countries' and industries' ability to participate in global trade (Da Silva et al., 2009).

Training and technical assistance. Complementing infrastructure investment with training and technical assistance enhances producers' and processors' capacity. Providing free or subsidized technical assistance and extension services strengthens skills and knowledge, enabling stakeholders to adopt improved practices and advanced technologies across the value chain (Urugo et al., 2024; Yasmeen and Kunin, 2018). Training in postharvest management or rapid/minimal processing techniques, including harvesting at the optimal time, cleaning, drying or milling, precooking, hygienic handling, quality control, and storage techniques, helps to meet international standards, reduce waste, improve quality, and extend the shelf life of perishable products (Yasmeen and Kunin, 2018).

Capacity building should also focus on the operation and maintenance of modern processing equipment and technology.

Business development services (accounting, marketing management, law, etc.) also support the professionalization and competitiveness of food processing enterprises (Da Silva et al., 2009). The availability of well-trained local technical personnel, ideally proficient in internationally spoken languages, can help operate production, processing, and marketing functions. Building these competencies requires coordinated efforts across technical and university education systems, along with continuous professional training that leverages academic expertise (Da Silva et al., 2009). For example, governments can offer technical degree programs in these areas. Training and technical assistance help bridge capacity gaps and foster innovation, ensuring that producers and processors can meet market demands and maintain high standards of quality and safety.

Development of industrial parks or shared processing hubs. The creation of integrated food processing industrial parks represents a strategic government intervention to increase the availability of moderately processed foods. These parks centralize facilities for storage, processing, packaging, and preservation in one location, allowing agricultural raw materials to be converted into higher-value products before spoilage occurs. This also includes establishing collection centers and cold chains. Locating them close to farming areas shortens transport times, helps preserve freshness, and limits postharvest losses using practical, cost-effective preservation technologies.

For smallholders and microprocessors, governments can promote shared food processing hubs, financed through public funding, public–private partnerships, or cooperatives. Producers can access machinery and facilities through rental or leasing arrangements, reducing capital barriers. Hubs may include mini collection points with cold storage or mobile containers to aggregate production, along with storage and processing equipment for milling, packaging, and refrigeration, all supported by reliable energy, clean water, and road access. They can also provide laboratories and mobile maintenance services for rural areas while fostering local manufacturing of small-scale food-processing equipment. By providing shared access to specialized equipment, cold-chain storage, processing facilities, and standardized quality-control systems, SMEs can overcome financial and technical constraints and meet domestic and international market standards (Urugo et al., 2024).

In addition to infrastructure, these initiatives deliver technical support, business development services, and training to improve competitiveness and product quality. They also promote innovation and knowledge exchange by connecting farmers, processors, research institutions, and trade associations. By incorporating farmer cooperatives and contract farming arrangements, these parks and hubs help build stronger linkages between smallholders and food processors, securing a reliable supply base and enhancing producers' negotiating capacity (Da Silva et al., 2009).

Access to credit. Limited access to credit remains one of the main constraints to food processing development, hindering investment in new technologies and expansion of production capacity (Da Silva et al., 2009). Addressing this challenge requires governments to create more open and flexible mechanisms for accessing capital, such as affordable interest rates, tailored financial services, and risk management tools such as insurance (Da Silva et al., 2009; Urugo et al., 2024; Yasmeen and Kunin, 2018). This can include providing public guarantees to back loans granted by commercial banks or offering credit lines through public development banks at subsidized interest rates, with extended

repayment terms or grace periods. Governments can also allow flexibility in collateral, including movable assets (commodity inventories or equipment). In addition, they can develop co-financing schemes to support cooperatives in purchasing processing units and adopting appropriate food processing technologies.

These measures can ease investment pressure on smallholders and support enterprises, enabling them to adopt new technologies and improve productivity (Da Silva et al., 2009). Loans can be complemented by technical assistance in equipment maintenance, quality control, and financial literacy training.

Enterprise formalization, cooperatives/associations registration, and land tenure. High informality is a common feature of food processing value chains in LMICs. Policies that promote formalization strengthen business development and inclusion. According to Da Silva et al., reducing administrative costs, simplifying regulatory procedures, and ensuring that the benefits of formalization outweigh its burdens can encourage small producers and enterprises to operate within the formal economy (Da Silva et al., 2009).

Governments can design gradual compliance pathways, starting with simple, low-cost registration processes that allow enterprises to formalize step by step. They can also introduce intermediate categories of formalization, providing partial recognition and benefits for farmers, microprocessors, or rural associations as they transition toward full formal status. Some potential benefits include access to public procurement programs (with technical support), basic food safety advisory services, grace periods for tax payments, and free or subsidized legal and accounting training. For associations and cooperatives, governments can offer simplified registration and licensing procedures, reducing administrative barriers and supporting the formal establishment of collective enterprises. Facilitating this transition improves access to finance, markets, certifications, and public support programs. At the same time, land tenure and property rights provide incentives for farmers and enterprises to invest in land improvements and value addition, thereby enhancing productivity and long-term competitiveness.

Market access and digital platforms. Governments can promote rural wholesale markets linked to collection centers, organize trade fairs for moderately processed foods, create public procurement or export promotion programs that prioritize nutritious, locally processed foods, and support SMEs that offer culturally relevant, nutritious foods (Scrinis et al., 2025). These measures help enterprises access new markets, strengthen value chain integration, and increase the visibility of moderately processed foods. In addition, developing platforms that connect producers directly with industrial parks, processors, or consumers can enhance market efficiency and reduce transaction costs. These initiatives should be complemented with digital literacy training for smallholders and expanded access to smartphones and internet connectivity to ensure participation. Governments can support this by investing in rural broadband infrastructure and subsidizing access to digital tools for producers and processors.

Incentives

The incentives aim to encourage private sector engagement, promote innovation, and expand market opportunities for moderately processed foods.

Fiscal incentives. Fiscal incentives stimulate private sector investment and encourage the production and consumption of nutritious foods. Governments can support this process through targeted instruments (Da Silva et al., 2009). Tax reductions and deductions for equipment and technologies can lower initial investment costs and encourage technological upgrading and innovation in food processing. For example, governments can introduce zero-tariff regimes or temporary VAT exemptions on the import of food processing machinery and spare parts, including refrigeration equipment, dryers, mills, and preservation technologies. Moreover, tax credits for companies that integrate smallholder farmers into their supply chains can promote inclusiveness, and temporary reductions in profit taxes for new food-processing firms stimulate market entry.

On the other hand, governments can grant tax reductions or exemptions for ingredients used in the production of nutritious, moderately processed foods—such as whole grains, legumes, fruits, and vegetables. They can also apply reduced VAT rates to moderately processed foods that meet nutritional criteria set by health authorities. These measures make nutritious products more affordable for consumers and incentivize companies to produce healthier options.

Investment in technology. As Sautier et al. mention, "*agro-processing activity requires investment*" (Sautier et al., 2006). Investment in processing technologies ensures that food is handled safely and maintains its nutritional quality. Governments can foster technology adoption by creating a supportive environment that includes adequate regulatory frameworks, trained local personnel, and collaboration with equipment manufacturers (Da Silva et al., 2009).

Moreover, governments can provide targeted incentives for high-tech agriculture to increase productivity, improve product quality, and help producers meet market standards and consumer expectations (Yasmeen and Kunin, 2018). For instance, supporting the use of mechanized sorting and advanced processing equipment (Da Silva et al., 2009). For small-scale processors, governments can also promote the development of simple, locally adapted, and scalable technologies for minimal processing, such as drying, milling, fermentation, preservation, and packaging.

Strengthening inclusive value chains. Longer and more integrated value chains connect farmers with consumers, supporting rural development and food security (Yasmeen and Kunin, 2018). Governments can facilitate the inclusion of smallholders through farmer cooperatives and contract farming arrangements, which strengthen vertical linkages between small producers and food processors (Da Silva et al., 2009; G7 Agriculture Ministers, 2016).

Making contract farming more inclusive requires organizing farmers into groups or building their capacity to supply consistently (Da Silva et al., 2009). Promoting associations or cooperatives reduces informality, increases bargaining power, and improves contract terms with food processors. Governments can support legal formalization and certification through simple, stepwise procedures. Associations and cooperatives can also benefit from preferential credit lines, technical assistance in postharvest management and quality standards, and public procurement programs that prioritize products sourced from these groups.

Contract arrangements can also be promoted. While contracts can integrate farmers into supply chains, they should not create barriers for smallholders, as these schemes often require greater organization and resources (Sautier et al., 2006). Policies such as tax credits for food processors that

purchase from and contract with smallholders, as well as certification or labeling programs recognizing inclusive and sustainable practices, can support integrated value chains. Food processors can also be encouraged to provide technical support or small loans to smallholders as part of these arrangements, helping them invest in input, technology, or postharvest improvements. Processor or supermarket quotas to purchase from smallholders can further strengthen inclusion.

Promote the consumption of moderately processed food. Incentives can encourage the consumption of moderately processed foods while reducing ultra-processed alternatives. Specific incentives include subsidies for local moderately processed foods or their inputs (Scrinis et al., 2025), taxes on common ingredients of ultra-processed products (Graziano Da Silva, 2019), and measures to keep moderately processed foods affordable and accessible for vulnerable populations—such as cash-based food transfer programmes—as well as actions to increase their availability in stores and fast-food chains (Monteiro et al., 2019; Scrinis et al., 2025). Additionally, governments can recognize schools, hospitals, and companies that include moderately processed foods in their menus, thereby encouraging regular consumption among the population.

These measures can be combined with public health campaigns and nutrition policies that promote traditional diets (Monteiro et al., 2019). For instance, consumer education campaigns highlighting the benefits of moderately processed foods. These products must be accessible, appealing, and culturally acceptable, which requires a clear understanding of local consumption preferences.

