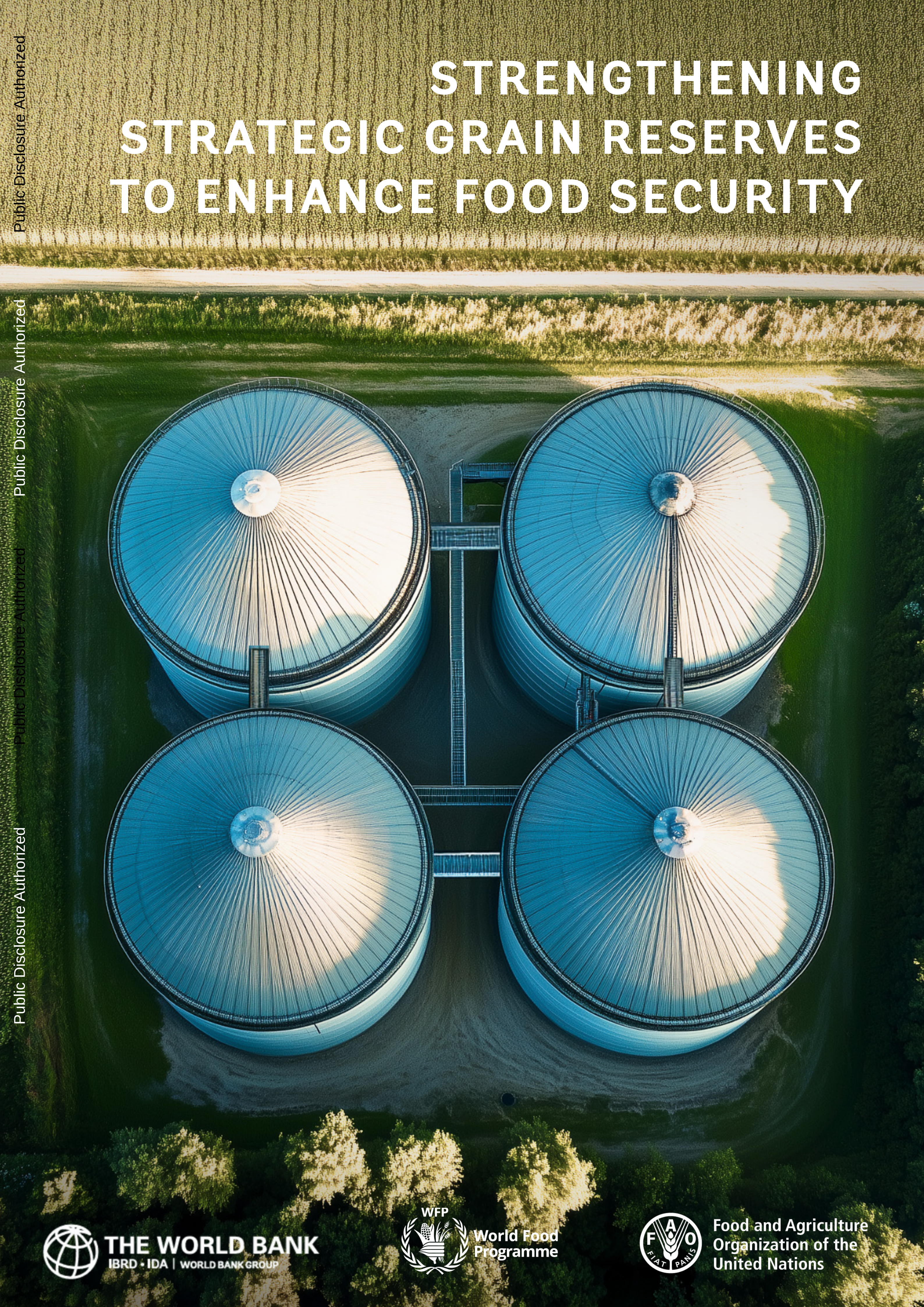
# STRENGTHENING STRATEGIC GRAIN RESERVES TO ENHANCE FOOD SECURITY



THE WORLD BANK
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WFP
World Food Programme

Food and Agriculture Organization of the United Nations

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APRIL 2025

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| **AMIS** | Agricultural Market Information System |
| **APTERR** | ASEAN Plus Three Emergency Rice Reserves |
| **ASEAN** | Association of Southeast Asian Nations |
| **CRED** | Centre for Research on the Epidemiology of Disasters |
| **ECOWAS** | Economic Community of West African States |
| **EU** | European Union |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **FCV** | Fragility, Conflict, and Violence |
| **FEWS NET** | Famine Early Warning Systems Network |
| **FRA** | Food Reserve Agency of Zambia |
| **FS2030** | Food Systems 2030 |
| **FSQ** | Food Safety and Quality |
| **FSIN** | Food Security Information Network |
| **GAFS** | Global Alliance for Food Security |
| **GDP** | Gross domestic product |
| **GIEWS** | Global Information and Early Warning and Information System |
| **GNAFC** | Global Network Against Food Crises |
| **GRFC** | Global Report on Food Crisis |
| **HICs** | High-income countries |
| **IFPRI** | International Food Policy Research Institute |
| **IMF** | International Monetary Fund |
| **IoT** | Internet of Things |
| **IPC** | Integrated Food Security Phase Classification |
| **LICs** | Low-income countries |
| **LMICs** | Lower-middle-income countries |
| **MENA** | Middle East and North Africa |
| **MICs** | Middle-income countries |
| **MSFP** | Modern Food Storage Facilities Project |
| **NFA** | National Food Authority of the Philippines |
| **NGO** | Nongovernmental Organization |
| **OECD** | Organisation for Economic Co-operation and Development |
| **P4P** | Purchase for Progress |
| **RFSR** | Regional Food Security Reserve of ECOWAS |
| **PUNGRAIN** | Punjab State Grain Procurement Corporation |
| **SAARC** | South Asian Association for Regional Cooperation |
| **SFRA** | Strategic Food Reserve Agency |
| **SGR** | Strategic Grain Reserves |
| **SSA** | Sub-Saharan Africa |
| **UN** | United Nations |
| **UNHCR** | United Nations High Commissioner for Refugees |
| **US$** | United States Dollar |
| **WFP** | World Food Programme of the United Nations |
| **WTO** | World Trade Organization |

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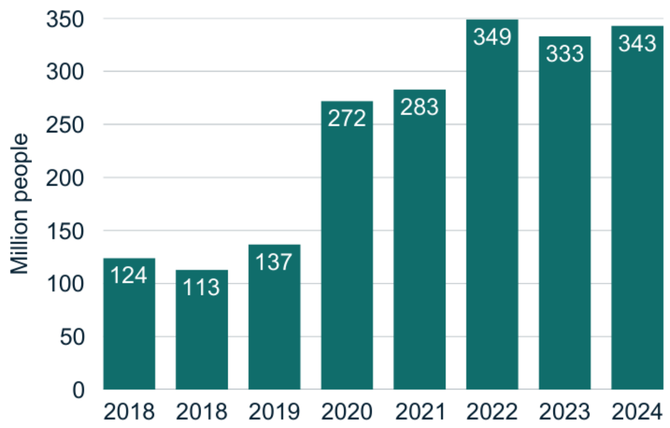
# EXECUTIVE SUMMARY

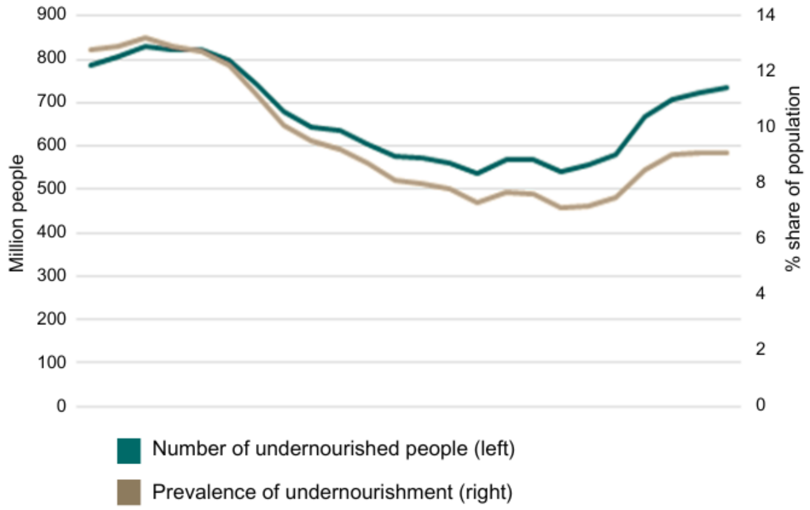
**Food insecurity today remains widespread and is increasing.** In recent years, global hunger and food insecurity have risen after decades of improvement (FAO *et al.* 2024). Crises have caused a significant increase in *acute* food insecurity, with 343 million people in 74 countries facing this challenge in 2024 (Figure ES1). The COVID-19 pandemic and recent geopolitical conflicts, which escalated food prices and triggered a global cost-of-living crisis, substantially contributed to this rise. Although the number of acutely food-insecure people has slightly decreased since 2022, it remains more than double the pre-pandemic level. Among the 343 million acutely food-insecure people, 44 million across 47 countries have escalated from crisis to emergency levels. *Chronic* food insecurity also remains high, with up to 757 million people undernourished in 2023: one in 11 globally and one in five in Africa (Figure ES2). This represents a significant increase from 581 million undernourished people globally in 2019.

FIGURE ES1: Number of Acutely Food-Insecure People, 2017–24




*Sources:* WFP 2024b (for 2020–24), FSIN and GNAFC 2024 (for 2017–19).

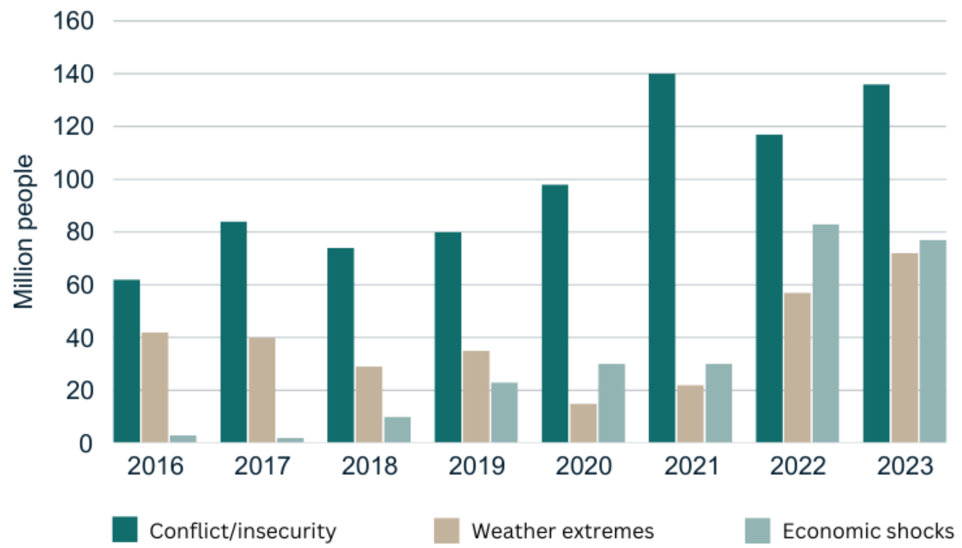
FIGURE ES2: Prevalence and Number of Undernourished People, 2000–23




*Source:* FAOSTAT 2024.

**Rising food insecurity levels have intensified the debate on whether current policies can adequately address new and heightened food security risks.** Two main concerns are often highlighted (FAO *et al.* 2023). The first concern is that global risks to food security have increased and will continue to do so, driven by climate change, conflicts, and economic shocks (Figure ES3). Additionally, the frequency and magnitude of food supply disruptions have increased. Since the 2007–08 global food price spike, countries have increasingly restricted food exports during periods of high prices, heightening supply risks for import-dependent nations (OECD 2024; World Bank 2024). Additionally, geopolitical tensions have placed growing pressure on international trade, at times reducing its ability to quickly soften food price spikes. The second concern is that current instruments for responding to acute food insecurity events have coverage gaps. These coverage gaps mainly result from insufficient resources and access of first-line responders, making prioritization necessary. For example, in 2024, the World Food Programme (WFP), the largest provider of food assistance, reached less than 40 percent of the acutely food insecure due to funding shortfalls, with interventions targeting households mostly in areas with Crisis or Emergency levels of acute food insecurity.

FIGURE ES3: Key Drivers of Acute Food Insecurity, 2016–23




*Note:* The number of countries assessed varies by year: 48 in 2016; 51 in 2017; 53 in 2018; 55 in 2019; 55 in 2020; 53 in 2021; 58 in 2022, and 59 in 2023.
*Source:* GRFC 2024.

**Strategic Grain Reserves (SGRs) are one of the tools for food security crisis management, emergency preparedness, and response.** They could be relevant in light of the current context described above. SGRs need to perform tasks that the private sector will not take on—i.e., supporting the availability of food during emergencies. With efficient SGR management, it is possible to crowd in the private sector so they engage more in storage and trade. SGRs can enhance food availability during food supply disruptions, particularly in vulnerable and isolated regions. They are especially relevant for developing countries with high import dependency. SGRs are not intended for price stabilization and are most effective when integrated with broader food security strategies, where trade, private sector development, and safety nets play important roles. To maximize their impact, SGRs should be small, simple, and smart, focusing on cost-effective and efficient management to complement other food security efforts.

**Generating net gains from the use of public stocks is challenging.** Only about 30 countries globally have actively used public stocks for enhancing food security. Most countries that use public stocks are developing countries that are net importers of grains, with the exceptions of India, Pakistan, and Zambia, which export grains. These countries must occasionally import grains when experiencing large production shortfalls. Some countries with public stocks are landlocked, meaning the cost and time required to import grains during emergencies can be



significantly higher for them than other countries, justifying the use of SGRs. For example, Uzbekistan, a double landlocked country, faces risks related to inconsistent access to wheat imports and volatile prices, particularly due to frequently changing trade policies in neighboring countries and domestic production fluctuations. As such, maintaining a well-managed SGR is crucial for Uzbekistan to mitigate these risks and ensure stable wheat availability.