Regulations and Standards

Finally, regulations and standards encompass the implementation of production and safety requirements, the establishment of a central food authority, the introduction of labeling systems, and the recommendation of rules for public procurement programs.

Standards. Norms and standards for production, processing, and food safety protect consumers and enable producers to access higher-value domestic and international markets (Da Silva et al., 2009). Clear hygiene, sanitation, and quality standards should be established across production and processing. For smallholders, gradual programs with simplified registration and training can support progressive compliance with hygiene and sanitation standards. This allows them to formalize their operations step by step without interrupting production.

For food products, benchmarks can be established to ensure nutrient retention during processing, as well as to define maximum levels for ingredients such as sugar and salt, and minimum levels for essential nutrients like vitamins, fiber, and protein.

Public procurement. Governments can establish regulations for public procurement programs, such as school feeding initiatives, hospitals, military and government canteens, that prioritize locally produced foods and explicitly include moderately processed products (Scrinis et al., 2025). Such policies create a stable demand for these foods, support local producers and processors, and help promote healthier eating habits. Additionally, linking procurement to clear nutritional standards and periodic monitoring can ensure the quality of purchased products while encouraging continuous improvements in production and processing practices.

Food authority. In connection with the previous points, the creation of a food authority would help coordinate regulation and monitoring to ensure compliance with safety and hygiene standards. This institution would protect consumer interests domestically and internationally, ensuring that food products meet established quality and safety requirements (Da Silva et al., 2009).

The authority could coordinate efforts across the Ministries of Agriculture, Transport, Industry, and Trade to streamline regulatory enforcement and support the development of the food processing sector. It could also regulate food marketing, for example, by promoting moderately processed foods through education and social media campaigns, while restricting advertising of ultra-processed products targeted at children (Graziano Da Silva, 2019; World Health Organization, 2022). In public procurement programs, the authority could ensure that moderately processed foods are included in institutional diets.

Labeling. Food labeling systems based on the degree of processing can help consumers make more informed purchasing decisions. At the same time, supermarkets can use these labels to organize products by level of processing and adjust store layouts to make moderately processed foods more visible and accessible (Davidou et al., 2021). Governments can also promote the consumption of locally produced, moderately processed foods through country branding initiatives—for example, "Healthy Food Made in Rwanda". Such certification or labeling schemes recognize nutritious products, increase consumer trust, and facilitate market access for local producers.

Table 9 summarizes these mechanisms available to policy makers. For measures implemented for specific value-chain actors and corresponding challenges, please refer to Table A2 (Annex).

Table 9 Support measures, incentives, regulations and standards in case studies and literature review

Category	Focus/measure	Details
Support Measures	Infrastructure	Investment in roads, ports, clean water, electricity, sanitation, refrigeration, and cold chains.
	Training & technical assistance	Postharvest technologies, business development, and technical skills for producers and processors.
	Development of industrial parks and shared processing hubs	Integrated food-processing parks or hubs with shared facilities; innovation and knowledge hubs; connecting farmers, processors, and research institutes.
	Access to credit	Affordable loans, targeted financial instruments for SMEs and smallholders: subsidized or affordable interest rates, public guarantees to back loans granted by commercial banks, credit lines through public development banks, extended repayment terms or grace periods.
	Enterprise formalization & land tenure	Policies promoting formal businesses and secure land rights: low-cost and simplified registration processes, gradual compliance pathways of formalization, and offering benefits (access to public procurement programs).
	Market access and digital platforms	Promoting rural markets, trade fairs, and procurement programs that favor local, moderately processed foods. Investments in digital infrastructure, literacy, and connectivity.

Incentives	Fiscal Incentives	Tax reductions on processing equipment and spare parts, and loan grace periods. Tax reductions on moderately processed foods and their ingredients.
	Investment in Technology	Adoption of high-tech agriculture to improve productivity and product quality. Create a supportive environment that includes adequate regulatory frameworks, and trained local personnel.
	Strengthening Inclusive Value Chains	Contract farming, cooperatives, and market linkages to include smallholders and boost rural incomes.
	Promote Consumption of Moderately Processed Foods	Targeted food subsidies, taxes to UPF, cash-based food transfer programmes, and campaigns to encourage healthy diets and affordable, moderately processed foods. Improving the availability of moderately processed foods in stores and fast-food chains.
Regulations and Standards	Standards	Norms for production, processing, and food safety to access domestic and export markets.
	Public procurement	Public procurement programs that prioritize locally moderately processed foods: meals in schools, universities, hospitals, etc.
	Food Authority	Ensure compliance with safety, quality, and hygiene standards, and strengthen coordination with other institutions.
	Labeling	Labels based on processing levels to guide consumers and organize supermarket layouts.

10. Conclusion

Rapid urbanization and economic growth are driving a rising demand for processed foods. Although there is ongoing debate about what constitutes food processing and which levels may be harmful to human health, ultra-processed products can result in nutrient-poor and unhealthy products. However, moderately processed foods offer several practical advantages, as well as nutritional and health benefits. Food processing enhances food availability and convenience, making nutritious options more accessible to consumers and helping address the double burden of malnutrition facing Africa. It also generates economic opportunities, particularly in rural areas, by creating jobs, increasing incomes, and adding value to primary production.

Governments must implement balanced policies, as excessive restrictions may impede the development of the food processing sector. In contrast, insufficient oversight can increase public health risks associated with the consumption of ultra-processed foods. In low- and middle-income countries, governments play a catalytic role in shaping the food processing sector. Coordinated support policies, incentives, and regulatory frameworks can stimulate private investment, improve product quality, and expand the availability of nutritious, moderately processed foods.

Since the food processing value chain faces persistent challenges such as limited access to credit, outdated technologies, and inadequate infrastructure; policies should aim to overcome these barriers by creating an enabling environment that supports private sector development while safeguarding public health. This can be achieved through improved infrastructure, technical assistance, the promotion of industrial parks or shared hubs, better access to credit, business formalization, fiscal incentives, and the development of more inclusive value chains. Furthermore, measures that promote the consumption of nutritious foods, together with regulations that ensure quality standards and

transparent labeling, can help processed food products contribute to both public nutrition and economic development.

Policies that increase the availability of nutritious, moderately processed foods represent an opportunity to improve nutrition, generate employment, raise incomes, and strengthen the food value chain in LMICs, provided coordinated, evidence-based, and holistic public strategies guide them.

11. Annex

Table A1 Classification and subclassification – food systems

Classification	Subclassification	
NOVA	NOVA1. (Unprocessed and minimally processed foods)	
	NOVA2. (Processed culinary ingredients)	
	NOVA3. (Processed food products)	
	NOVA4. (Ultra-processed products)	
SIGA	A. Un-/minimally processed	A0. intact raw initial matrix A1. degraded raw matrix A2. culinary ingredients
	B. Processed	B1. added salt, sugars, fat ≤ official recommendations B2. added salt, sugars, fat > official recommendations
	C. Ultra-processed – loss of matrix/contains purified and/or denatured ingredient (excludes vitamins, minerals, tolerance of preservatives)	C01. balanced nutritional profile & one industrial ingredient/additive C02. high added fat/sugar/salt C1. unprocessed industrial ingredients and/or limited additives C2. processed industrial ingredients and/or high additives C3. ultra-processed industrial ingredients and/or very high additives
NIPH	Non-industrialized	Not processed Locally made traditional foods Traditional preparations outside the home Modern preparations outside the home
	Industrialized traditional (IT)	
	Modern industrialized (MI)	
IARC-EPIC	Foods with an unknown process	
	Non-processed foods (consumed raw)	
	Moderately processed foods	Modest processing, no further cooking. Cooked foods from raw or moderately processed foods
	Highly processed foods	
IFPRI	Unprocessed	
	Primary or partially processed	
	Highly processed	
IFIC	Minimally processed	
	Processed for preservation	
	Mixtures of combined ingredients	
	“Ready-to-eat” foods	
	Prepared foods/meals	
UNC/POTI	Less processed (Unprocessed/minimally processed)	
	Basic processed	Processed basic ingredients Processed for basic preservation or precooking
	Moderately processed	Moderately processed for flavour Moderately processed grain products
	Highly processed	Highly processed ingredients Highly processed stand-alone

Source: (Sadler et al., 2021)

Table A2 Key challenges and corresponding policies to address them

Actors	Challenges	Policies
Smallholder farmers	Low productivity <ul style="list-style-type: none"> Limited adoption of good agricultural practices High cost and low-quality agricultural inputs 	<p>Training and technical assistance: Training in good agricultural practices and climate-smart/climate-resilient farming practices.</p> <p>Input support. Provision of high-quality input (seeds, fertilizers, etc.) through subsidies, vouchers, or distribution programs.</p> <p>Access to credit. Loan guarantees, subsidized interest rates, or grace periods to help enterprises adopt new technologies and boost productivity.</p> <p>Investment in technology. Targeted incentives for high-tech agriculture to increase productivity.</p>
	Post-harvest losses	<p>Infrastructure. Improving roads, ports, telecommunications, electricity, sanitation, clean water, refrigeration, and cold chain facilities.</p> <p>Training and technical assistance. Training in postharvest management/technology and storage techniques.</p> <p>Development of industrial parks or shared processing hubs. Establishment of collection centers and cold chains. Facilities for storage, processing, packaging, and preservation in one location.</p>
	Low profitability <ul style="list-style-type: none"> Low agricultural prices Losses due to pests or weather shocks 	<p>Minimum price regulations for agricultural products. Setting minimum prices for staple crops (price floors).</p> <p>Training and technical assistance: Training in good agricultural practices and climate-smart/climate-resilient farming practices.</p> <p>Input support. Provision of high-quality input through subsidies, vouchers, or distribution programs.</p> <p>Market access and digital platforms. Develop rural wholesale markets or organize trade fairs to connect producers directly with industrial parks, processors, or customers. Provide digital literacy training for smallholders and expand access to smartphones and internet connectivity.</p>
Smallholder farmers, small-scale aggregators, small-scale agro-processors	Limited access to credit <ul style="list-style-type: none"> Restricting investment in quality inputs and new technologies (use of outdated methods). Challenging to meet product quality standards. 	<p>Enterprise formalization, cooperatives/associations registration, and land tenure. Gradual registration pathways that allow step-by-step formalization or introduce intermediate categories. Facilitating this transition supports access to finance.</p> <p>Access to credit. Providing public guarantees for loans granted by commercial banks or offering credit lines with subsidized interest rates and extended repayment terms or grace periods.</p> <p>Strengthening inclusive value chains. Food processors can also be encouraged to provide small loans or credit to smallholder farmers as part of integrated supply arrangements.</p>
	Exclusion of smallholders from value chains and low bargaining power <ul style="list-style-type: none"> Smallholders' non-compliance with quality 	<p>Strengthening inclusive value chains. Encourage associations or cooperatives and facilitate linkages between farmers and food processors through contracts. Establish quotas for processors to purchase from smallholders.</p> <p>Enterprise formalization, cooperatives/associations registration, and land tenure. Facilitate the registration or formalization process by implementing gradual, step-by-step procedures.</p>