**Jointly prepared by the World Bank, the World Food Programme of the United Nations (WFP), and the Food and Agriculture Organization of the United Nations (FAO), this report examines how SGRs can be strengthened at country, regional, and global levels, amid alarming global food security challenges.** This is an update to a previous report on public foodgrain stocks published by the World Bank in 2012. This report aims to inform policymakers and development practitioners on good practice's guiding principles for designing and managing SGRs that would help enhance food security. These could inform the preparation and implementation of the National Food Security Crisis Preparedness Plans. This report, however, does not provide country-specific recommendations and does not analyze trade-offs among various food crisis response instruments using country typologies; these analyses are left to country-specific studies.

**This report reviews lessons learned from public stock management in developing countries with a long history of using them.** It draws insights from the existing literature and the background studies prepared for this report on Bangladesh, India, the Philippines, and Uzbekistan in Asia; Ghana, Ethiopia, Zambia, and the ECOWAS regional reserve in Sub-Saharan Africa (SSA); Egypt and Tunisia in the Middle East and North Africa (MENA) region; and Honduras and the Dominican Republic in the Caribbean. These provide ample examples of key aspects of SGR management, offering practical insights on successful strategies and common pitfalls.

**The lessons learned show that SGRs can generate positive results if they follow key principles and when integrated with broader food security strategies.** SGRs can deliver results when they are underpinned by clear and manageable objectives, prudently managed from a fiscal standpoint, and employed smartly to mitigate the impact of temporary food supply disruptions. Successful SGRs use market channels such as commodity exchanges for interventions or are embedded in targeted safety net programs and maximize development impacts by supporting smallholder commercialization. The lessons learned also show that SGRs fail to enhance food security when they are managed as buffer stocks to address too many and often conflicting policy objectives. There are numerous causes of SGR failure, including lack of clarity of objectives, high fiscal costs, and crowding out of private storage and trade.

**Country-level SGRs are most likely to succeed.** International price stabilization schemes for agricultural commodities have historically failed, and there is no reason to assume that international grain reserves will succeed in the near future. Regional reserves, despite their potential, face coordination challenges and trust issues among participating countries. Lessons from existing regional reserves, described in this report, underscore the need for more robust coordination and agreements, considering diverse socio-economic factors and crisis contexts. While stronger regional cooperation can improve early warning systems, information sharing, and capacity building for public stock management, regional reserves are unlikely to replace country-level SGRs in the near future.[1]

[1] The review of virtual grain stocks at global and regional level was beyond the scope of this report.

**The list of guiding principles for managing country-level SGRs is extensive but crucial for ensuring high value for money and improved food security.** Public stocks fail for numerous reasons, including unclear objectives, high fiscal costs, and crowding out of private storage and trade, alongside other market distortions. Countries should carefully consider these factors to use SGRs effectively. SGRs are especially difficult to manage in countries with weak public institutions or those experiencing fragility, conflict, and violence (FCV). The following principles should be followed to maximize the impact of SGRs:

- **Ensuring effective governance, transparency, and communication:** Transparency and clear communication are essential for SGRs. Stock size, procurement, and decisions relating to timing and approach for release should be based on market principles with limited public interventions. The institutional setup for managing SGRs can vary, but their effective governance is critical. Public management of stocks is common, but private-public partnerships can be effective if release decisions remain a public responsibility. Clear criteria help ensure that SGRs serve their intended purpose without distorting market signals. Changes in operation and management decisions should be timely and clearly explained to avoid overreactions by market participants.
- **Avoiding multiplicity and unclear objectives:** The success of SGRs hinges on having clear and well-defined objectives. Too many or conflicting goals can undermine their ability to improve food security, with many public stock initiatives failing for these reasons. Therefore, setting strategic goals, and adhering to them is essential.
- **Keeping SGR's fiscal costs manageable:** SGRs are inherently costly, particularly due to the uncertainty of emergencies and the unsustainable fiscal burden of maintaining large reserves. To reduce fiscal costs, countries should maintain relatively small reserves, optimize the timing of stock replenishment, procure and release stocks at market prices, and minimize financing, storage, transportation, and distribution costs. Public funds for SGRs should not be excessively diverted from other critical agriculture and food security investments.
- **Determining an effective size of SGRs:** The size of stocks should carefully balance fiscal cost and effectiveness. Large stocks are costly and can disrupt private trade, while small stocks may not cover food supply shocks. When calculating public stock size, decision-makers should take into account the size of private stocks and incentivizing the private sector to increase them. For more accurate calculations, thresholds should be adjusted over time and account for the trade environment and likelihood of shocks.
- **Reducing price distortions and other economic costs:** To minimize price distortion, SGRs should focus on mitigating food supply disruptions and providing relief during crises, not on generating profits or stabilizing prices. SGRs should act as a last-resort safety net, intervening only when necessary to alleviate temporary supply constraints without distorting overall market dynamics. For instance, releasing grain from SGRs at market prices during temporary import delays can be effective. Governments should avoid using SGRs to combat the impact of global prices on local prices, as intervening in broader market pressures is usually futile. Following these principles, SGRs can remain compatible with liberalized grain markets, avoid large-scale interventions, and address supply disruptions pragmatically.
- **Reducing the cost of SGR replenishment:** Clear and transparent replenishment rules for SGRs are crucial for minimizing fiscal costs and market disruptions. Effective strategies include transparent procurement at market prices, appropriate timing and locations for purchases, and efficient storage and transportation. Acquiring stocks at market prices through open tenders ensures competitive pricing and involves private traders, which benefits farmers. However, two exceptions may be considered for their potential developmental benefits even if they increase the cost of procurement: (a) where possible, integrating smallholder farmers into the SGR's procurement mechanisms can support local economies and smallholder commercialization; and (b) where relevant, prioritizing procurement from regions with limited private trader presence can limit crowding out and benefit farmers in the region. In countries with large import volumes to replenish public stocks, such as those in the MENA region, large budget savings could be achieved by procuring wheat through open tenders and increasing tender efficiency. Choosing slightly lower wheat protein content, increasing the average size of tender, paying on time, reducing the urgency of wheat delivery, and ensuring competition among sellers all could help reduce the cost of grain procurement, saving billions of valuable public funds.
- **Improving outcomes of stock release:** Where markets function, stocks should be released through market channels, including auctions and commodity exchanges. Auctions are effective in urban areas with strong markets, rapidly increasing food availability during price surges. Commodity exchanges also enhance market functionality and are recommended for price transparency and stock rotations.
- **Integrating SGRs into social safety net programs:** In countries with weak market systems, targeted distributions via safety nets, such as food-for-work programs and school meals, remain necessary. Effectively integrating stock releases with safety net programs, in this case, would ensure that the vulnerable populations included in those safety nets receive food supplies during emergencies. Yet, because safety net support and emergency food assistance are given as grants, fiscal and other costs could quickly escalate unless kept targeted and small-scale.
- **Pursuing complementary trade policies:** Even amid heightened geopolitical tensions and climate change, food importers must continue trading to receive timely food supplies. Aligning SGRs with trade policies would enhance the effect of SGR releases. Reducing trade protection levels, eliminating barriers for private sector grain imports, and improving information systems and trade infrastructure can all help lower domestic food price volatility.
- **Investing in storage infrastructure, technology solutions, and innovations:** Investing in modern grain storage solutions such as silos, flat warehouses, and advanced digital monitoring technologies can reduce the cost of managing SGRs by minimizing grain losses and maintaining quality. Rapidly developing technologies help detect early spoilage and pest infestations, preserving the economic value of reserves. However, selecting the right technology requires careful consideration of each method's advantages and disadvantages within specific country contexts.

**In summary, SGRs can be one of the tools for food security crisis management, emergency preparedness, and response.** They should complement broader nonstock food security strategies that enhance the resilience of rural livelihoods and the functionality of overall safety nets. Properly managed SGRs should be part of a long-term plan that incorporates trade, agricultural productivity investments, and targeted safety net programs. SGRs are most effective for short-term interventions, stabilizing food supply during market shocks, especially during food import delays. While design will inevitably vary from country to country, SGRs should be small, simple, and smart to maximize impact, focusing on cost-effective, efficient management to complement other food security efforts.

# 1

# INTRODUCTION

## 1.1 REPORT BACKGROUND

**This report reviews how strategic grain reserves (SGRs) can improve food security as a risk management instrument.** For decades, countries have implemented public policies and programs enhancing economic growth, agricultural productivity and trade, and safety nets to reduce food insecurity and provide emergency food assistance. These approaches have generally been effective, significantly reducing the prevalence and geographic spread of famine and food insecurity. However, progress has recently slowed due to new challenges such as increased uncertainty over food price levels and volatility, more frequent and intense weather risks from climate change, an increasing number of conflicts, geopolitical tensions, and constrained food export/supply disruptions during periods of tight global inventories. These challenges have exposed vulnerabilities in current food security strategies, calling for renewed attention to instruments such as SGRs.

**Rising food insecurity levels have intensified the debate on whether current policies can adequately address new and heightened food security risks.** Two main concerns are often highlighted (FAO *et al.* 2023). The first concern is that global risks to food security have increased and will continue to do so, driven by climate change, conflicts, and economic/trade shocks. As this report will later detail, these three key drivers are increasingly overlapping, mutually reinforcing, and interconnected. While not all food supply shocks cause emergencies or spikes in food prices,[2] shocks are often triggers. Conflicts and insecurity are the primary drivers of acute food insecurity, with 65 percent of the acutely food-insecure population living in conflict-affected areas (WFP 2024b). Additionally, the frequency and magnitude of food supply disruptions have increased. Since the 2007–08 global food price spike, countries have increasingly restricted food exports during periods of high prices, heightening supply risks for import-dependent nations (OECD 2024; World Bank 2024).

**The second concern is that current instruments for responding to acute food insecurity events have coverage gaps.** These coverage gaps mainly result from insufficient resources and access of first-line responders, making prioritization necessary. For example, in 2024, the World Food Programme (WFP), the largest provider of food assistance, reached less than 40 percent of the acutely food insecure due to funding shortfalls, with interventions targeting households mostly in areas with Crisis or Emergency levels of acute food insecurity. However, pockets of acute food insecurity can persist in otherwise food-secure areas since targeting these populations can be very costly. Government-provided safety nets are typically designed to target households based on a poverty metric. The assistance is ongoing if the household remains poor, making it well-suited for addressing chronic food insecurity.

**Geopolitical tensions have placed growing pressure on international trade, at times reducing its ability to quickly soften food price spikes.** Export restrictions remain frequent and are rising, especially during periods of global food commodity price spikes and tight inventories. This rise is unfortunate because, as the changing climate has major adverse effects on the overall food supply, trade is becoming

[2] In the report, food supply and food prices refer to supply and prices of agricultural and food commodities and are used interchangeably.

increasingly vital for ensuring that food, farm inputs, and technologies move easily and cheaply across borders. Virtually all countries would have a lower risk of food and nutrition insecurity were markets better integrated; the impact is especially marked for the least-developed countries and emerging economies.

**This report examines the role of SGRs at the country, regional, and global levels within this new context.** The report is jointly prepared by the World Bank, the WFP, and the Food and Agriculture Organization (FAO), bringing together the experience of these international institutions, and updates the report on foodgrain public stocks published by the World Bank in 2012. This report aims to inform policymakers and development practitioners on good practices and guiding principles for designing and managing SGRs that might help enhance food security, not undermine it. The report uses country examples to derive the guiding principles in managing SGRs. This global report, however, does not provide country-specific recommendations and does not analyze trade-offs among various food crisis response instruments along country typologies.

**The report will also inform the preparation and implementation of the national Food Security Crisis Preparedness Plans**. These plans identify food security vulnerabilities, monitor risks, and prepare responses to emergencies. Twenty-five countries have committed to developing such plans with support from the Global Alliance for Food Security, recently renamed the Global Food and Nutrition Security Platform (World Bank 2023). Some of these plans are already under implementation, and this report will inform improvements in SGR governance and management.

**The report is structured into six chapters**. The introduction provides the background, discussing the key objectives of SGRs, the optimal roles of public and private storage in grain markets, and circumstances under which SGRs could be effective for market intervention. Chapter 2 provides details on the rapidly emerging risks and vulnerabilities for food security and how they influence the role of SGRs in addressing these challenges. Chapter 3 delves into key design elements and strategies for effective SGR governance and management, highlighting what has worked and not worked in the past. Chapter 4 discusses innovations and technologies in grain storage and monitoring, and storage infrastructure enhancements. Chapter 5 discusses how regional and global reserves can complement and support country-level public reserves. The report concludes with a list of guiding principles for effective SGRs in Chapter 6.

## 1.2 WHAT ARE SGRS?

**The term 'Strategic Grain Reserves' has been indiscriminately applied to several types of public stocks**. For this report, SGRs are defined as publicly owned inventories of food grains held in anticipation of episodes of acute food insecurity caused by trade and supply-chain disruptions. SGRs can be held for two broad purposes. First, SGRs can be used to boost private food supplies during short-term trade and supply-chain disruptions that result in sharp increases in domestic food prices. This action is done by releasing SGRs into regular marketing channels. Second, SGRs can be a precautionary source of grain for food assistance programs during market disruptions.



**In terms of how SGRs are used an emergency grain source during market disruptions, most governments deploy two types of food assistance programs**. The first is public in-kind food distributions, which are integrated into comprehensive public safety nets. Public stocks held for this purpose are often referred to as Public Distribution Stocks. The second type consists of public stocks held to deliver in-kind relief during acute food insecurity emergencies. Public stocks held for this purpose are generally known as Emergency Food Stocks. Some countries also use public stocks, known as buffer stocks, to manage food prices by acquiring stocks to boost low prices and releasing stocks to depress high prices. As discussed later, price stabilization programs based on buffer stocks, once common, have had limited success.

**When used to provide liquidity to constrained grain markets, SGRs represent one of three potential instruments to address household food insecurity, the strengths and weaknesses of which relate to their targeting mechanisms**. Safety nets (a first instrument), target poor households. Food assistance programs (a second instrument), address acute food insecurity, and, traditionally, target households and communities. As a third instrument, SGRs also address acute food emergencies by targeting markets. SGR releases are triggered when assessment is made that short-term market constraints have led to food shortages and price increases that significantly increased the number of food-insecure households. SGR operations are meant to provide relief to food-insecure households indirectly by increasing food availability.

**Because of their design, the three instruments have differing budget consequences**. Typically, safety net support and emergency food assistance are given as grants. By contrast, SGR reserves are sold and purchased at market rates, so some program costs are recovered. That said, because SGR assistance is untargeted when released through regular marketing channels, households that are not food insecure also benefit from SGR operations. Consequently, the scale of inventories needed to benefit all consumers might be quite large, especially if designed to bridge supply disruptions lasting months. This large inventory size, in turn, drives up the cost of SGR programs.

**Another distinction worth emphasizing is the difference between high domestic prices driven by disrupted markets and high domestic prices in connected markets**. In the first instance, disruptions leave local food systems autarkic; price increases primarily allocate existing supplies rather than elicit new ones. This factor is why an influx of new supplies through a release from SGRs can be effective. Alternatively, theory and practical experience suggest that releasing inventories into well-connected markets will have little impact on prices since gaps between domestic and external prices create arbitrage opportunities that effective markets will close. Said differently, SGRs can be effective as an instrument to mitigate sharp price increases—brought about by disruptions that constrain food supplies—but not as an instrument to lower food prices generally.

**For similar reasons, market constraints will determine the relative advantage of in-kind relief** *versus* **cash transfers**. As discussed in Box 1, the use of cash transfers rather than in-kind food distributions has become more prevalent as an instrument for safety net and emergency programs, as they have proven to be cost-effective in many contexts.

## BOX 1: IN-KIND FOOD ASSISTANCE OR CASH TRANSFERS

**In recent decades, emergency food assistance has gradually moved from in-kind food distribution to cash transfers.** In-kind household food distributions are less prominent than in previous decades due to cost and impact considerations. The Independent Evaluation Group of the World Bank found projects with conditional cash transfers to be more consistent in achieving objectives than those with in-kind transfers (IEG 2011). More recent estimates show that in-kind food transfers account for a relatively small share of safety net arrangements at 18 percent of all safety-net funding in MENA, 11 percent in SSA, 10 percent in South Asia, and 9 percent in Latin America and the Caribbean (World Bank 2018).

**Furthermore, it is estimated that only 44 percent of the global safety nets in recent years was provided in kind.** The remaining 56 percent was delivered as cash or fee waivers (Honorati, Gentilini, and Yemtsov 2015; Gadenne *et al.* 2024). Even for food assistance, in case of WFP, about one-third of assistance is provided as cash even though its largest operations are in FCV countries (WFP 2023). However, in-kind transfers can be preferred over cash where local markets are not fully functional or delivery mechanisms (connectivity issues, liquidity problems) of cash transfers are constrained, especially in FCV countries. WFP takes a modality agnostic approach to assistance. Detailed analysis of the country context, including levels of liquidity, market functionality, logistics networks, inform the decision on which modality of assistance WFP will deploy.

**The recent shift from in-kind to cash assistance for safety nets has important implications for SGR design.** While SGRs are not widely expected to deliver food to targeted beneficiaries, with some exceptions where it is still justifiable, they are needed to boost private food supplies during short-term trade and supply-chain disruptions, making sure that safety net recipients can afford to buy food.

## 1.3 THE ROLE OF STORAGE IN GRAIN MARKETS AND THE ESSENTIAL ROLE OF SGRS

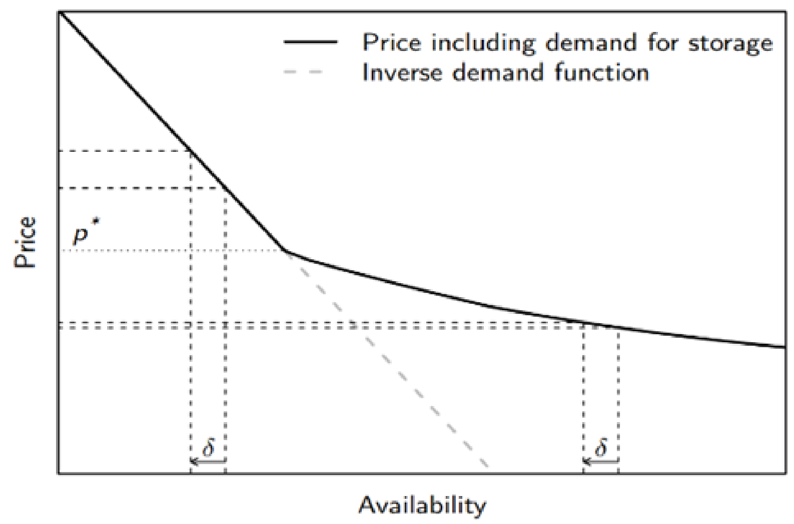
**Extensive research covers how private storage markets, trade, and public stocks influence commodity price levels and volatility**. This section outlines the theoretical foundations that inform the SGR design, focusing on the role of the public in relation to private stocks. Grain markets are inherently volatile due to shocks and the low-price supply and demand elasticities.[3] Weather, pests and diseases, and fluctuating input prices affect grain production, while demand is influenced by consumer income changes and preferences as well as policy changes (e.g., biofuels) and cross-market linkages (e.g., livestock feed demand). Low price elasticities of demand arise from grains being essential food and the lag between planting and harvesting. Traders and processors stabilize prices by buying low and selling high, linking prices across periods. However, private storage cannot prevent all price spikes, as extreme or consecutive adverse shocks can leave stocks unexpectedly low.

[3] See Gouel and Legrand (2022) for a characterization of these two dimensions.



**Grain markets operate in two regimes: sufficient availability with low prices and positive storage demand, and limited availability with high prices and limited storage demand**. Figure 1 illustrates these regimes. In the first regime, price elasticity is higher, and adjustments to supply shocks come from stock changes, resulting in small price changes. In the second regime, adjustments rely on less elastic consumption, leading to higher price increases and greater sensitivity to shocks. Intra-seasonal storage by farmers, traders, and processors adjusts based on continuous updates about crop conditions, reducing price spikes from bad harvests by limiting destocking when negative information about crop conditions emerges (Gouel 2020). Spatial arbitrage ensures that price gaps between markets do not exceed transport costs. Trade interactions highlight two risks: (a) aggregate (global harvest year-on-year variations) and (b) idiosyncratic (individual country crop production variations). International trade smooths idiosyncratic risks, while storage in exporting countries mitigates aggregate risks. However, transport costs and trade barriers in exporting countries mean storage must also address idiosyncratic risks for less integrated and import-dependent countries, providing an opening for SGRs.

FIGURE 1: Price With and Without Demand for Storage




*Note:* $p^*$ represents the price above which no speculative stocks are held. $\delta$ represents a negative supply shock occurring at two different levels of availability.
*Source:* Gouel 2024.

**A market price that clears temporal markets must also clear spatial markets**. Arbitrage opportunities for storage also compete with arbitrage opportunities for trade. That is, grain that could be held for storage in one location for sale in that location tomorrow could also be shipped for sale in another location. Consequently, a market-clearing price is one that leaves no temporal or spatial opportunities (Larson 1994, 2007). This is important for SGR operations since releasing public stocks into a local market can create spatial arbitrage opportunities, including smuggling across the border, that, when acted upon, can limit the ability of SGR operations to lower local prices.

**With this competitive benchmark market setting, private storers are vital for private marketing systems and provide basic grain price stability**. They respond to public policies affecting their incentives, which is crucial for designing effective interventions. In an ideal setting with perfect competition, information, rational expectations, and complete asset markets, market equilibrium is efficient and achieved by the private sector's actions, making public interventions unnecessary (Coles and Hammond 1995). However, when these conditions fail, which is often the case in developing countries, market equilibrium becomes suboptimal, leading to disruptions and a potential role for SGRs.

**Failures in spatial and temporal markets can threaten food security, requiring interventions like SGR operations**. Poverty and food insecurity can persist despite perfect markets, and high food prices can occur even with efficient private storage (Coles and Hammond 1995). Developing countries often face market failures, including imperfect risk perceptions, information, and coordination issues, affecting storage decisions (Barrett and Mutambatsere 2016). Imperfect risk perceptions affect storage decisions. Unpredictability can lead to suboptimal private storage inventories. Imperfect information and coordination issues arise from incomplete or inaccurate market data on prices, weather impacts, harvest sizes, and demand shifts. Grain inventories, dispersed among governments, firms, and farms, are particularly problematic. The 2007–08 global food price spike highlighted how the lack of reliable real-time information on rice inventories contributed to the runup in prices.[4] Constraints on private storage include diverse firm capacities, credit and insurance market imperfections, poor infrastructure, and lack of competition. These constraints can lead to suboptimal private storage levels.

**Policymakers in net-importing countries should, however, note that private storage is generally optimal unless market disruptions occur, and they need to promote trade even during times of global food price spikes**. The 2007–08 global food price spike illustrates this point. At the start of the crisis, wheat prices rose due to production shortfalls, but trade continued despite export bans from some large wheat exporters. Prices increased significantly, but supplies remained available, and the resulting wheat price spike was modest compared to adjustments in rice prices. By contrast, rice prices rose more sharply despite relatively ample supplies, as multiple sellers such as India and Viet Nam banned exports, and the few that remained (e.g., Thailand) considered restricting exports (Headey 2011). However, as the policy debate over price stabilization escalated, numerical models became crucial, providing baselines to measure intervention impacts. Research suggests there is limited scope for public interventions, including buffer stock programs, due to practical challenges like detecting actual commodity price trends, political capture, and the risk of depleting buffer stocks (Williams and Wright 2005; Larson *et al.* 2014; Gouel, Gautam, and Martin 2016. In the medium to long term, governments are instead recommended to focus on improving information flows and trade and institutions that support private storage, given the significant benefits of doing so. Yet, in the short-term, weak private storage markets can present vulnerabilities that must be addressed in food security policies.

**Determining the appropriate context for utilizing SGRs is crucial for their effective implementation**. SGRs can improve food security during supply disruptions and are necessary for countries based on their risk exposure, not just economic status. High-income countries like Switzerland, South Korea, Japan, and Norway[5] maintain some public reserves, highlighting this point. Assessing risk exposure involves evaluating factors such as the proportion of imported *versus* domestically produced grains, risks of export restrictions and other global food supply disruptions, logistical bottlenecks, domestic production vulnerabilities, and the potential for substituting grains and other adjustment margins, such as livestock feed.[6] These risk factors can also help determine the appropriate reserve size.[7] By evaluating and aligning the size and management of SGRs with each country's specific risks and needs, policymakers can ensure these reserves effectively contribute to national and global food security.

## THE BOTTOM LINE

SGRs are one of the tools for food security crisis management, emergency preparedness, and response. They need to perform tasks that the private sector will not take on—i.e., supporting the availability of food during emergencies—while, by efficient SGR management, crowding in the private sector to engage more in storage and trade. SGRs can enhance food availability during food supply disruptions, particularly in vulnerable and isolated regions. They are especially relevant for developing countries with high import dependency. SGRs are not intended for long-term price stabilization and are most effective when integrated with broader food security strategies that bring together trade, SGRs, private sector development, and safety nets to improve food security.

[4] This led to the creation of the Agricultural Market Information System in 2011, an inter-agency platform established by G20 Ministers of Agriculture, which assesses global food supplies focusing on wheat, maize, rice and soybeans, and facilitates coordinated policy action during critical times. See also Delgado *et al.* (2010).

[5] Norway has recently reintroduced SGRs after discontinuing them in the past (see Box 3, Chapter 3, for details).

[6] Studies by FAO (2021) and Deteix, Salou, and Loiseau (2024) characterized the risk exposure of agricultural markets in various countries, providing a basis for developing vulnerability indicators that could guide countries in the use of SGRs.

[7] In theory, SGRs' size should balance costs and benefits. In practice, reserve sizes are often set using simple rules of thumb, such as maintaining reserves for a specified number of months of demand or import requirements (e.g., 4 months for cereals in Switzerland; 90 days for petroleum imports for International Energy Agency members).

# 2

# THE RELEVANCE OF SGRS AMID EVOLVING RISKS AND VULNERABILITIES

## 2.1 HISTORY AND THE RECENT GROWING CHALLENGE OF FOOD INSECURITY AND HUNGER

**The modern concept of food security began with the 1974 World Food Conference, which emphasized expanding food supplies to meet demand and stabilize prices.** Initially, the focus was on national self-sufficiency, with food imports seen as a sign of insecurity (Upton, Cissé, and Barrett 2016; Clapp *et al.* 2022; Maletta 2024). Over time, several significant insights redirected the notion of food security away from national self-sufficiency.

**An important turning point was Sen's observation that supply shortfalls of a similar scale did not always lead to famine, which sometimes occurred when available supplies were adequate.**[8] Another was the development of studies into the dynamics of resource allocation within households, a framework suitable for understanding how households managed the production and consumption risks that threatened food security (Binswanger and Rosenzweig 1986; Corbett 1988). In combination, the new thinking moved the focus of food insecurity discussions from national outcomes to household outcomes. The focus on households also allowed for the distinction between chronic and acute food insecurity. Chronic food insecurity is a persistent lack of adequate food intake over a long period and is commonly linked to household poverty. Acute food insecurity is a manifestation of food insecurity occurring at a specific point in time, posing a threat to lives, livelihoods, or both, regardless of its causes, context, or duration. Acute food insecurity can be idiosyncratic, for example, when a household can no longer acquire food due to illness, lost income, or temporary food price spikes. These kinds of food insecurity require different policy responses.