	standards for processing, supermarkets, or export	<p>standards for processing, supermarkets, or export</p> <ul style="list-style-type: none"> • High informality 	<p>Standards. Support gradual compliance with hygiene and sanitation standards through technical assistance.</p> <p>Development of industrial parks or shared processing hubs. Provide smallholders with access to cold chains, collection, shared processing centers, and technical assistance.</p> <p>Training and technical assistance. Provide training for small producers and processors to enhance skills and integration into the value chain.</p>
Smallholder farmers, small-scale agro-processors	<p>Inefficient technology: reliance on outdated or low-capacity equipment</p> <ul style="list-style-type: none"> • Low level of processing or added value • Low competitiveness 	<p>Enterprise formalization, cooperatives/associations registration, and land tenure. Gradual registration pathways that allow step-by-step formalization or introduce intermediate categories. Facilitating this transition supports access to finance to acquire technology.</p> <p>Access to credit. Providing public guarantees for loans granted by commercial banks or offering credit lines with subsidized interest rates and extended repayment terms or grace periods.</p> <p>Fiscal incentives. Zero tariffs or temporary VAT exemptions for the purchase of machinery, spare parts, processing technologies, refrigeration equipment, solar dryers, mills, and packaging machines.</p> <p>Investment in technology. Fostering technology adoption by creating a supportive environment that includes adequate regulatory frameworks, trained local personnel, and collaboration with equipment manufacturers.</p> <p>Training and technical assistance. Technical assistance strengthens skills and knowledge, enabling stakeholders to adopt improved practices.</p> <p>Development of industrial parks or shared processing hubs. Provide shared access to specialized equipment, cold-chain storage, processing facilities, and standardized quality-control systems.</p>	
	<p>Limited human capital</p> <ul style="list-style-type: none"> • Shortage of trained personnel capable of operating and maintaining modern technologies. 	<p>Training and technical assistance. Training programs focused on the operation and maintenance of modern processing equipment and technologies. It can also provide technical degree programs in these areas.</p> <p>Access to credit. Loans can be complemented with technical assistance.</p> <p>Development of industrial parks or shared processing hubs. Industrial parks can serve as growth hubs, providing technical support, business development services, and targeted training to enhance competitiveness and product quality.</p>	
Consumers	<p>Lack of availability of moderately processed foods that are competitive with ultra-processed versions.</p>	<p>Fiscal incentives. Tax reductions on moderately processed foods or their ingredients. Tax on UPF to discourage its consumption.</p> <p>Promote the consumption of moderately processed food. Subsidies for local moderately processed foods or their inputs. Recognition of schools, hospitals, and companies that include moderately processed foods in their menus. Campaigns to encourage healthy diets.</p> <p>Public procurement. Regulations for public procurement programs to prioritize moderately processed foods</p> <p>Cash-based food transfer programmes. Vouchers or benefit cards for purchasing healthy moderately processed foods.</p>	

		Labeling. Implement food labeling systems based on processing levels and promote local, moderately processed foods through national branding initiatives.
All actors	Lack of Infrastructure <ul style="list-style-type: none"> • Inadequate basic services • Poor road conditions • Insufficient cold-chain systems, storage, or collection facilities 	Infrastructure. Improving roads, ports, telecommunications, electricity, sanitation, clean water, refrigeration, and cold chain facilities. Development of industrial parks or shared processing hubs. Centralize facilities for storage, processing, packaging, and preservation. Shared food processing hubs. Access to machinery and facilities through rental or leasing arrangements.
Government and public institutions	Limited long-term fiscal space for policy interventions	Establish public-private partnerships or blended finance mechanisms that combine public, private, and donor resources. These can include co-financing schemes, revolving funds, or concessional loans.

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13. Appendix: Value chains

This section reviews case studies examining moderately processed foods and their value chains in selected LMICs. The analysis focuses on soy chunks in Zambia, tempeh in Indonesia, milk in Rwanda, apple cashew in Cameroon, and fruits and vegetables in Kenya.

For each case, the value chain is described—from input supply to consumption—highlighting its leading actors, challenges, and opportunities. The section then analyzes the policies, programs, and projects implemented or planned by governments to strengthen these value chains, enhance value addition, and increase the availability of nutritious, moderately processed foods.

13.1. Zambia: Soy chunks

South Africa, Nigeria, and Zambia are the leading soybean producers in Africa. In Zambia, production has increased, primarily driven by smallholder farmers, who contribute about 59% of the total output—surpassing large commercial producers. However, this growth has not been accompanied by improvements in yields or value addition, creating inefficiencies across the value chain. Soybeans' demand is driven by livestock feed production and human food products such as soy milk, soy flour, and textured vegetable protein (TVP), commonly known as soya chunks (Hichaambwa et al., 2014; Lubungu et al., 2013). While livestock feed remains the dominant use, TVP has emerged as a low-cost protein alternative for human consumption, particularly in urban markets (Hichaambwa et al., 2014). The chain begins with input suppliers, followed by production, aggregation/trading, processing, marketing, and finally consumption (FAO and UNIDO, 2025).

Regarding the input segment, the private sector is the leading supplier. Companies such as Zamseed, Pannar, Pioneer, MRI, Kamano, and Seedco stand out for certified seeds, fertilizers, and agrochemicals. The Zambia Agricultural Research Institute (ZARI) also provides improved seeds, though on a smaller scale. Additionally, the government, through the Farmer Input Support Program (FISP), distributes soybean seeds to selected beneficiaries. Overall, most small-scale farmers do not use fertilizers (FAO and UNIDO, 2025).

In production, there are two categories of farmers: large-scale commercial farmers and small-scale farmers. Large-scale commercial farmers rely on modern machinery, recommended agronomic practices, and high-quality inputs. This allows them to achieve higher yields and better-quality soybeans, which they sell at premium prices. They usually operate in more structured markets and often secure forward contracts with major traders or processors (FAO and UNIDO, 2025). Small-scale farmers, by contrast, are concentrated in poorer rural areas. Their production depends on recycled seeds, minimal mechanization, and limited use of chemical inputs. They also face gaps in technical know-how, resulting in low yields. While soybeans provide a market opportunity for these farmers—since many buyers show up at harvest—they have weak bargaining power and are forced to sell at low prices. Moreover, access to higher-paying processors is limited, as they are located far away and accept deliveries only at specific points (FAO and UNIDO, 2025).

After harvest, farmers sell soybeans to aggregators or traders. Smallholders mainly depend on aggregators who collect grain from central points or directly from farms. These buyers usually offer low prices, which reduces farmers' margins (FAO and UNIDO, 2025). Aggregators operate at different scales. Small and medium aggregators sell to larger ones, as well as to processors or exporters. Larger aggregators often have storage facilities and conduct grain cleaning, which allows them to wait for

better prices and earn higher returns. Access to finance remains a challenge for aggregators, particularly the smaller ones. Informal trade in this segment is also widespread. To bring more structure to the market, the government supported the establishment of the Grain Traders Association of Zambia (GTAZ) in 2005. Members benefit from incentives such as preferential trade agreements and export quotas (FAO and UNIDO, 2025). For large-scale commercial farmers, trading is typically conducted through contracts with major traders or processors. The domestic market is their main outlet, while surpluses are exported.