**This new understanding emphasized the importance of local circumstances, markets, and institutions** (Sen 1981; Ravallion 1997; Fogel 2004; Devereux 2018). At the 1996 World Food Summit, trade became an essential element of food security just as countries began to dismantle agricultural trade barriers (World Food Summit 1996; Maletta 2024). Soon, most of the core elements of a multi-dimensional approach to combating food insecurity, as advocated by the FAO, WFP, the World Bank, and other members of the international community, were in place. Over time, people's increased incomes and lower grain and food prices reduced poverty (Table 1). The rise of food crisis monitoring institutions has also contributed to timely responses (Box 2).

[8] See Sen (1980, 1981). The idea that some starved while others ate well was often observed but not applied to discussions of famine. Sen (1980) quoted Bernard Shaw's play, *Man and Superman*, to make this point (Shaw, 1903).

TABLE 1: Food Availability, Food Prices, and Poverty Rates by Decade

| Decades | Calories | Protein | Population | Grain Prices | Food Prices | Income | Poverty |
|---|---|---|---|---|---|---|---|
| 1960s | 2,292 | 63 | 3.3 | 86.3 | 73.1 | 4,236 | - |
| 1970s | 2,403 | 65 | 4.0 | 98.1 | 88.5 | 5,466 | - |
| 1980s | 2,572 | 69 | 4.8 | 59.6 | 54.8 | 6,225 | 40.0 |
| 1990s | 2,653 | 72 | 5.7 | 41.0 | 38.5 | 7,079 | 33.8 |
| 2000s | 2,766 | 76 | 6.5 | 35.8 | 34.9 | 8,517 | 23.0 |
| 2010s | 2,895 | 87 | 7.4 | 44.1 | 43.0 | 10,081 | 11.3 |
| 2020s | 2,972 | 91 | 7.9 | 44.0 | 42.0 | 11,141 | 9.4 |

*Note:* Calories are measured as available calories per capita per day; protein is measured as available grams of protein per capita per day (FAOSTAT 2024). Population is measured in billions (World Bank 2024b). Monthly international price indices (World Bank 2024a) are deflated by the monthly U.S. consumer price index where 1982–1984 = 100 (Federal Reserve Bank of St. Louis 2024). Prices begin in January 1960 and end in September 2024. Income is global GDP per capita, measured as constant US$ 2015. Poverty is calculated as a headcount ratio (percentage of the population) at US$2.15 per day, deflated by the 2017 PPP (World Bank 2024b). Undernourishment is given as the prevalence of undernourishment as a percentage of the population (World Bank 2024b). All values are decade averages, except for the 2020s, which includes annual data through 2023 and monthly price data through September 2024.

## BOX 2: THE RISE OF FOOD CRISIS MONITORING'S INTERNATIONAL INSTITUTIONS

**The later decades of the twentieth century saw a rise in international institutions designed to boost food security, provide advanced warnings of potential famines, and limit their severity.** In 1961, the United Nations established the WFP as a collaboration between the United Nations and the FAO. Its first operation was to provide emergency food relief following a 1962 earthquake in Iran (WFP 2024a). In 1968, the FAO and the WFP set up a warning system to anticipate food shortages (Würdemann, Meijerink, and van Dorp 2011). Over the years, the system was improved and expanded. In its present form, the FAO's Global Information and Early Warning and Information System (GIEWS) operates a network of data collection and information sharing (FAO 2024). Among other activities, GIEWS provides publicly available information on country cereal balances, food prices, and indicators of crop stress, using remote sensing data. The system, housed within the FAO's Markets and Trade Division, dispatches rapid crop and food security assessment missions to investigate potential food shortages.

**WFP established the vulnerability analysis and mapping (VAM) unit in 1994 to improve monitoring of vulnerability to food insecurity and support a comprehensive understanding of structural and emergency factors causing food insecurity – a requirement for effective programming and planning.** A network of food security analysts across around 80 countries runs household assessments and analyses geospatial and economic data to gain insights on who is food insecure or vulnerable, why, where, and how the situation is likely going to evolve. VAM harnesses mobile technology, artificial intelligence and data analytics for remote real-time food security monitoring, forecasting and scenario simulations, and provides its data as a global public good.



**The Famine Early Warning Systems Network (FEWS NET) is another agency that was established to anticipate events that might lead to famine.** It was initially established and funded by the United States in response to the deadly 1984–85 famines in Sudan, Ethiopia, and other African countries. It has since grown into a multi-stakeholder partnership that monitors global food security risks. The system expanded considerably in 2000 to strengthen local food security information and response planning systems in Africa. Until its work was recently discontinued, the agency coordinated with partners on information, training, and assessment missions.

**Another important institution is the Integrated Food Security Phase Classification (IPC). This multi-party partnership encompasses a methodology for classifying acute food insecurity events and facilitates the analysis for declaring famines.** The FAO originally developed the methodology in 2004 to assess an evolving food crisis in Somalia (Andrews and Flores 2008). The need for a rigorous assessment of acute malnutrition events and stakeholder agreement on the severity of events became apparent when earlier multi-donor relief efforts were hampered by a lack of shared sense of urgency during evolving food emergencies. The IPC classification system is a 5-stage scaled classification system focused on nutrition outcomes and household coping behaviors. Normal circumstances are classified as stage 1, while stage 2 reflects situations where households can avoid food gaps by shifting household budgets from non-food expenditures to food expenditures. Food gaps and malnutrition appear in stage 3 and mark the early stages of an acute hunger crisis. Assets are liquidated and food gaps widen in stage 4, and famine appears in stage 5. At the global level, it is now a partnership of 19 organizations and intergovernmental institutions.

**In recent years, other efforts were made to prompt monitoring and data collection efforts around food insecurity.** One example is the Food Security Information Network (FSIN), an EU-funded collaborative platform with a Secretariat housed within the WFP. As part of its collaboration with the Global Network against Food Crises, the FSIN facilitates the annual, multi-partner, consensus-based Global Report on Food Crises, its mid-year update as well as regional reports. The 2024 Global Report on Food Crises report includes information from 59 countries (FSIN and Global Network Against Food Crises, 2024).

**Another example is the Agricultural Market Information System (AMIS).** It is an inter-agency platform to enhance food market transparency and policy response for food security. It was launched in 2011 by the G20 Ministers of Agriculture following the global food price hikes in 2007–08 and 2010. Bringing together the principal trading countries of agricultural commodities, AMIS assesses global food supplies, focusing on wheat, maize, rice, and soybeans. It provides a platform to coordinate policy action in times of market uncertainty.

**Finally, the World Bank Group and German G7 Presidency jointly launched the Global Alliance for Food Security (GAFS), recently renamed the Global Food and Nutrition Security Platform.** Launched in May 2022, GAFS was designed to catalyze an agile and coordinated response to the global food security crisis. GAFS has been a one-stop platform, providing timely, quality food and nutrition security information for decision-makers. The GAFS dashboard displays the inter-relatedness of food crisis monitoring, financial response, and research to achieve complementarity toward the GAFS objective.

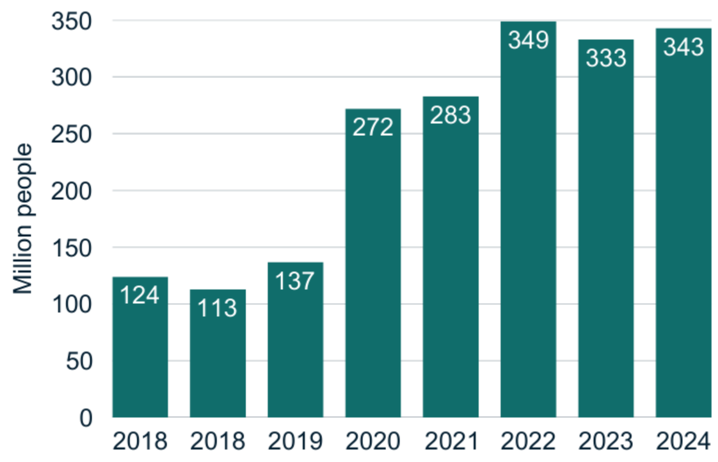
**The global food security landscape has shifted significantly in recent years, diverging from past trends**. Global hunger and food insecurity have risen after decades of improvement (FAO *et al.* 2024). Past crises, such as the 2007–08 and 2010–12 global food price spikes, did not lead to a global increase in chronic food insecurity due to strong economic growth in developing countries. In recent years, however, crises have seen a significant increase in *acute* food insecurity, with 343 million people in 74 countries facing this challenge in 2024 (Figure 2). The COVID-19 pandemic and recent geopolitical conflicts, which escalated food prices and triggered a global cost-of-living crisis, contributed substantially to the rise. Although the number of acutely food-insecure people has slightly decreased since 2022, it remains more than double the pre-pandemic level. *Chronic* food insecurity also remains high, with up to 757 million people undernourished in 2023: one in 11 globally and one in five in Africa (Figure 3). These figures represent a significant increase from 581 million people undernourished around the world in 2019. Projections estimate that 582 million people will be chronically food insecure by 2030 - significantly above pre-pandemic estimates.

**Food insecurity today is widespread and increasingly severe**. Among the 343 million acutely food insecure people, 44 million across 47 countries have escalated from crisis to emergency levels. These populations experience large food consumption gaps, high acute malnutrition, and excess mortality or are mitigating such gaps through emergency strategies and asset liquidation. Acute hunger can persist in conflict-affected areas, leading to prolonged food insecurity. From 2019 to 2023, an average of 71 percent of areas monitored by FEWS NET in Yemen and 62 percent in South Sudan were designated as IPC Phase 3–5 areas. Driven mainly by conflict, the number of people facing catastrophic hunger (IPC5) reached a level unprecedented in this century. At the time this report went to press, up to 1.9 million people in the Gaza Strip and the West Bank, Sudan, South Sudan, Haiti and Mali were estimated to experience catastrophic levels of food insecurity (IPC5) in 2024 (WFP, 2024d), including starvation, death, destitution and extremely critical levels of acute malnutrition.

**In 2024, half of the world's acutely food-insecure people lived in SSA, a quarter in Asia and the Pacific, and the remainder in MENA, Latin America, and the Caribbean** (Figure 4). The latest FAO-WFP Hunger Hotspots report provided early warnings on acute food insecurity for an outlook period of November 2024 to May 2025. The report flags that food insecurity is likely to deteriorate further in 16 hunger hotspots, with those of highest concern continuing to be Haiti, Mali, the Gaza Strip and the West Bank, South Sudan, and Sudan (WFP and FAO, 2024). The GRFC 2024 report shows a noticeable increase in food insecurity in Asia in recent years. Unfortunately, some of the drivers in the region were all too common: weather extremes in Pakistan and continued conflict in Myanmar.

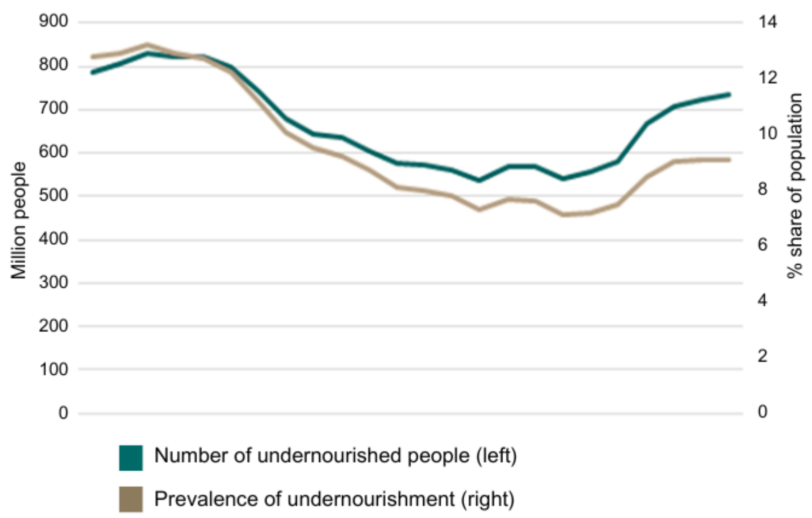


FIGURE 2: Number of Acutely Food-Insecure People, 2017–24[9]



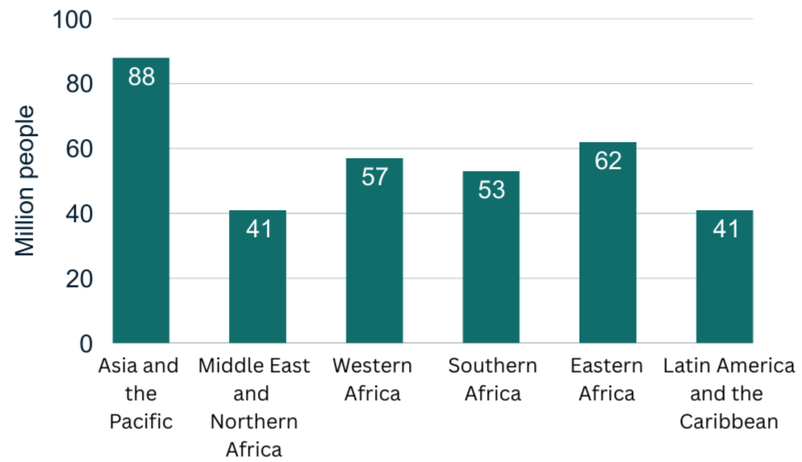

Sources: WFP 2024b (for 2020–24), FSIN and GNAFC 2024 (for 2017–19).