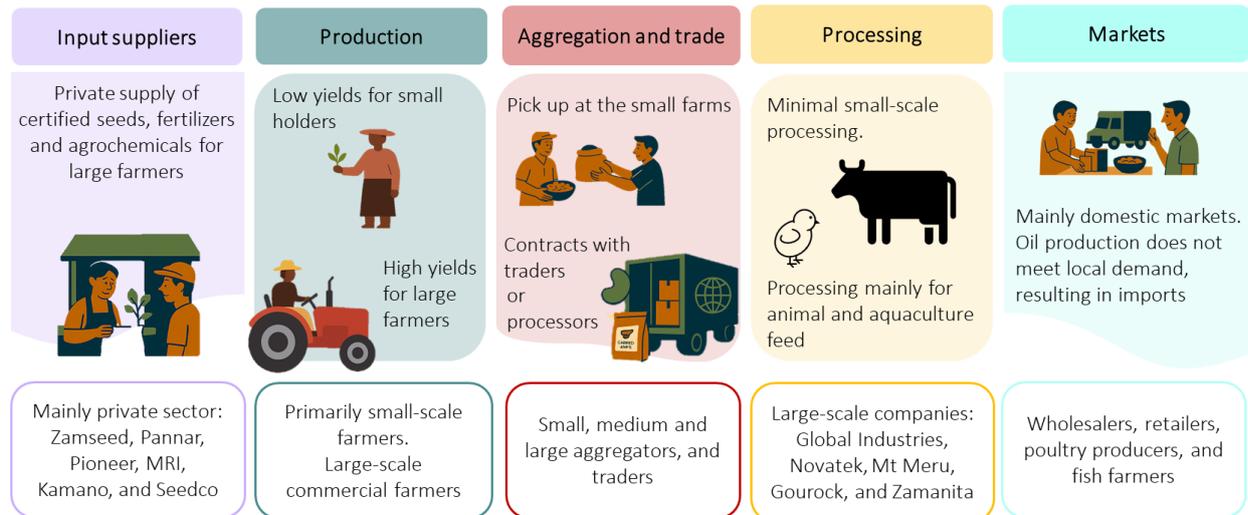
In processing, Zambia is dominated by a handful of large-scale companies, including Global Industries, Novatek, Mt Meru, Gourrock, and Zamanita. Small-scale processing is almost non-existent due to the high cost of equipment. Most soybeans are processed into soybean meals for animal and aquaculture feed. A smaller share is refined into edible products, including oils and soy chunks. Although refining capacity has expanded over the past decade, it still falls short of meeting national demand. The processors are relatively well organized, with most of the processing companies belonging to the Crushers of Edible Oils and Refiners Association (FAO and UNIDO, 2025).

Once processed, soy products are distributed mainly within the domestic market. The animal feed sector is the largest consumer. Processors sell edible oil and soybean by-products through wholesalers, retailers, poultry producers, and fish farmers. Domestic oil production does not meet demand, so Zambia relies on imports to fill the gap (FAO and UNIDO, 2025). While formal distribution channels ensure quality and branding, informal sales—often of unbranded or home-processed products—remain important, particularly in low-income urban and peri-urban areas (Hichaambwa et al., 2014; Lubungu et al., 2013).

This means two models coexist. Large-scale commercial farmers rely on more structured and formal channels, which in some cases involve forward contracts. Smallholder farmers, on the other hand, are price-takers, selling their harvest in small quantities. They rely on informal, less-organized channels that involve a long chain of aggregators at different scales, ranging from small and medium to large. This market remains unregulated mainly (FAO and UNIDO, 2025).

Zambia is also a regional exporter. Its main destinations include South Africa, Zimbabwe, Tanzania, Botswana, and Malawi. Raw grain exports are particularly attractive to traders because they generate quick returns. However, the country's trade policies have created uncertainty. On several occasions, the government has imposed temporary bans on soybean exports and their derivatives. This unpredictability discourages private investment and hinders the sector's growth (FAO and UNIDO, 2025).

Figure 7 Soy chunks value chain flowchart



Key stakeholders in the value chain include input suppliers, represented mainly by the private sector; producers, consisting of small-scale and large-scale farmers; aggregators and traders; large-scale processors; as well as wholesalers, retailers, and informal market vendors.

Opportunities lie in expanding consumer awareness of soy products, integrating TVP into school feeding and nutrition programs, scaling up mechanization, and improving contract farming arrangements to stabilize supply and enhance value addition (Hichaambwa et al., 2014; Lubungu et al., 2013).

Implemented programs and policies

The soybean value chain in Zambia faces limitations that have hindered its development. Small-scale farmers, who represent a central part of national production, lack access to certified seeds, fertilizers, and chemical pesticides, as prices remain unaffordable for them. This is compounded by limited mechanization and poor knowledge of good agricultural practices, factors that result in low yields and poor-quality grains (FAO and UNIDO, 2025).

Insufficient financing is another obstacle. Commercial banks prioritize large-scale farmers, while smallholders and microenterprises remain excluded due to their lack of credit history, the absence of formal records, and insufficient collateral. This financing gap also affects small-scale aggregators, who lack the capital to purchase vehicles or maintain storage facilities. Consequently, small-scale farmers operate with weak bargaining power, constrained by limited cooperation and mistrust of cooperatives. The sector also struggles with poor rural infrastructure and government-imposed restrictions, such as recurrent bans on soybean exports and by-products, which create instability in international markets (FAO and UNIDO, 2025).

Government policies have been isolated and have a limited impact. Some policy frameworks include the Second National Agriculture Policy (SNAP 2012–2030), the Comprehensive Agriculture Transformation Support Programme (CATSP), the Eighth National Development Plan (8NDP), and the National Food and Agriculture Delivery Compact, which includes soybeans among its crops. However, implementation has heavily focused on maize, leaving soybeans without a coherent strategy to guide their development (FAO and UNIDO, 2025).

As specific measures, in 2022, faced with overproduction, the government directed the Food Reserve Agency to purchase soybeans from farmers. However, by 2023, soybeans had been excluded from the list of crops with a guaranteed minimum price. In 2017, a subsidy for seeds and fertilizers was introduced to encourage new farmers to enter the soybean sector, but its scope was limited. The subsidy accounted for only a fraction of the allocated funds for maize and benefited only a small group of producers. Other interventions, such as those by the Zambia Agricultural Research Institute (ZARI) and the Farmer Input Support Programme (FISP), have also had minimal impact due to their limited scale. Even infrastructure improvements developed over the past decade have been concentrated in urban areas, leaving rural regions—where soybean production is most concentrated—underserved (FAO and UNIDO, 2025).

This reveals that the sector lacks an effective governance structure to foster coordination, collaboration, and trust among value chain actors. This weakness is particularly evident among smallholder farmers, MSMEs, and financial institutions that operate without strong vertical and horizontal linkages (FAO and UNIDO, 2025). As a result, government interventions have been small-scale, isolated, and low-impact, making it challenging to measure significant outcomes.

Nevertheless, the government acknowledged soybeans' potential to diversify agricultural production, increase income, and generate employment. In this regard, in 2021, the Government of Zambia, together with the FAO and UNIDO, launched the Incentives for Public and Private Investment Programme (IPPIP). Soybeans were identified as the most promising strategic value chain, with potential impacts on nutrition, youth employment, dietary diversification, and sustainability through climate-smart agricultural practices. This initiative is at the diagnostic stage, with policies proposed but not yet fully implemented (FAO and UNIDO, 2025).

To build a more competitive soybean sector, greater investments in public goods and services supporting production will be essential. A strategy would be to adopt a cluster approach in soybean-producing areas, fostering collaboration among actors and concentrating benefits in productivity, diversification, and stronger linkages between farmers and processors. This could include promoting sustainable farming practices, ensuring access to certified seeds, inputs, and mechanization technologies, and implementing contract farming schemes to bring smallholders into formal markets (FAO and UNIDO, 2025).

Strengthening local infrastructure is also critical. Establishing community-managed collection centers would improve grain quality, reduce postharvest losses, and facilitate access to financing. At the same time, developing small-scale processing plants within farming communities could make animal feed more affordable for local poultry and fish farmers and create dynamic local markets. Such facilities could run on solar power, reducing production costs and creating new opportunities for rural SMEs without competing directly with large processors (FAO and UNIDO, 2025).

Access to credit is another requirement. Guaranteeing funds, tailored credit lines, or financing mechanisms aligned with agricultural seasonality would enable the inclusion of smallholders and entrepreneurs. Designing subsidies and incentive schemes that make soybean investment attractive, with resources channeled through input suppliers and processors—who could extend credit to farmers (FAO and UNIDO, 2025).

On the market side, regulating the role of intermediaries and aggregators would help prevent smallholders from being exploited with low prices. Also, stable mechanisms are needed to avoid sudden export bans, which create uncertainty and discourage private investment. Expanding domestic demand by promoting soybean-based foods as part of healthy diets would also support the sector (FAO and UNIDO, 2025).

The government must ensure a stable and predictable institutional environment for investment. This involves modernizing transport infrastructure, including railways, expanding access to financial and digital services, and strengthening agricultural research and extension. Only through such measures, Zambia can consolidate a more integrated, inclusive, and resilient soybean value chain (FAO and UNIDO, 2025).

The opportunities for soybeans in Zambia are considerable. The country benefits from abundant natural resources, favorable climatic conditions, and a skilled labor force. In addition, growing coordination among value chain actors, increased interest from domestic and foreign investors, and the government's commitment to diversifying agricultural production position the sector strategically.

Overall, soybean production in Zambia represents an opportunity, driven by rising demand both locally and globally. Nevertheless, the soybean value chain still faces many challenges, and it has only recently begun to receive government support. In this context, the processing of soy chunks offers a promising avenue not only for job creation but also for improving nutrition, given their role as an affordable source of protein. To realize this potential, measures must take a holistic approach that supports multiple stages of the value chain. Such efforts could ultimately increase the availability of soy chunks nationwide.

13.2. Indonesia: Tempeh

Soybeans in Indonesia are the base for traditional foods like tempeh and tofu, as well as modern products such as soy milk. Among Indonesians, tempeh and tofu are popular choices thanks to their good taste, nutritional value, and affordability (Susilowati and Kirana, 2018). However, domestic soybean production meets only a small share of total local demand. Imports, mainly from the United States, Canada, or South America, fill the big gap, leaving the sector vulnerable to price volatility and importer concentration (Susilowati and Kirana, 2018).

The Indonesian soybean value chain begins with input supply, where agricultural kiosks and suppliers provide seeds, fertilizers, pesticides, and other inputs. Meeting the high demand for production facilities requires substantial capital, yet many suppliers struggle with limited financial resources. Also, smallholder farmers rely heavily on subsidized urea fertilizer, not only because of its affordability but also due to long-standing habits and cultural familiarity (Qori'ah et al., 2023; Susilowati and Kirana, 2018).