FIGURE 3: Prevalence and Number of Undernourished People, 2000–23




*Source:* FAOSTAT 2024.

FIGURE 4: Number of Acutely Food-Insecure People by Region, 2024



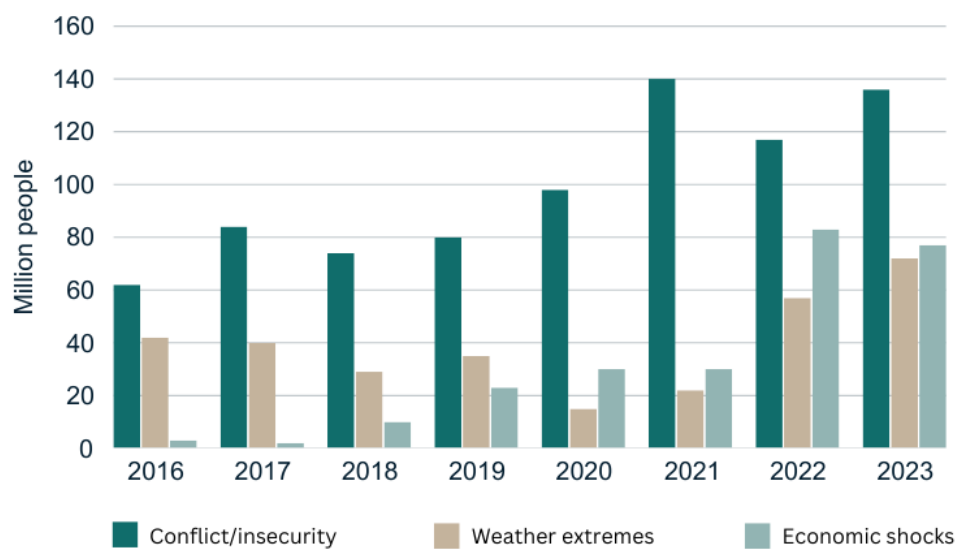

*Source:* WFP 2025.

[9] Country coverage varies between years, depending on the number of food-crisis countries and data availability. The 2017 figure is based on 51 countries, 2018 on 53 countries, 2019 on 55 countries, 2020 on 79 countries, 2021 on 81 countries, 2022 on 79 countries, 2023 on 78 countries, and 2024 on 71 countries.

## 2.2 UNDERLYING TRENDS IN FOOD SECURITY CHALLENGES

**The GRFC database contains an assessment of the single-most important driver associated with each acute food insecurity event**. There is rarely a single driver of food insecurity in any country (Figure 5). Still, the streamlined classification of drivers helps reveal trends and common global drivers. The GRFC employs three categories of acute food insecurity events: conflict/insecurity, weather extremes, and economic shocks. Unsurprisingly, conflict and insecurity are the main reasons why so many people face hunger. Conflict disrupts food systems, blocks the delivery of humanitarian assistance, and displaces people who must abandon the resources they own and their support networks. Impacts are often mutually reinforcing.

FIGURE 5: Principal Drivers of Acute Food Insecurity, 2016–23




*Note:* The number of countries assessed varies by year: 48 in 2016; 51 in 2017; 53 in 2018; 55 in 2019; 55 in 2020; 53 in 2021; 58 in 2022, and 59 in 2023.
*Source:* GRFC 2024.

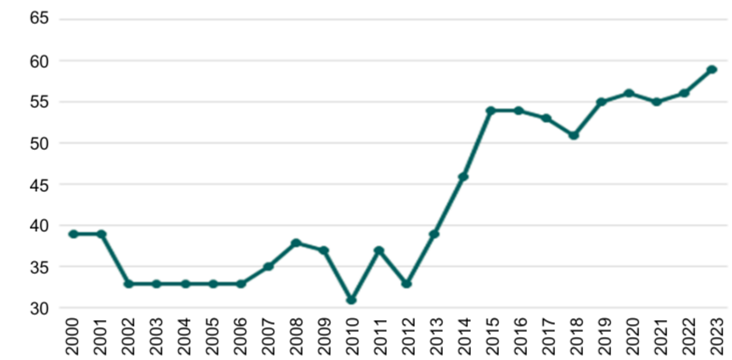
### *2.2.1 Conflict and food emergencies*

**The number of state-based armed conflicts worldwide has increased significantly over the last decade**. The world is experiencing the highest level of state-based conflicts since World War II, with significant implications for food security (Rustad 2024). Between 2012 and 2023, the number of conflicts rose from 33 to 59, the highest since the Uppsala Conflict Data Program began collecting data in 1946 (Figure 6). Moreover, 92 countries are engaged in conflict elsewhere, more than at any point since the inception of the Global Peace Index in 2008. This increasing internationalization complicates negotiation processes and prolongs conflicts. At the same time, 108 countries are becoming more militarized - again the highest number since the Global Peace Index started tracking (Institute for Economics and Peace 2024). Trends in forced displacement highlight the global lack of peace and security, with 117 million people forcibly displaced at the end of 2023 due to persecution, conflict, violence, and human rights violations (Figure 7). UNHCR estimates that this number has reached 123 million by mid-2024—nearly tripling in size since 2010—with Sudan, Syria, and the Democratic Republic of Congo having the highest numbers of internally displaced people (UNHCR 2024; IDMC 2024).

**Conflicts have become a significant risk for agricultural markets, severely impacting food security**. In SSA, conflicts have been the primary driver of food insecurity since 2013, exacerbated by droughts and locust infestations. Conflict disrupts all aspects of the food system, including crop production, storage, processing facilities, and transport infrastructure, preventing supplies from reaching markets and causing local food prices to surge. Economic contraction and limited livelihood opportunities further erode purchasing power.

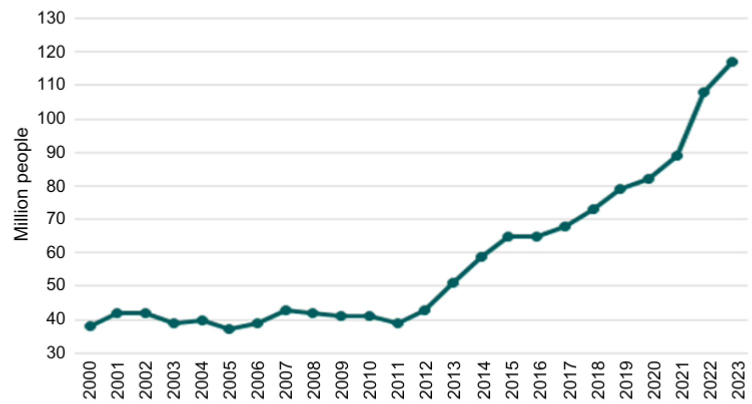
**Conflicts force farmers, pastoralists, and urban workers to abandon their livelihoods, leading to prolonged food insecurity even years after the violence ends**. Internally displaced people often reduce their food intake, and food security deteriorates with repeated displacement. Additionally, conflicts impede humanitarian assistance, with catastrophic outcomes. The latest FAO-WFP Hunger Hotspots report warns that, without humanitarian aid and efforts to reduce access constraints, further starvation and death are likely in Mali, the Gaza Strip and the West Bank, South Sudan, Sudan, and Haiti (WFP and FAO 2024). Also, food production and supply rehabilitation in war-torn countries take decades (Kemmerling, Schetter, and Wirkus 2022). Displaced people may stay away from their homes for years, even when conflicts are resolved.

FIGURE 6: Number of State-Based Armed Conflicts Worldwide




*Source:* Uppsala Conflict Data Program (database).

FIGURE 7: Number of Forcibly Displaced People Worldwide




*Source:* UNHCR Refugee Data Finder (database).

**There is also a growing recognition that the relationship between conflict and food insecurity is bidirectional**. Food insecurity results from conflict but also sparks, reinforces, or perpetuates conflicts (Sova *et al.* 2023). Under certain conditions, severe hunger can drive protests, unrest, and even civil wars. While food insecurity alone may be unlikely to incite violence, when combined with socio-economic and political inequalities, it can exacerbate grievances and spark conflict (Kemmerling, Schetter, and Wirkus 2022).

### 2.2.2 Climate change and weather-driven events

**Among the various drivers reshaping global food security, climate change is a key factor with far-reaching implications**. Weather extremes have increased in frequency and intensity over time. According to the Centre for Research on the Epidemiology of Disasters' EM-DAT database, from 1964 to 1983, an average of 76 climate disaster events were reported annually. This number increased to 225 events per year in the following two decades and reached 339 events per year between 2004 and 2023 (Table 2).[10] Munich Re's NatCatSERVICE database also shows exponential growth in the frequency of natural disasters at a rate of 2.6 percent over the last four decades (Chatzopoulos *et al.* 2021).

TABLE 2: Number of Reported Meteorological, Hydrological, and Climatological Disasters

| Type | 1964–83 | 1984–2003 | 2004–23 |
|---|---|---|---|
| Droughts | 184 | 277 | 315 |
| Extreme temperature | 30 | 211 | 396 |
| Floods | 559 | 1,841 | 3,373 |
| Glacial lake outbursts | 0 | 0 | 4 |
| Landslides | 113 | 309 | 354 |
| Storms | 606 | 1,653 | 2,125 |
| Wildfires | 29 | 213 | 219 |
| **Total** | **1,521** | **4,504** | **6,786** |

*Source:* EM-DAT (database) 2024.

**Climate change significantly impacts agricultural production**. Adverse effects on crop yields are already visible and projected to intensify. Attribution studies generally show the adverse effects of recent climate change on crop yields, with few exceptions (FAO 2023). New-generation models suggest these impacts could occur sooner than expected (Jägermeyr *et al.* 2021). While most studies focus on average yield decreases, the rationale for SGRs requires scrutiny into large deviations caused by weather extremes, which are becoming more common due to climate change. Such extremes in yields present a significant challenge for analysis due to their low frequency, but evidence is mounting that climate change is making large deviations in yield more common. For instance, heat waves and droughts are found to have caused substantial crop yield reductions (Lesk, Rowhani, and Ramankutty 2016), with a tripling of such events in Europe (Brás *et al.* 2021), leading to significant crop losses. In the last decade, the growth in global food per capita production declined while volatility increased, highlighting that more volatile yields affect food production (Figure 8).

FIGURE 8: Growth and Volatility Trends in Global Food Production per Capita, 1980–2020


*Source:* FAOSTAT 2022.

**Extreme weather events are already affecting agricultural export patterns**. Recent research finds that two-standard-deviation extreme weather events—measured using the water balance deficit—reduce maize, rice, and soybean bilateral export values by 48.2 percent, 53.4 percent, and 21.7 percent, respectively (Nes *et al.* 2025). The long-term results imply that increases in the standard deviation of weather are associated with lower export values across all three crops. An increase in the frequency of extreme events can greatly shift current commodity export patterns, creating uncertainty in the short run that SGRs could potentially manage. Understanding these shifting trade patterns is necessary to implement trade policy that enables countries to leverage their evolving comparative advantages and ensure the effectiveness of trade as a tool for mitigating the negative production effect of climate change.

**There is also a critical connection between climate change and conflicts, thus indirectly affecting food security and its direct impact on agricultural production**. Climate change exacerbates conflicts, especially in regions with fragile social and political conditions (Buhaug and von Uexkull 2021). Weather-related displacements have ranged from 14–38 million people annually since 2008, with 20 million in 2023, mainly due to floods and storms (IDMC 2024). Slow-onset climate impacts could force 216 million people to migrate within their countries by 2050, with the largest shares in SSA (86 million people) and East Asia and the Pacific (59 million people) (Clement *et al.* 2021).

### 2.2.3 Economic shocks and food emergencies

**Economic disruptions and recessions are more common causes of acute food insecurity, partly due to lingering COVID-19 pandemic impacts**. One in four

[10] Over time, improved disaster reporting and evolving technologies have led to more comprehensive data, though earlier years may lack consistency, which explains some patterns in natural disaster data (Ritchie and Rosado 2024; Alimonti and Mariani 2023). This means that cautious interpretation of trends over time is key, especially when examining early data.

acutely food insecure people around the world live in countries where economic shocks are the primary driver of hunger (FSIN and GNAFC, 2024). Historically, large global economic downturns have contributed to food price declines due to reduced demand. Economic cycles have primarily driven food and commodity prices rather than prices driving recessions, with the significant exception of energy (Baffes *et al.* 2015). However, the 2020 global recession, triggered by the COVID-19 pandemic, was exceptional. It caused a nearly 4 percent drop in global average incomes, affecting nearly all markets, including agriculture ( IMF 2022; World Bank 2024b). Yet, the food price index rose by 14 percent due to supply-chain disruptions, with integrated markets experiencing higher price increases than segmented ones (Dietrich *et al.* 2022).

**Not only prices, but income levels also determine households' ability to afford food**. The pandemic triggered a global recession, but the economy rebounded quickly (Figure 9). Despite this recovery, global economic growth in 2024 remains below the pre-pandemic average of 3.1 percent. Forecasts indicate that 60 percent of economies, representing 80 percent of the global population, will experience slower growth in the coming years compared to the 2010s. In FCV regions, all economies are expected to be poorer at the start of 2025 than before the pandemic (World Bank 2024a).

FIGURE 9: Global GDP Growth in Real Terms


*Source:* World Development Indicators.

**Globally, public debt levels have risen sharply in recent years, exacerbating food crises as high debt servicing costs limit social transfers and investments**. Over the past 15 years, government borrowing has surged—initially driven by low interest rates and later accelerated by massive COVID-19-related spending. By 2023, global public debt reached US$97 trillion, doubling over the past decade. The debt of developing countries has grown twice as fast as that of developed economies since 2010 (UNCTAD 2024). Furthermore, the sharp interest rate hikes by major central banks two years ago, aimed at curbing inflation, have severely impacted poorer nations with high foreign debt. In 2024 and 2025, low-income countries are expected to spend US$60 billion annually on debt repayment—three times the average annual refinancing cost between 2010 and 2020 (Holland and Pazarbasioglu 2024).



**Trade disruptions might diminish the ability of trade flows to smooth over idiosyncratic risks, compelling countries to rely more heavily on domestic production and storage capabilities**. While these factors suggest increased risks, they may not represent a fundamentally new environment but a continuation of existing trends. International trade in agricultural products has always been subject to public interventions during crises (Anderson and Nelgen 2012), with countries systematically adjusting their trade measures to insulate domestic markets from world price changes (Martin, Mamun, and Minot 2024). The World Trade Organization (WTO) has historically struggled to provide a robust framework to address these issues (Cardwell and Kerr 2014). However, the potential aggravation of these risks in the future, especially as they compound, cannot be excluded. In their medium-term agricultural outlook, the FAO and OECD stress the importance of trade to smooth national production variations. They point to worrisome potential disruptions of trade along bottlenecks such as the Panama and Suez Canals—problems in both of which hampered maritime shipping in 2024—increased yield variability, and water scarcity due to accelerating climate change and policies that could limit food supplies (OECD-FAO 2024).

**Increased risks challenging a steady supply should trigger higher average grain stock levels**. If private agents accurately account for these risks, they will increase their private stocks due to new profit opportunities. However, this assumes market operators have high knowledge and foresight—which is often unrealistic given the unpredictability of extreme events—and that they have access to affordable finance. The lack of knowledge about shock distributions and the high cost of finance in many developing countries justifies public interventions. The link between climate, conflicts, and food security strengthens the rationale for SGRs, assuming they follow good practices detailed in Chapter 3.

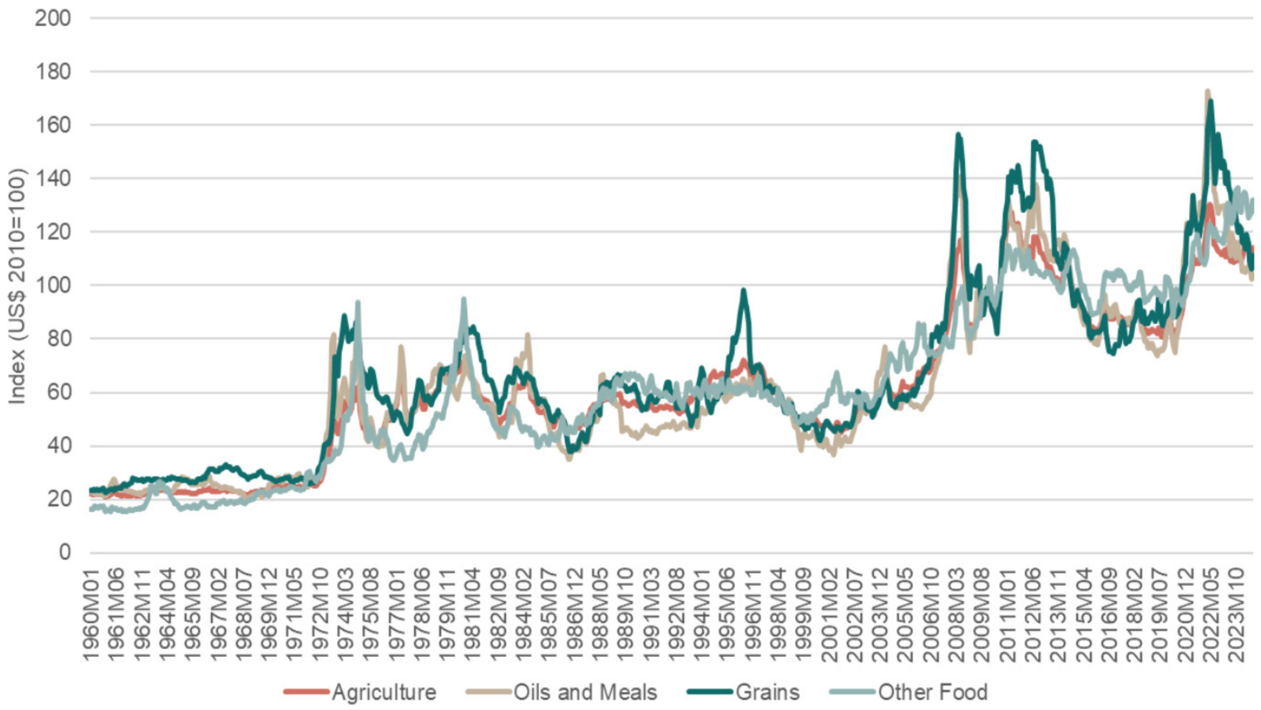
## 2.3 RECENT TRENDS AND VOLATILITY IN GLOBAL AND DOMESTIC FOOD PRICES

**Food price spikes are behind many recent food insecurity events.** National macroeconomic events like high inflation or currency devaluations often trigger sharp increases in food prices. However, a price jump in internationally-traded commodities, especially in staple food grains like rice and wheat, is a systemic event that can worsen acute food insecurity globally. This section discusses the recent developments in international food prices, their volatility, and the relationship between private storage and commodity prices. It also presents empirical evidence about the extent and speed of transmission of global grain price spikes into local markets and what these findings mean for SGR management.

### *2.3.1 Global food price developments*

**Food price volatility, common since 1970, has been especially pronounced since 2008** (Figure 10). These fluctuations reverberate through external trade, exchange rate movements, and inflation rates, influencing the stability and growth of national economies. Understanding the nature and causes of this volatility is essential to improving agricultural and trade policymaking and understanding the implications for SGR's management.

FIGURE 10: Global Agricultural and Food Prices, 1960–2024




*Source:* World Bank data.

**Food price volatility is driven by cyclical, short-term shocks, and long-term shifts. The cycles of commodity prices have lasted for several years and even decades.** These so-called "supercycles," were particularly evident in the 1970s, 1990s, and early 2000s to the present (World Bank 2025).

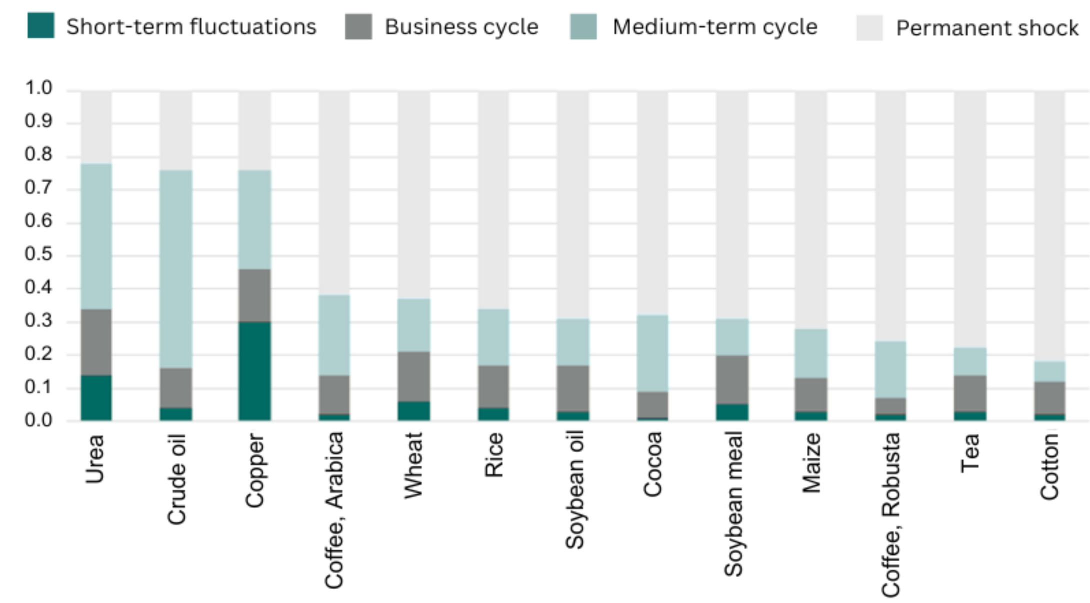
**Short-term shocks to food commodity prices are caused by many factors**. Major drivers are transitory, or short-term demand-side shocks, trade tensions, export bans by major exporters, adverse weather conditions, and supply-chain disruptions, like those during the COVID-19 pandemic. Shocks in related markets can also spill over into food markets. For example, energy price booms raise food production costs through higher fertilizer and fuel prices (Baffes *et al.* 2022) and can contribute to government policies, for example the promotion of biofuel production in the early 2000s, which required large-scale agricultural expansion (Baffes 2013).

**Certain market conditions and macroeconomic variables can cause short-term swings in food prices**. Food prices are more volatile when futures contracts near expiration or when inventories are low. There is also a debate about whether financial markets, like futures and derivatives, increase food price volatility. Despite some studies attributing food price spikes to these markets, most do not establish a clear link (Boyd, Harris, and Li 2018; Aulerich, Irwin, and Garcia 2014; Brunetti, Büyükşahin, and Harris 2016; Capelle-Blancard and Coulibaly 2011) or even suggest that increased trading can lower price swings by mitigating risks (World Bank 2025). Macroeconomic variables, such as the equity index, crude oil prices, and the U.S. dollar exchange rate are found to influence price volatility of commodity markets. Price volatility was also more persistent during the multi-shock period (2022-23) compared to the era before the boom (1985–2001) showing that economic uncertainty influences agricultural commodity prices.

**Other types of shocks can affect commodity markets more permanently**. These shocks with permanent effects include technological innovations, public policies, such as those supporting domestic agricultural production (Aksoy and Beghin 2004) or the expansion of biofuel production (Rulli *et al.* 2016), or changes to food demand from growing populations, shifting consumer preferences, and other factors. For example, advances in biotechnology during the 1990s increased crop productivity by over 20 percent (Klümper and Qaim 2014).

**Volatility differs across commodities, but short-term fluctuations generally contribute less to overall price volatility than cyclical and permanent shocks**. Figure 11 breaks down global price volatility for 13 commodities into four components: short-term fluctuations, business cycles, medium-term cycles, and shocks with permanent consequences. The data reveal that the relative importance of these components varies by commodity. Nonetheless, short-term price swings consistently represent a smaller proportion of total volatility, with cyclical components and permanent shocks accounting for the majority. As such, trade protection or price stabilization efforts will do little to lower long-term food prices but could undermine food security. Trade remains important to smooth out spikes in food prices.

FIGURE 11: Volatility Differences Across Commodities, 1970–2022




*Source:* World Bank 2024.

**Irrespective of the driving force, food price volatility remains a large concern, exacerbating the negative impacts of higher food prices on food security**. Some food price spikes are hard to predict, making it more difficult to manage them through trade and early warning systems. The issues draw special attention from policymakers when food prices increase suddenly and sharply as governments search for ways to limit the impact of high prices on food insecurity. Table 3 lists the 20 price runs[11] with the largest percentage price gain or loss from start to end. The table separately lists runs based on food prices and grain prices. While food prices are generally the prime concern for food security, grain prices and trade are the practical focus of most policy interventions, including those involving SGRs. Two out of the top seven price spikes for food and three of the top eight price

[11] A price run is defined as beginning when prices move in the same direction for two consecutive months and ends when prices move in the opposite direction for two consecutive months.

spikes for grains have occurred since 2005. Most of the events with the largest price gain lasted over a year. While the onset can be sudden, the events play out over months, and the most impactful events linger for a year or longer. These lengthy durations are partly due to most major grain production occurring on an annual cycle, which often means that new supplies enter the market at six-month intervals between harvests in the northern and southern hemispheres. The nature of storage markets also plays a role since inventories are built up or drawn down over time.

TABLE 3: Most Significant Price Runs Ordered by the Absolute Change in Real Food and Grain Prices

| | Food Price Index | | | Grain Price Index | | |
|---|---|---|---|---|---|---|
| Rank | Start | Duration (Months) | Price Change (Percentage) | Start | Duration (Months) | Price Change (Percentage) |
| 1 | Jul-72 | 12 | 113.56 | Feb-72 | 18 | 162.88 |
| 2 | Apr-07 | 14 | 64.60 | Apr-07 | 14 | 85.15 |
| 3 | Nov-80 | 23 | -50.18 | Jul-94 | 22 | 77.46 |
| 4 | Nov-74 | 7 | -43.25 | Jun-10 | 10 | 69.01 |
| 5 | May-20 | 12 | 42.40 | Nov-19 | 18 | 45.63 |
| 6 | Oct-82 | 11 | 37.44 | Jan-81 | 21 | -44.44 |
| 7 | Aug-87 | 13 | 36.32 | Jun-93 | 7 | 42.97 |
| 8 | Jun-10 | 14 | 35.27 | Nov-05 | 15 | 39.90 |
| 9 | Apr-22 | 28 | -33.11 | Aug-77 | 8 | 39.01 |
| 10 | Jun-08 | 9 | -31.89 | Feb-74 | 16 | -38.33 |
| 11 | Jul-03 | 8 | 29.85 | Oct-22 | 22 | -35.61 |
| 12 | Sep-77 | 7 | 28.08 | Sep-21 | 8 | 34.35 |
| 13 | Oct-73 | 4 | 27.78 | Jun-08 | 10 | -34.02 |
| 14 | Mar-14 | 20 | -27.77 | Jul-12 | 18 | -32.72 |
| 15 | Apr-77 | 5 | -27.72 | May-96 | 6 | -32.15 |
| 16 | Sep-83 | 17 | -25.49 | Apr-84 | 18 | -30.36 |
| 17 | Jun-74 | 5 | 24.24 | Jan-86 | 8 | -29.42 |
| 18 | Nov-76 | 5 | 21.48 | Oct-73 | 4 | 29.12 |
| 19 | Dec-21 | 4 | 20.97 | Aug-87 | 6 | 28.71 |
| 20 | Jan-99 | 6 | -20.10 | Apr-02 | 5 | 27.62 |

*Source:* Authors' calculations based on deflated monthly food and grain price indices, January 1960 to September 2024 (Federal Reserve Bank of St. Louis 2024; World Bank 2024a).