Indonesia's soybean production remains largely outdated and inefficient, relying primarily on smallholder farmers (Harmayani, 2022). Drying, as part of postharvest activities, helps preserve quality and prepares the crop for storage or further processing (Qori'ah et al., 2023). Following harvest, the aggregation and trading stage connects farmers to processors or markets. Village collectors usually purchase soybeans from farmers and sell them to sub-district wholesalers, who aggregate supply for

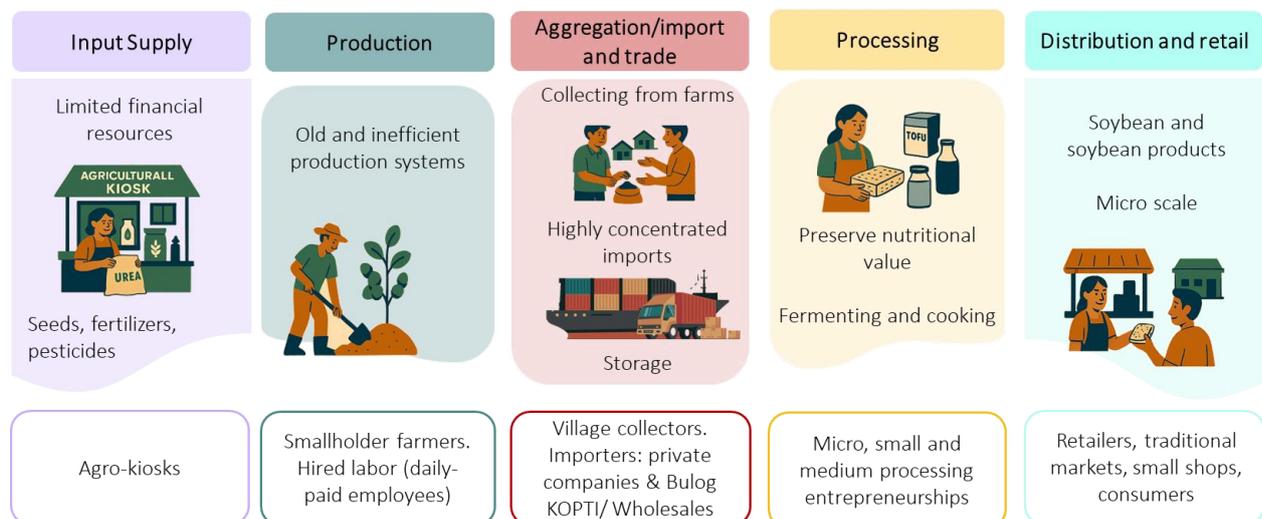
distribution to processors or cooperatives such as the Tofu and Tempeh Producer Cooperative (KOPTI). Wholesalers purchase soybeans to maintain inventory, and warehousing allows for long-term storage while preserving quality.

In parallel, imported soybeans, which represent the largest portion of the total supply, are brought in by importers and, more recently, by the National Logistics Agency Bulog, a state-owned enterprise aimed at maintaining price stability. Then it is distributed to provincial wholesalers before reaching processors. The high concentration of import channels during the 2000s raised concerns about potential price manipulation, prompting Bulog to resume its active role (Devinarahma, 2024; Susilowati and Kirana, 2018).

The processing stage includes fermentation and cooking, which preserve the nutritional value of soybeans while adapting them for direct consumption as tempeh, tofu, soy milk, or soy sauce. Processing is carried out by a mix of micro, small, and medium-sized enterprises (Susilowati and Kirana, 2018). These processors depend on both local and imported soybeans and are highly sensitive to fluctuations in input prices.

Finally, the distribution and retail stage delivers soybeans and soy-based products to consumers, primarily through traditional markets or small shops that typically operate at a micro scale (Qori'ah et al., 2023). Retailers act as the bridge to consumers in the soybean value chain, but price volatility in the early stages of the chain is quickly passed on to consumers.

Figure 8 Tempeh value chain flowchart



Key actors in the value chain include agricultural kiosks, smallholder farmers, village collectors, wholesalers, large importers, cooperatives such as KOPTI, processing entrepreneurs, retailers, and consumers. In addition to these specific actors, as noted by Qori'ah et al., the government also plays a cross-cutting role by providing infrastructure such as roads and bridges, as well as access to healthcare, education, training, and capital. Also, Bulog plays an important role in regulating soybean trade and stabilizing prices (Qori'ah et al., 2023).

Implemented programs and policies

Tempeh and tofu play a strategic role in enhancing food security and strengthening the food industry in Indonesia. Domestic production has steadily declined, with reduced cultivated area and low yields, reflecting the lack of incentives and market prices that often fall below production costs (InCorp Indonesia, 2023). In this context, public policies have sought to balance three objectives: stimulating local production, ensuring consumer access, and stabilizing prices.

One of the main problems is that producers face low profit margins. Competition for land use with more profitable crops, particularly maize, has reduced the area allocated to soybeans (Harsono et al., 2021; Sayaka et al., 2021). In addition, the domestic price is often below the government-set reference price, which discourages farmers. This is compounded by low average productivity, vulnerability to pests and diseases, and the limited availability of quality seeds (Harsono et al., 2021). On the economic side, input suppliers face capital constraints, which limit the expansion of production infrastructure (Qori'ah et al., 2023).

Dependence on imports has deepened since the late 1990s liberalization. At present, the largest share of soybeans consumed comes from abroad, which exposes local producers to competition from cheaper grains and consumers to the volatility of international prices (Hulu et al., 2024). This situation explains the social sensitivity to price increases, especially for small tofu and tempeh industries.

In response, the government has implemented production programs that include input subsidies, productivity enhancement support, and agricultural extension (Harsono et al., 2021; Sayaka et al., 2021). The government has also implemented fiscal and infrastructure incentives to strengthen the value chain, including subsidies and improvements in transport and storage (Suwardi et al., 2023). At the market level, Bulog regained a key role in 2013 as the state agency responsible for soybean importation and distribution, with the mission of stabilizing prices (Kementerian Perdagangan Republik Indonesia., 2013; Sayaka et al., 2021). In parallel, direct subsidies have been granted to tofu and tempeh producers (Assegaf, 2022).

Despite these implemented policies, the results have been limited. Productivity has barely improved, the harvested area remains low, and competitiveness against imported soybeans remains weak. This performance is mainly due to the low efficiency of the marketing system, poor seed quality, and the difficulty of attracting farmers to a crop with lower profitability than alternatives such as maize (Harsono et al., 2021; Sayaka et al., 2021), along with fragmented and small-scale policies that have failed to deliver improvements.

The challenges to achieving self-sufficiency are considerable: increasing yields; expanding the harvested area; and modernizing agricultural mechanization to reduce costs and improve efficiency (Harsono et al., 2021). In addition, it is necessary to guarantee effective minimum prices through Bulog purchases and sufficient state budgets, since current price ceilings discourage local production (Sayaka et al., 2021).

Nevertheless, there are still opportunities. Soybean demand continues to grow, driven by domestic consumption of tempeh and tofu, as well as increasing use in animal feed (Harsono et al., 2021; Qori'ah et al., 2023). This provides an opportunity to design policies that increase the crop's appeal to farmers by ensuring market stability and profitable margins.

In terms of recommendations, experts suggest strengthening the seed system, accelerating the adoption of improved and pest-resistant varieties, and improving technology transfer (Harsono et al., 2021; Sayaka et al., 2021). They also propose restructuring price policy with a floor guaranteed by Bulog and greater public financing, along with more effective regulation of imports through quotas or seasonal schedules (Sayaka et al., 2021). At the supply chain level, improvements in transport and storage infrastructure, along with access to credit and technical training for farmers, would be key to increasing the sector's competitiveness (Suwardi et al., 2023). In sum, Indonesian soybean policies have sought to achieve self-sufficiency. However, experience over the past few decades shows that the implemented programs have not been able to reverse dependence on imports.

13.3. Rwanda: Milk

Milk is a nutrient-rich perishable product that plays a central role in Rwanda's agriculture and nutrition strategies, with growing demand for fresh and processed dairy products (Miklyaev et al., 2017; Ntaganda and Ernest, 2022). The fermented whole milk is the most consumed dairy product in Rwanda, reflecting local dietary preferences alongside the increasing interest in other processed products. In Rwanda, milk consumption per capita more than doubled between 2008 and 2013, driven by public campaigns such as One Cup of Milk per Child and the Girinka program (Miklyaev et al., 2017). The dairy value chain includes production at the farm level, collection and bulking at Milk Collection Centers (MCCs), processing into various dairy products, distribution, and retail. This chain operates in a context of strong government involvement, donor-funded programs, and a dual-market structure — formal and informal — that primarily serves domestic markets (Miklyaev et al., 2017; Ntaganda and Ernest, 2022).

Milk production in Rwanda begins at the farm level, where most output comes from smallholder farmers who typically rear 1 to 2 cows under zero-grazing systems. Larger farmers, managing between 10 and 20 cows, often employ open grazing in specific regions (Miklyaev et al., 2017). Supporting this initial stage of the value chain are input suppliers who provide essential goods and services—such as veterinary drugs, milking equipment, feed, and technical services—that enable farmers to maintain animal health and improve productivity.

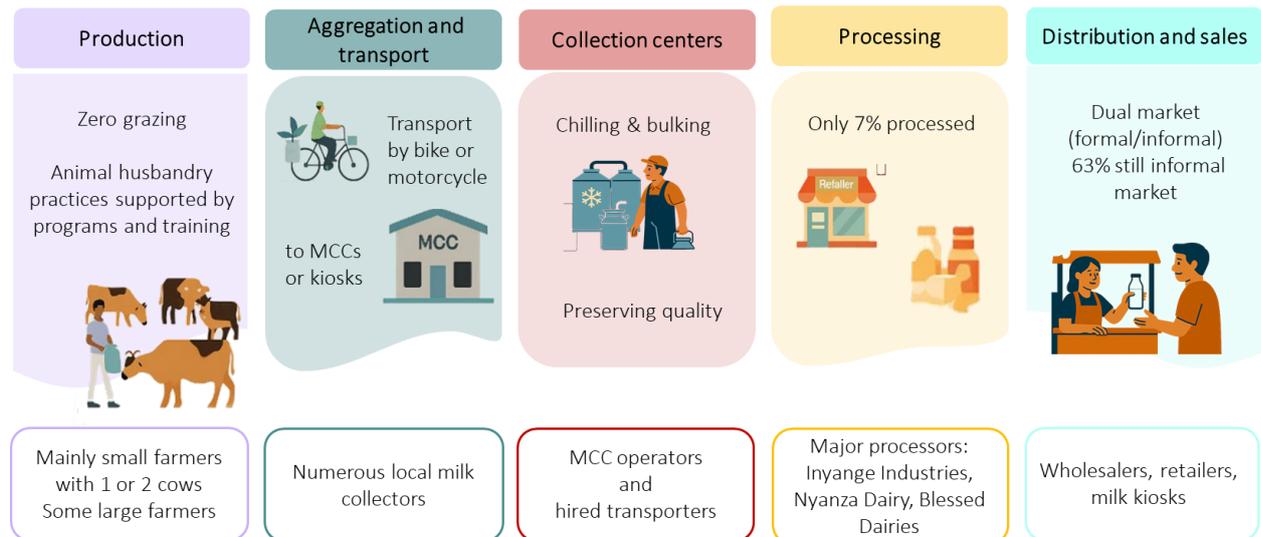
The smallholders, in addition to their home consumption, sell surplus to neighbors and/or to numerous local milk collectors. Because each household produces only small quantities, the local collectors aggregate the milk and transport it—often by bicycle or motorcycle—to Milk Collection Centers (MCCs), or directly to kiosks and business centers (Miklyaev et al., 2017). The establishment of MCCs, many supported by programs such as the Livestock Infrastructure Support Program (LISP), has been important for chilling and bulking milk to preserve quality and delay spoilage before it reaches processors, retailers, and kiosks.

In general, many MCCs lack the capacity to supply milk directly to processors or retailers. In practice, two main arrangements are used. In some cases, MCCs sell their milk to transporters or, more commonly, hire them to deliver milk to processors or markets. When milk enters the processing stage, it is transformed into a range of products, including pasteurized milk, fermented milk, yogurt, cheese, and butter. Major processors, including Inyange Industries, Nyanza Dairy, and Blessed Dairies, have contributed to diversifying the product range and extending its market reach. However, only about 7% of national milk production is processed commercially, indicating significant untapped potential in

this segment (Miklyaev et al., 2017). Processing adds value by enhancing shelf stability, meeting diverse consumer preferences, and facilitating regional trade.

The final stages of the chain involve distribution and retail. Processed products are distributed through wholesalers, retailers, hotels, restaurants, and specialized milk kiosks, which can sell up to 1,000 liters per day and provide local employment opportunities (Ntaganda and Ernest, 2022). Despite the growth of formal distribution channels, the informal market, dominated by raw and fermented milk -sold directly to consumers- remains the largest, accounting for approximately 63% of total milk sales (Miklyaev et al., 2017).

Figure 9 Milk value chain flowchart



As seen, stakeholders in the value chain include smallholder and large-scale dairy farmers, local milk collectors, MCC operators, transporters, processors, and retailers such as milk kiosks. The government, through programs like Girinka (One cow per poor family) and LISP, along with development partners, plays a significant enabling role.

Challenges in Rwanda’s dairy value chain include high production costs, seasonal fluctuations in milk supply (especially during the rainy season), preservation of milk quality, and the dominance of informal markets that may compromise quality control (Miklyaev et al., 2017). Infrastructure and logistics constraints also hinder the expansion of formal market channels (Ntaganda and Ernest, 2022). Nevertheless, opportunities exist to expand processing facilities, promote fodder conservation techniques to stabilize supply, strengthen cooperative structures, and enhance exports to neighboring countries. Policy measures that support small-scale pasteurization, transfer MCC ownership to cooperatives, and encourage investment in value-added products could further improve profitability and long-term sustainability (Miklyaev et al., 2017; Ntaganda and Ernest, 2022).

Implemented programs and policies

In Rwanda's dairy sector, government policies have focused on strengthening the entire value chain. According to the Annual Report 2023/24 of the Ministry of Agriculture and Animal Resources, efforts have been directed toward modernizing and expanding the dairy value chain, from veterinary services to processing plants (Ministry of Agriculture and Animal Resources, 2024).

At the input supply stage, for example, the government invested in vaccine storage equipment—such as fridges and coolboxes—to ensure adequate disease control and preserve vaccine quality. Veterinary infrastructure was further strengthened through the acquisition of advanced laboratory equipment, improving the capacity to detect, monitor, and manage livestock diseases. These investments were complemented by enhanced veterinary services, including mass vaccination campaigns and the purchase of insemination equipment to support artificial insemination services (Ministry of Agriculture and Animal Resources, 2024).

Despite a considerable share of milk still being traded informally as fresh or fermented milk, formalization has been encouraged through upgrades to Milk Collection Centers (MCCs) (Miklyaev et al., 2017). These upgrades increased capacity and efficiency, enabling MCCs to handle larger milk volumes while maintaining higher quality control standards. This was accompanied by an assessment of milk production costs, which led to revised and higher milk prices to incentivize formal deliveries. Infrastructure development also included the construction of a new milk powder processing plant, designed to expand value-added processing for domestic consumption and exports (Ministry of Agriculture and Animal Resources, 2024).

The dairy value chain in Rwanda has been strengthened through the Rwanda Dairy Development Project (RDDP) phases 1 and 2, implemented since 2016 by the Ministry of Agriculture and Animal Resources with joint funding from the International Fund for Agricultural Development (IFAD) and the Government of Rwanda. The project aims to enhance competitiveness and profitability in the sector by improving the supply of quality dairy products from small-scale producers to domestic and regional markets (Rwamulangwa, n.d.). In parallel, other initiatives align with RDDP objectives and have helped strengthen the value chain. For example, Girinka, a presidential program launched in 2006, provides cows to low-income households to improve nutrition through milk consumption and create income opportunities from dairy sales. To date, 467,984 cows have been distributed (Ministry of Agriculture and Animal Resources, 2024). The Government of Rwanda has also invested in complementary programs, including efforts to expand national cooling capacity, improve animal health and genetics, and provide insurance through the National Agriculture Insurance Scheme. Under this scheme, launched in 2019, 51,231 cows, 214,499 chickens, and 8,453 pigs were insured in the 2023/24 fiscal year (IFAD, 2023).

The sector has received substantial government support and has already achieved positive results. However, several challenges remain. At the production level, feed and fodder are often of low quality, and the genetic potential of dairy herds remains limited. Although access to artificial insemination services has improved, it is not yet universal. In addition, there are inadequate facilities for housing cattle and limited water availability. Another challenge is suboptimal livestock management practices, particularly in areas such as feeding, reproduction, animal welfare, and health (IFAD, 2023).

Besides, ensuring sustainability remains a challenge. Free vaccination and insemination campaigns initially supported by the Rural Development Programme (RDDP) were later discontinued due to insufficient long-term funding (IFAD, 2023). As noted by IFAD, vaccination against production diseases should be treated as a private good and financed through mechanisms involving producers and possibly the private sector. Thus, future interventions must secure sustainable financing arrangements or establish cost-sharing mechanisms with smallholders to ensure services remain accessible without compromising their livelihoods.

Rwanda has pursued a comprehensive strategy to increase milk availability through investments, projects, and policies that strengthen multiple stages of the dairy value chain. The government's role has been central in reinforcing the chain and, consequently, improving milk and milk products availability.

13.4. Cameroon: Apple cashew

Cashew (*Anacardium occidentale*) is a tropical crop of high global value. Its cultivation has spread across Africa, contributing to the improvement of rural economies and agroforestry systems. In Cameroon, cashew cultivation is mainly concentrated in the northern regions, though it has recently expanded into the eastern and central parts of the country (Hamawa et al., 2019).

The cashew value chain extends from smallholder farmers to local consumers or exporters. The general structure includes production, collection, trade, and consumption, with minimal exports and almost no industrial processing. In general, the value chain remains underdeveloped, with challenges related to market access, low processing capacity, and weak institutional coordination.

In production, farming remains informal, and cashew seeds and seedlings are mainly obtained through self-production or non-certified purchases (Sali et al., 2020). This lack of standardized planting material constrains productivity and quality improvements. Production is primarily dominated by smallholder farmers who practice intercropping with fruit trees (Sali et al., 2020). Fertilizer application and pest management are minimal, and knowledge transfer is limited due to weak technical assistance.