### 2.3.2 Do high international prices lead to high domestic prices?

**While the development of global prices matters for food security and related policy decisions—including on SGRs—as global price changes transmit to local prices, such price transmission differs in extent and speed**. How quickly and to what extent the shocks in global markets are transmitted into local markets depends on transport and marketing costs, policy measures, local currency valuation, market structure, and degree of processing of goods for final consumption (Zorya, Townsend, and Delgado 2012):

- *Transport and other marketing costs*, when substantial, cause a rise in world prices to be under-reflected in import parity prices and over-reflected in export parity prices.



- *Policy measures* such as export bans, import duties, export taxes, non-tariff barriers, or domestic policies such as price support all influence the extent to which price changes in domestic markets mirror those in international markets.
- When a country's *local currency* appreciates against the U.S. dollar, food prices in the local currency rise less than they do internationally.
- The *market structure* is also important. In monopsonistic markets, whether private or state-controlled, higher international prices may not always result in better prices for producers or consumers.
- The *degree of processing of final consumption goods* also affects price transmission. The higher the cost share of raw production in the final product and the less scope there is for substitution, the more a price change for the raw product will be transmitted into a price change for the final product.

**This section presents evidence on price transmission from global to local grain prices**. The magnitude and differences in price transmission have implications for SGRs and other policy responses. When global prices spike, policymakers need to assess more than changes in global food prices to decide whether to activate their SGRs. Other factors also matter, and a global shock does not always quickly trigger a local shock. At the global level, the implication is that stabilizing global food prices alone has limits in terms of ensuring price stability at the country level. Chapter 5 discusses this implication in more detail, covering regional and global reserves.

**Enabling the transmission of international food prices to domestic prices is essential to pursuing comparative-advantage-based, sustainable agricultural production.** Doing so ensures that domestic production responds to global food scarcity or surplus (Zorya, Townsend, and Delgado 2012; Barrett 2001). For many price-taking developing countries, international prices serve as opportunity costs and play a key role in shaping the effective allocation of domestic resources. When the long-term trend of international prices is transmitted slowly and imperfectly to domestic markets, consumers and producers make decisions based on prices that do not represent their actual social costs and benefits. Thus, a sustained deviation of domestic prices from world prices in either direction leads to substantially suboptimal outcomes. Moreover, as international food prices reflect global scarcity or surplus, their transmission to domestic prices can help improve the global food system's responsiveness to shocks.

**At the same time, price transmission can lead to food security risks when uncertainty and price volatility on global food markets are high**. Volatile and unpredictable prices may spill over to domestic markets, undermining incentives for farmers to respond to high price levels with an urgent increase in production, which is needed to lower food prices. In practical terms, farmers and countries face uncertainty when deciding what to plant or when to import, respectively, as they rely on likely price levels and distributions to inform their current decisions. This uncertainty keeps food prices high for longer, leading to fundamental food security risks for consumers and governments.

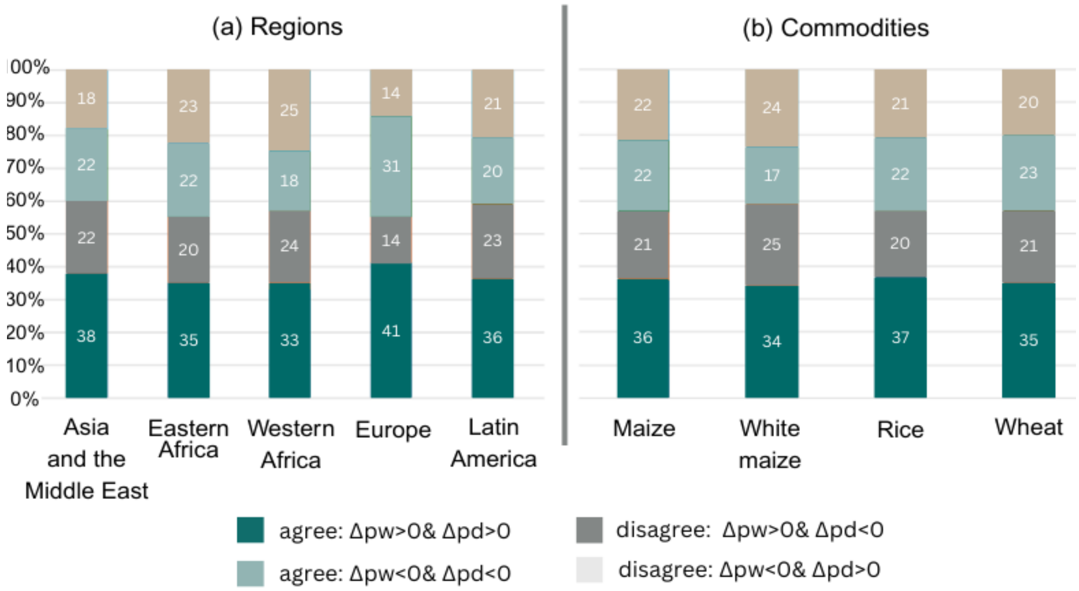
**Decoupling from international markets and pursuing a food self-sufficiency policy to manage the increased global food price volatility are not sustainable**

**solutions, however**. Self-sufficiency policies have not worked in the past, and they are unlikely to work in the future, even with more uncertain and volatile world markets. Countries would be better off continuing their reliance on trade to align their long-term food prices with those on global markets, while reducing short-term food price volatility by improving early warning systems, SGRs, and safety nets.

**Among regions and products, there are significant differences in the speed and degree to which world price movements were felt in regional or local markets**. Domestic and international prices do not even always move in the same direction. The analysis of quarterly changes of domestic[12] and international grain (i.e., maize, rice, and wheat) prices[13] from 1995–2011 showed agreement in the direction of change for only 60 percent of cases. In 37 percent of cases, domestic prices increased when international prices increased, and in 23 percent of cases, domestic prices declined when international prices declined (Figure 12). The extent of agreements was highest in Europe and lowest in West Africa, without significant difference by commodity. Domestic and international prices moved in opposed directions in 40 percent of all cases.

**Cointegration analysis confirmed that price transmission between market pairs has been neither swift nor universal** (Table 4). During 2000–11, only 25 percent of wheat market pairs were cointegrated with international prices. For maize, 31 percent of market pairs were cointegrated with international prices, while for rice, the share was 55 percent. Analysis of the price data for the 2024–23 period showed similar results for maize and rice; while the prevalence of cointegration for wheat prices has increased, it is only at 60 percent.

FIGURE 12: Directions of Quarterly Price Movements on Domestic and International Markets – Agreement and Disagreement by Region and Commodity




*Source:* Authors' estimate based on Greb *et al.* 2012.

[12] Data included 57 domestic prices for wheat, 262 domestic prices for rice, and 180 domestic prices for maize.
[13] The following international prices were used: wheat - US No. 2 HRW; rice - Thai 5 percent; yellow maize - US No. 2 yellow Gulf; and white maize - Randfontein (South Africa).



TABLE 4: Percentage of Market Pairs Showing Cointegration Between Local and Global Food Prices

| Commodities | 2000–11 | 2004–23 |
|---|---|---|
| Wheat | 25 | 59 |
| Yellow maize | n/a | 60 |
| White maize | 31 | 39 |
| Rice | 55 | 58 |

*Source:* Authors' estimate based on Greb *et al.* (2012) and World Bank 2024.

**For countries where domestic prices are linked to international prices, it usually takes several months for local prices to reflect the changes in international food prices**. Changes in international prices are passed through to domestic prices within 36 months, depending on the local production situation, access to markets, and import/export logistics. Even where markets are integrated, changes in international prices are rarely fully transmitted. The average passthrough ranges from 20–70 percent, i.e., a 1 percent change in international prices results in a 0.2–0.7 percent change in the domestic price. Yet even a 20 percent increase in local food prices can make a big difference to the poor (Greb *et al.* 2012).

**In Asia, the long-term price transmission elasticities for rice were largest in countries open to trade**, such as Bangladesh (0.34), Cambodia (0.70), and Viet Nam (0.51). In the Philippines, the long-term transmission was small (0.23) due to its insulating measures. India and Indonesia are also decoupled from the international market. India is largely self-sufficient, while Indonesia, which pursues a food self-sufficiency policy, imported irregularly and sought to break the link between international and domestic prices. When the price link is broken, imports or exports from these countries are difficult to anticipate, making the world rice market more volatile.

**In the large wheat-importing countries in the MENA region, wheat prices are transmitted relatively quickly**. Long-term price transmission coefficients average 0.2 to 0.4. The passthrough effects are notably higher for Djibouti, Egypt, Iraq, and the United Arab Emirates. By contrast, price transmission is very small in Algeria and Tunisia due to high food subsidies and controlled prices. In Latin America, transmission is relatively high in Ecuador, Nicaragua, and the Dominican Republic, while in Asia, price transmission elasticities range from 0.1 in India (a more closed economy) to 0.4 in Pakistan and 0.7 in Bangladesh (more open economies) (Greb *et al.* 2012).

**Transmission of international maize prices appears to be the lowest of the grains, particularly in SSA countries**. Most SSA countries are close to self-sufficiency in white maize, with yellow maize mainly traded internationally. As such, local prices are driven more by local factors. In addition, the reasons for weak transmission include high infrastructure costs, small quantities for trade, and ad hoc trade policies. Of the 40 maize markets studied by IFPRI, prices in only four have any relation to international prices. As a result, domestic food prices are mainly determined by local and regional factors and are often more volatile than global prices.

## THE BOTTOM LINE

Climate change, conflicts, and economic shocks are likely to continue bringing uncertainty, supply disruptions, and price volatility to global and local food markets, contributing to food insecurity. As such, SGRs, where relevant, could play a role in reducing food security risks. Despite frequent spikes in global food prices in the last two decades, long-term factors continue to dominate global food price changes, which SGRs cannot revert. Instead, SGRs should focus on addressing local food supply shocks, reflected in local food price spikes; the transmission of global food prices could cause such shocks, but this is not always and rarely fully the case.

# 3

# KEY ELEMENTS AND DESIGN STRATEGIES FOR EFFECTIVE SGRS

**While earlier chapters identify the benefits of SGRs, they also come with challenges**. Market distortions, high fiscal costs, corruption, and enforcement issues can all undermine an SGR's effectiveness. Thus, designing and implementing interventions that minimize these failures is crucial in ensuring that an SGR's benefits outweigh the drawbacks. Reaching this outcome requires clearly defined, transparent, accountable, and well-coordinated policy frameworks that adapt to the evolving market conditions and effectively address immediate and long-term food security needs. As mentioned in the previous chapters, SGRs must also work together with trade and safety nets to deliver results.

**This chapter reviews lessons learned from public stock management in developing countries with a long history of using them**. It draws insights from the existing literature and the background studies prepared for this report on Bangladesh, India, the Philippines, and Uzbekistan in Asia; Ghana, Ethiopia, Zambia, and the ECOWAS regional reserve in SSA; Egypt and Tunisia in the MENA region; and Honduras and the Dominican Republic in the Caribbean. These provide ample examples of key aspects of SGR management, offering practical insights on successful strategies and common pitfalls, detailed below.

**Before reviewing the country-specific lessons, it is worth noting that few countries have used public stocks proactively in recent years**. This fact indicates a challenge in generating net gains from public stocks' use. About 30 countries globally—or only 15 percent of all countries worldwide—have been actively using public stocks. Usually, they are low-income countries (LIC) and lower-middle-income countries (LMIC), who are, at the same time, net grain importers (Table 5). Some high-income countries (HIC), such as Switzerland, South Korea, and Japan, also maintain public stocks, highlighting that the need for such reserves depends on a country's specific risk exposure rather than income level. Similarly, Norway has recently reintroduced public stocks as an extra layer to protect against potential disruptions in global trade (Box 3). Still, public stocks are rarely used in countries with well-functioning markets, typically seen in HICs, but are more common in developing countries, net importers of grains, where markets function less effectively and food accounts for a large share of expenditures (Table 5).

## BOX 3: REENGAGEMENT IN THE MANAGEMENT OF PUBLIC GRAIN STOCKS IN NORWAY

**Norway started to stockpile 30,000 tons of grain for 2024 and 2025, prompted by disruptions caused by the COVID-19 pandemic, geopolitical tensions, and climate change.** The agreement, signed between the Ministry of Agriculture and Food, the Ministry of Finance, and four private companies, will ensure that wheat is stored in existing facilities across the country, with three companies committed to store at least 15,000 tons in 2024. Companies are allowed to invest in new storage facilities and choose locations, but they must ensure that the grain is available to the state for emergencies. This move reflects an extra layer of security to protect against potential disruptions in global trade or domestic production failures. Norway, with a population of 5.6 million, will spend 63 million kroner (US$6 million) annually on grain stockpiling.

**Norway had previously stored grain in the 1950s but closed its storage facilities in 2003, deeming them unnecessary.** However, in 2023, following geopolitical tensions, the Norwegian government established a commission to assess the country's emergency preparedness, leading to the recommendation to reintroduce grain stockpiling. This initiative aligns with a model like that of Switzerland, where the government pays the private sector to store food and make it available in case of emergencies. Although not a widespread practice among HICs, the decision to stockpile grain in Norway highlights the growing importance of such measures in developed nations, particularly in the context of geopolitical instability and global supply-chain vulnerabilities.

*Source:* The Washington Post.