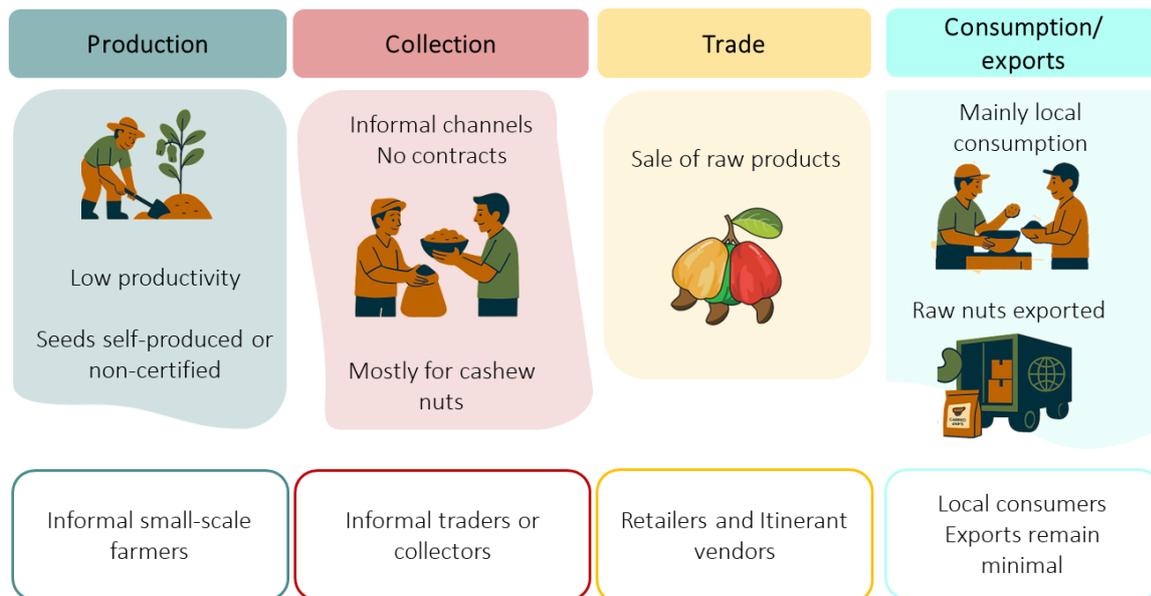
According to Palou Madi et al., fruit harvesting can pose challenges, including a lack of adequate tools and occasional labor shortages, as fruits tend to ripen simultaneously. Additional difficulties involve farmers' isolation in remote areas, or limited transportation options, and insufficient knowledge of proper preservation techniques (Palou Madi, 2014).

Collection is conducted primarily through informal channels. Collectors purchase cashew nuts and apples, as well as informal traders who move through fields and local markets (Sali et al., 2020). These collectors buy mostly raw cashews directly from farmers, often without price differentiation by size or quality and without formal contracts or grading systems (Sali et al., 2020). They then resell the products to retailers or itinerant vendors (Palou Madi, 2014; Sali et al., 2020). Itinerant vendors of fruits and vegetables sell their products as they travel throughout the day in large urban centers (Palou Madi, 2014).

Industrial processing is virtually absent, and cashews are still sold raw, both the cashew apple and the cashew nut (Sali et al., 2020). In general, although Africa is the largest producer of raw cashew nuts, most processing takes place in Vietnam and India. Only about 10% of African production is processed locally. As a result, most of the added value—including roasting, packaging, and labeling—associated with African production is generated outside of the producing countries (Sustainable Nut Initiative (SNI), 2021). In Cameroon, there are few processing units, mainly artisanal, that produce kernels or derivative products intended primarily for local consumption (Conseil International Consultatif du Cajou (CICC), n.d.). Exports remain minimal.

Regarding consumption, in departments such as Bénoué, Mayo, Louti, Diamaré, Mayo-Sava, and Mayo-Danaï, located in the North and Far North regions, local consumers use cashew apples (Palou Madi, 2014). In other departments, the focus is on the nut, while the cashew apple is discarded. Overall, the cashew apple remains highly undervalued, leading to significant postharvest losses. Discarding apples in the fields represents a direct loss of potential income. However, cashew apples can also be processed into a nutritious juice that can be consumed year-round (Association des communes forestieres du Cameroun, 2023). Of the total production, the vast majority is consumed locally.

Figure 10 Apple cashew value chain flowchart



Key actors in the value chain include informal smallholder farmers, collectors who purchase directly from producers, itinerant vendors who sell products on the move, retailers, and local consumers.

Implemented programs and policies

In the context of diversifying agricultural incomes, cashew has become a strategic crop for populations in northern Cameroon, both for its export potential and the rural employment opportunities it provides. However, the cashew value chain remains constrained by technical and structural limitations (Palou Madi, 2014). Added to this is the lack of dissemination of adapted technologies, which restricts the sector's competitiveness (Association des communes forestieres du Cameroun, 2023).

With the objectives of improving productivity, generating employment, increasing incomes, and contributing to climate change mitigation, the government launched the Support Program for the Development of the Cashew Sector (PADF-CAJOU) in 2018 (Atcha, 2018). As part of this effort, improved seeds were distributed to farmers between 2020 and 2021 (Association des communes forestieres du Cameroun, 2023). In 2023, the Institute of Agricultural Research for Development (IRAD) distributed 50,000 seedlings and set a target to export 8,000 tons of high-quality cashew to the international market (Mbodiam, 2020; The Farmer's Journal Africa, 2023). Looking ahead to 2025, the project foresees new investments in agricultural equipment (Agence de Régulation des Marchés Publics (ARMP), 2025, 2021). From the private sector, initiatives such as Foods and Beverages Engineering (FBE), created in 2021, have also emerged. This company aims to add value to nuts and

cashew apples through processed products. However, its progress still depends on individual financial efforts (Ministère de l'Agriculture et du Développement Rural du Cameroun, 2022).

A central challenge for sector policy is strengthening processing. Currently, nut processing is minimal, and cashew apples are largely wasted. Despite its high nutritional potential, much of the pulp rots in the fields due to inadequate processing and preservation techniques (Association des communes forestieres du Cameroun, 2023). This waste represents a loss of income for farmers and a missed opportunity to diversify local production into juices, jams, or vinegars, which could stimulate the domestic agro-industrial sector.

The programs implemented are relatively recent, and evaluations have not yet been conducted. However, barriers are evident: weak organization among actors, lack of strong cooperatives, limited financial and human capacity, and the absence of a regulatory authority to coordinate the chain (Conseil International Consultatif du Cajou (CICC), n.d.; Ministère de l'Agriculture et du Développement Rural du Cameroun, 2022). As a result, the sector remains in an embryonic stage, with low commercial production and minimal local processing.

The experience of other African regions provides lessons for progress. ComCashew (formerly the African Cashew Initiative), launched in 2009, has benefited over 620,000 farmers in West Africa, leading to higher yields, improved nut quality, increased incomes, and expanded local processing capacity with the creation of jobs in processing companies (Kaske et al., 2019; Silvestrini and Wicke, 2023). Similarly, the Pro-Cashew project strengthens orchard management, access to inputs and finance, and improves producers' competitiveness. Although Cameroon has been a member of the International Consultative Cashew Council (CICC) since 2019 (Cultivating New Frontiers in Agriculture (CNFA), n.d.), it has not yet joined these regional initiatives. Doing so would allow the country to benefit from successful experiences, gain access to technical assistance, and advance regional market integration.

The sector's prospects are significant. Global demand for cashews is growing at a rate of 6–7% annually (Ministère de l'Agriculture et du Développement Rural du Cameroun, 2022), and the uses of this crop extend beyond food to pharmaceutical, cosmetic, and chemical industries (Palou Madi, 2014). To seize this momentum, Cameroon needs to:

- Promote local processing of both cashew nuts and apples to reduce current waste (Association des communes forestieres du Cameroun, 2023).
- Modernize agricultural mechanization and introduce high-yield varieties (Palou Madi, 2014).
- Organize actors into associations and cooperatives to strengthen the value chain (Conseil International Consultatif du Cajou (CICC), n.d.; Ministère de l'Agriculture et du Développement Rural du Cameroun, 2022; Palou Madi, 2014).
- Design incentives to attract investment in processing plants, with support from both the public and private sectors.
- Learn from the experiences of ComCashew and Pro-Cashew by joining these initiatives to improve productivity, processing, and access to international markets.

The future of cashew in Cameroon will depend not only on expanding cultivated areas or distributing more seedlings, but above all on developing local processing of the nut and the apple to achieve higher value addition. The cashew apple, currently underutilized, represents a strategic opportunity to

diversify the processing sector and generate additional income if it is supported by processing policies, infrastructure, and technical training aimed at its sustainable use.

13.5. Kenya: Fruits and vegetables

Fruits and vegetables serve domestic and export markets. Horticultural products account for about 20% of the country's exports, making the sector an important source of foreign exchange. Within horticulture, flowers contribute the most to production and export value, followed by vegetables and fruits, with the European Union being the primary export market (Heher and Steenbergen, 2020). The fruit and vegetables sector is highly heterogeneous. Nevertheless, the value chain typically begins with input suppliers, production, packaging, and storage, then moves to processing, and culminates in distribution/marketing and consumption.

At the input stage, global multinational corporations serve as the primary suppliers, mainly for large-scale farmers. Inputs include seeds, fertilizers, pesticides, farm equipment, and irrigation systems, all of which are essential for achieving the quality and productivity required for exports (Heher and Steenbergen, 2020). In contrast, smallholder farmers, who rely on traditional cultivation methods, typically depend on homemade inputs (Alulu et al., 2019; Amare et al., 2024) or receive supplies through government interventions, which often serve social objectives (International Finance Corporation (IFC), 2019).

Production is characterized by a diverse range of producers, from smallholders to large commercial farms. Smallholders, who constitute the majority and primarily supply local markets, face numerous challenges. These include traditional farming practices, poor infrastructure, high postharvest losses, limited technical knowledge, insufficient innovation, and inadequate training. These constraints limit their ability to participate in and remain part of export-oriented value chains (Amare et al., 2024). However, some small farmers do engage in exports, typically when they are organized or linked to exporters who provide inputs, training, and certification support. On the other hand, large producer-exporters benefit from extensive infrastructure and advanced technologies. Rigorous standards govern the export-focused segment of the market to meet international requirements, attracting foreign investors who participate at various points along the horticulture value chain (Heher and Steenbergen, 2020).

Production can be intended for either direct consumption or processing. For export-oriented consumption, the harvest moves to the packing and storage stage, which is managed either by producer-exporters or specialized export firms, as substantial capital investment is required for air conditioning, ventilation, or water purification. Key handling activities include washing, trimming, chopping, mixing, packing, and labeling. Kenya's integration into global value chains has driven the development of advanced cold-chain logistics that preserve freshness during handling, storage, and transport. These systems allow perishable goods to be moved, ensuring they reach international markets in excellent condition (Heher and Steenbergen, 2020).

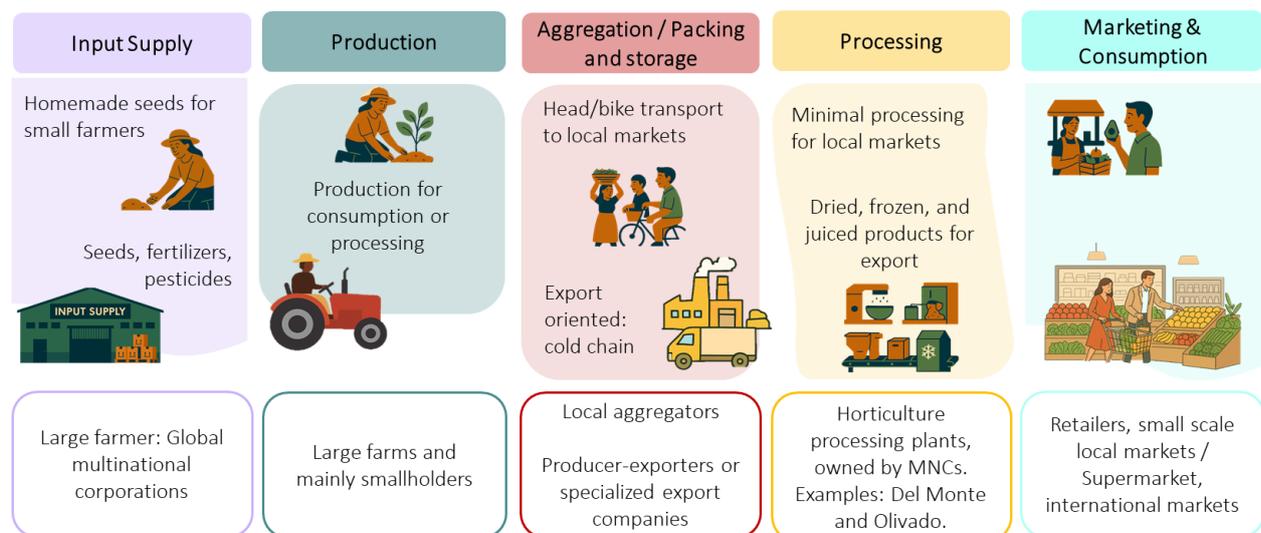
The process differs when produce is intended for local consumption. For example, with vegetables, women often carry goods in baskets or sacks to local markets, sometimes balancing them on their heads. At the same time, men may use bicycles to transport and sell the produce in nearby markets (Amare et al., 2024). Most of these products do not go through a formal packing stage, and sales occur in the open air without refrigeration or hygienic standards, which can lead to spoilage. Small farmers

are often not directly connected to markets or buyers and thus rely on brokers for sales and transport, which drastically reduces the shelf life of their goods (Agence de Régulation des Marchés Publics (ARMP), 2025, 2021).

Horticultural processing remains relatively limited and is applied mainly to export-oriented products, typically managed by private firms. Processing adds value by extending shelf life and diversifying the product range available to consumers. Fresh produce may be dried, frozen, or transformed into juices, pulps, and other preserved forms that are easier to transport, store, and market. However, most processing facilities are concentrated in a few plants, the majority of which are owned and operated by multinational corporations rather than local enterprises (Heher and Steenberg, 2020). For smallholders, processing is minimal. For instance, traditional vegetable producers rarely engage in value addition due to constraints on costs, skills, and equipment. This dual structure concentrates the benefits of value addition in modern chain segments, while traditional markets remain vulnerable to losses and price volatility (Alulu et al., 2019).

Finally, the distribution and marketing of horticultural products are mainly led by retailers. The main channels include supermarkets, wholesalers, small local shops, and food service outlets. Together, these channels enable products to reach consumers in Kenya and international markets reliably.

Figure 11 Fruits and vegetables value chain flowchart



The horticultural value chain in Kenya involves a range of actors across all stages. Multinational corporations supply inputs to large-scale farmers, while smallholders rely on homemade or government-supported inputs. Production is carried out by both smallholders, mainly for local markets, and large farms that supply export markets. Producer-exporters or specialized firms manage postharvest handling and packing for export-oriented produce, while local markets depend on smallholders and informal traders. Processing is primarily concentrated in modern facilities owned by multinationals, whereas smallholders rarely add value. Finally, retailers, wholesalers, supermarkets, small local shops, and food service outlets handle distribution and marketing, ensuring that products reach both domestic and international consumers. Strengthening the value chain offers an opportunity to enhance incomes and sustainability (Alulu et al., 2019; Amare et al., 2024).

Implemented programs and policies

Agriculture in Kenya contributes to economic growth and poverty reduction. In 2020, the sector grew by 4.8% and employed 8.5 million people, representing nearly 70% of rural employment (World Bank., 2022). Most production comes from smallholder farmers, who account for 78% of total output. However, these producers face constraints in accessing credit, using quality inputs, and adopting modern technologies. As a result, its productivity has remained stagnant over the past decade and is up to seven times lower than in Africa's leading countries. Additional challenges include deficiencies in postharvest management, low levels of processing, and limited value addition, even in agrifood exports (World Bank., 2022).

To address these challenges, the Government of Kenya has launched various programs and strategies. Among them are the Agriculture Sector Transformation and Growth Strategy (ASTGS), the National Agricultural and Rural Inclusive Growth Project (NARIGP), the Kenya Climate Smart Agriculture Project (KCSAP), and, more recently, the National Agricultural Value Chain Development Project (NAVCDP). At a broader strategic level, Kenya has also adopted the Kenya Food Systems and Land Use Action Plan 2024–2030 and the Kenya Postharvest Management Strategy 2024–2028 (FAO, 2024; Ministry of Agriculture and Livestock Development, 2023; Ministry of Agriculture and Livestock Development (MoALD), 2023; National Agricultural Value Chain Development Project (NAVCDP) and Ministry of Agriculture and Livestock Development (MoALD), 2024; World Bank., 2022).

The ASTGS seeks to improve the institutional environment and attract greater private investment. One of its main reforms has been the transformation of the agricultural subsidy scheme through an electronic voucher system, which allows farmers to choose the type of inputs and purchase them from private distributors. The strategy also promotes the establishment of a commodity exchange, which can facilitate fairer prices and reduce inefficiencies in the supply chain (World Bank., 2022).

In parallel, projects such as NARIGP and KCSAP emphasize farmer organization and the adoption of climate-smart technologies. They have financed micro-projects to improve agricultural practices and strengthen market linkages. Through these initiatives, more climate-smart technologies and practices have been introduced into value chains, with positive impacts on productivity and resilience (World Bank., 2022).

In 2022, the National Agricultural Value Chain Development Project started, which will run until 2028. The program focuses on some priority value chains, including fruits such as mango, banana, and avocado, and vegetables such as tomato and potato (National Agricultural Value Chain Development Project (NAVCDP) and Ministry of Agriculture and Livestock Development (MoALD), 2024). Its goal is to increase market participation and value addition by smallholders, targeting coverage of 3.8 million farmers. The project invests in infrastructure, financing, linkages with agribusinesses and SMEs, and the use of digital technologies to boost productivity and climate change adaptation (Ministry of Agriculture and Livestock Development (MoALD), 2023; World Bank., 2022).

At a broader planning level, the Kenya Food Systems and Land Use Action Plan 2024–2030 provides a roadmap to transform food and land use systems toward sustainability. It focuses on: healthier diets, productive and regenerative agriculture, nature protection, reduced losses and waste, and greater social and youth inclusion (Ministry of Agriculture and Livestock Development, 2023). Complementarily, the Kenya Postharvest Management Strategy 2024–2028 aims to reduce

postharvest losses and food waste, which pose threats to food security. The plan encompasses knowledge and management tools, value chain development services, and waste management, all of which are supported by policies, institutions, and research (FAO, 2024).

The results available so far come from NARIGP and KCSAP, which, in their mid-term evaluation, reported increases in yields in prioritized value chains. In addition, supported farmers have been linked to producer organizations, many of which now have business plans to access formal financing. Public–private partnerships have been established, and a national data platform has been created to provide agro-climatic and market information. Agreements have also been signed with agri-tech startups to deliver digital solutions for extension services, credit, and market access (World Bank., 2022). In contrast, the NAVCDP, the Action Plan 2024–2030, and the Postharvest Management Strategy have yet to deliver results, as they remain in early stages of implementation (FAO, 2024; Ministry of Agriculture and Livestock Development, 2023; Ministry of Agriculture and Livestock Development (MoALD), 2023).

Despite these advances, challenges remain, including limited access to finance and insufficient storage, cold chain, and logistics infrastructure. Most farmers still market without value addition, and postharvest losses remain high. In this context, it is necessary to complement ongoing policies with models that integrate credit, market access, and affordable technological solutions, especially for dispersed small-scale farmers with low levels of digitalization (Agence de Régulation des Marchés Publics (ARMP), 2025, 2021).

Opportunities are significant. There is significant potential to increase value addition in fruits and vegetables, thereby raising farmers' incomes, generating new jobs, and strengthening the country's food security. The articulation of NARIGP and KCSAP achievements, NAVCDP investments, and the agenda for sustainability and postharvest loss reduction creates favorable conditions for transforming Kenya's agriculture into more inclusive, profitable, and resilient systems (FAO, 2024; Ministry of Agriculture and Livestock Development, 2023; World Bank., 2022).

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