TABLE 5: Profile of Countries Actively Using Public Grain Stocks

| No. | Countries with Active SGRs | Income Status | Landlocked | Net Trade Position | Share of Food in Household Expenditure (%) |
|---|---|---|---|---|---|
| 1 | Algeria | MIC | No | Importer | 43.1 |
| 2 | Bangladesh | LMIC | No | Importer | 28.6 |
| 3 | Burkina Faso | LIC | Yes | Importer | n/a |
| 4 | China | UMIC | No | Importer | 33.6 |
| 5 | Dominican Republic | UMIC | No | Importer | 29.2 |
| 6 | Egypt | LMIC | No | Importer | 32.7 |
| 7 | Ethiopia | LIC | Yes | Importer | 57.0 |
| 8 | Ghana | LMIC | No | Importer | 56.9 |
| 9 | India | LMIC | No | Exporter | 35.4 |
| 10 | Indonesia | LMIC | No | Importer | 19.6 |
| 11 | Iraq | UMIC | Yes | Importer | 35.0 |
| 12 | Japan | HIC | No | Importer | 19.0 |
| 13 | Jordan | LMIC | No | Importer | 35.2 |
| 14 | Kenya | LMIC | No | Importer | 36.0 |
| 15 | Malawi | LIC | Yes | Importer | 50.0 |
| 16 | Mali | LIC | Yes | Importer | n/a |
| 17 | Morocco | LMIC | No | Importer | 40.4 |
| 18 | Niger | LIC | Yes | Importer | 47.0 |
| 19 | Nigeria | LMIC | No | Importer | 51.8 |
| 20 | Norway | HIC | No | Importer | 13.3 |
| 21 | Pakistan | LMIC | No | Importer/ Exporter | 37.5 |
| 22 | Philippines | LMIC | No | Importer | 39.0 |
| 23 | Saudi Arabia | HIC | No | Importer | n/a |
| 24 | South Korea | HIC | No | Importer | 14.4 |
| 25 | Senegal | LMIC | No | Importer | 53.4 |
| 26 | Switzerland | HIC | Yes | Importer | 10.8 |
| 27 | Tunisia | LMIC | No | Importer | 28.7 |
| 28 | Uzbekistan | LMIC | Yes | Importer | n/a |
| 29 | Zambia | LMIC | Yes | Importer/ Exporter | 52.5 |
| 30 | Zimbabwe | LMIC | Yes | Importer | n/a |

*Note:* LIC, Low-income countries; LMIC, lower-middle-income countries; UMIC, upper-middle-income countries; and HIC, high-income countries.
*Source:* Authors' assessment on public stocks and OECD for food expenditures 2023.

**Even fewer countries hold public stock primarily as protection against supply disruptions**. Countries that do include Japan, Norway, South Korea, Saudi Arabia and Switzerland. More common among the countries that hold public stocks, including the United States and countries in European Union, are programs that combine emergency protection and price support as objectives.

**Most countries that use public stocks are net importers of grains, with the exceptions of India, Pakistan, and Zambia, which export grains**. Still, sometimes, they must import grains when experiencing large production shortfalls. Some countries with public stocks are landlocked, meaning the cost and time required to import grains during emergencies can be significantly higher for them than other countries, justifying the use of SGRs. For example, Uzbekistan, a double landlocked country, faces risks related to inconsistent access to wheat imports and volatile prices, particularly due to the frequently changing trade policies in Kazakhstan and domestic production fluctuations. As such, maintaining a well-managed SGR is crucial for Uzbekistan to mitigate these risks and ensure stable wheat availability. In many cases, exporting countries defend the management of public stocks by pointing to the need to maintain social safety nets, as in India, or the significant risk of food insecurity should they rely on imports from the global market.

**This chapter discusses how successful SGRs enhance food security when managed with clear objectives, fiscal prudence, and strategic market interventions, while failing when mismanaged with conflicting goals and high costs**. The lessons learned show that SGRs can deliver results when they are underpinned by clear and manageable objectives, prudently managed in from a fiscal standpoint, and employed smartly to mitigate the impact of temporary food supply disruptions. Successful SGRs use market channels such as commodity exchanges for interventions or are embedded in targeted safety net programs, where in-kind food distribution for an acutely food insecure population is superior to cash assistance, and maximize development impacts by supporting smallholder commercialization. The lessons learned also show that SGRs fail to enhance food security when they are managed as buffer stocks to address too many and often conflicting policy objectives. There are numerous causes of SGR failure, including lack of clarity of objectives, high fiscal costs, and crowding out of private storage and trade. Other causes of failure are less visible, such as price stabilization achieved at a high average price level. The following subchapters present lessons learned on how to use SGRs to enhance food security rather than undermine it.

## 3.1 AVOIDING MULTIPLICITY AND UNCLEAR OBJECTIVES OF SGRS

**Public grain stocks, which include SGRs, often aim to achieve multiple objectives, resulting in complex management structures and inefficient use of public resources**. The underlying aim of maintaining price stability at affordable levels for the urban population has often been conflated with the objectives of meeting emergency food needs. There is also confusion about whether the public stock programs aim to achieve food self-sufficiency or food security, which requires access to sufficient, safe, and nutritious food for all people. Objectives become especially conflicted when public stocks are used to provide price incentives for both farmers and consumers. This approach is often called "buying high and selling low," which first increases prices for producers and then reduces prices for consumers. Such an approach leads to high fiscal costs, creates subsidy dependency for producers and consumers, crowds out the private sector, and creates other market distortions that collectively work against food security.

**The more objectives a grain reserve has, the more financially demanding it becomes, diverting funds from other priorities and potentially endangering fiscal sustainability**. Multiple objectives can reduce private storage and trade, requiring the public sector to fill the gap that the private sector could have filled. For example, the cost of large stores of grain for in-kind transfers are large relative to program benefits, which helps explain why most safety nets rely primarily on cash transfers or vouchers. Market interventions vary by country, and public



stock's objectives are clearer in some countries than others. Some countries—e.g., China, India, Indonesia, Zambia, Pakistan, and the Philippines before 2019[14]—focus on long-term price stabilization for both producers and consumers. Others, such as Bangladesh, Kenya, and Uzbekistan, respond to short-term supply disruptions and address emergencies. In West Africa, public stocks generally avoid price stabilization, often due to the small stock sizes. Egypt and Tunisia use public stocks to reduce the cost of bread, address emergency crises, and ensure a steady domestic supply.

**Having too many objectives, or even worse, having conflicting objectives, undermines SGRs' ability to enhance food security**. As such, clearly defining strategic objectives, complying with them, and communicating with market participants are critical for the SGR's success. Many public stocks have failed to deliver because multiple objectives led fiscal costs to escalate unsustainably. The next subchapter discusses how to avoid fiscal cost escalations.

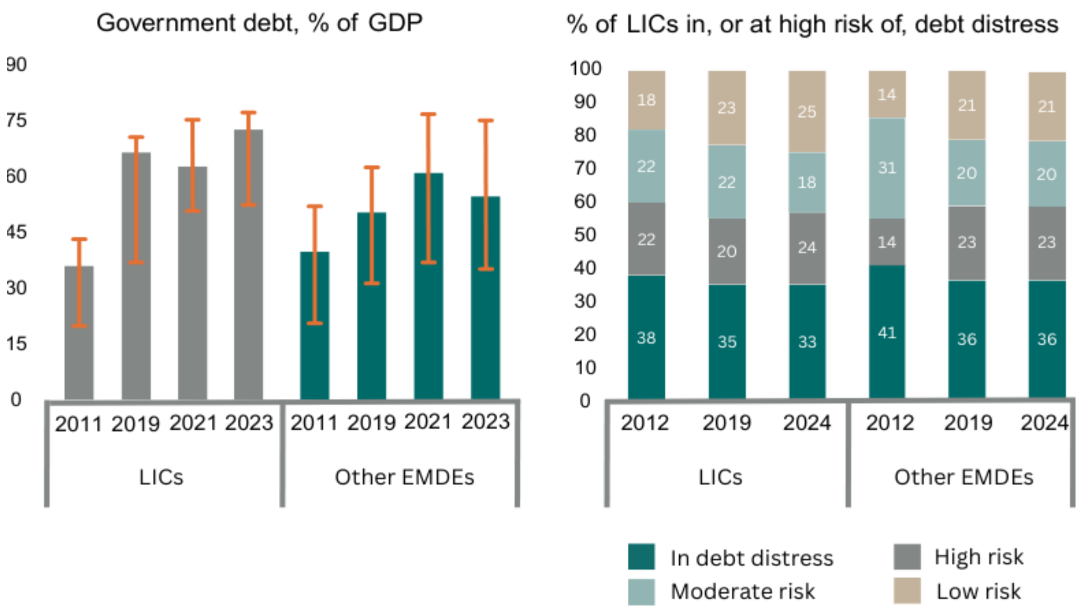
## 3.2 REDUCING THE SGR'S FISCAL COSTS

**Ballooning fiscal costs is a significant reason why public stock programs with multiple objectives fail**. To start, holding SGR stocks only for emergencies can be costly. The scale of reserves can be significant, since the likelihood of emergencies and their duration is uncertain. In addition to initial outlays, maintaining the quality of stored grain over time incurs significant expenses, including climate control, pest management, and stock rotation. Factors such as the size of the reserves, the timing of stock replenishment, and price differences between procurement and release of grain, influence the financial burden of managing SGRs. Adding the requirement to store grain for public distribution raises the scale and cost of public stocks. Moreover, the scale of buffer stocks sufficient to influence domestic grain prices under extreme conditions can be remarkably large. Consequently, the fiscal costs of maintaining very large public stocks can become unsustainable. Larger stocks result in higher fiscal costs, which divert already limited public funds from other priority investments in the agriculture sector.

**Thus, establishing and operating SGRs is not a zero-sum game**. This fact is noted by developing countries, which are becoming increasingly fiscally constrained (Figure 13). Many of these economies are poorer today than they were on the eve of the COVID-19 pandemic, even though the rest of the world has largely recovered. In the world's 26 poorest LICs, government debt stands at 72 percent of GDP in 2024—an 18-year high. Nearly half of these LICs—twice the number in 2015—are either in debt distress or at high risk of it. None are at low risk (World Bank 2025). Thus, fiscal constraints are critical to shaping the design of SGRs, ultimately determining what they can and cannot do.

[14] In the Philippines, the Rice Tariffication Law passed in February 2019. It liberalized trade and changed the mandate of the National Food Authority to focus only on addressing national emergency events (Box 4).

FIGURE 13: Government Debt and Debt Distress in Developing Countries




*Note:* EMDE, emerging markets and developing economies.

*Source:* World Bank 2025.

**When multiple objectives are pursued, costs become extremely high.** Here are several examples:

a. In *Zambia*, for example, public stocks are mandated to address food emergencies, stabilize prices, and support farmers and consumers. In 2021, spending on the country's Food Reserve Agency (FRA) accounted for 17 percent of tmmhe Ministry of Agriculture's budget (World Bank 2021).

b. In the *Philippines*, the multiple policy goals of the National Food Authority (NFA)—such as stabilizing prices, supporting self-sufficiency, and controlling imports—has caused economic distortions, fiscal difficulties, and welfare losses, contributing to public debt and price volatility until the rice importation reforms in 2019 (Tolentino and de la Pena 2020; Balié, Minot, and Valera 2021). The NFA did not recover its stockpiling and distribution costs, requiring subsidies from the government. Since 2019, the NFA's mandate changed from buying imported rice to procuring only domestically and selling its stocks to agencies involved in disaster-relief operations (Box 4). Even with this narrow mandate, the NFA continues relying on fiscal outlays to continue its operations. By 2023, the negative government net equity in the NFA balance sheet reached 116 billion pesos, or US$2 billion.

c. In *Tunisia*, the cost of public stock in 2022 was US$1.7 billion, with wheat purchases and financing making up most of the cost. Food subsidies represented over half of the food and agricultural public expenditures in the country (FAO 2023).

d. In 2025, the federal government of *Pakistan* stopped setting a minimum support price for wheat and ceased the staple's procurement operations moving forward. This decision followed that of Punjab, the largest agricultural state, which chose not to purchase wheat above market prices in 2024. This move is significant for Pakistan, as wheat price setting and procurement operations in Pakistan had been in place since the 1970s to guarantee farmers a minimum return during periods of surplus and deficits. Additionally, these measures were used to subsidize wheat retail flour prices for consumers. However, these measures placed a huge financial burden on the treasury, with the central government and provinces incurring high costs for procurement operations, including large expenditures on storage, freight, and interest payments on bank loans. In 2013–14, for example, the annual fiscal cost was estimated at US$280 million, in addition to US$900 million of the unpaid liabilities accumulated from previous years (World Bank 2015). The large subsidy the government paid as a price for its interventions in the wheat market was not the only basis for the reform. Its interventions in wheat trade made the sector unresponsive to changing technology and farming practices, increased price volatility, encouraged hoarding, and misallocated resources. Thus, even in a country with such a long history of public wheat procurement at above-market prices, at some point, the unsustainable fiscal cost eventually left no choice but to suspend the program.

e. *India* maintains public stocks to ensure fair prices for farmers, provide affordable grains to 800 million people, control inflation, and maintain a strategic reserve against emergency shocks. From 2019 to 2024, India annually procured over 110 million tons of rice and wheat at minimum support prices, buying about 30 percent of total production. By 2022, surplus stocks peaked at 33 million tons. Managing these stocks, including the minimum price support and the public distribution system, costs India US$35 billion in 2022–23, representing 6.5–7.0 percent of public expenditure and about 1 percent of GDP. Maintenance of grain stocks accounted for 10 percent of the total food subsidy in the country. These fiscal costs for public stocks have been supplemented by production subsidies, amounting to US$21–22 billion in 2019, including fertilizer and income transfers (Chatterjee *et al.* 2022). The effectiveness of these stockpiles in controlling inflation has been mixed despite high fiscal costs (Figure 14).

## BOX 4: RICE SECTOR REFORMS IN THE PHILIPPINES

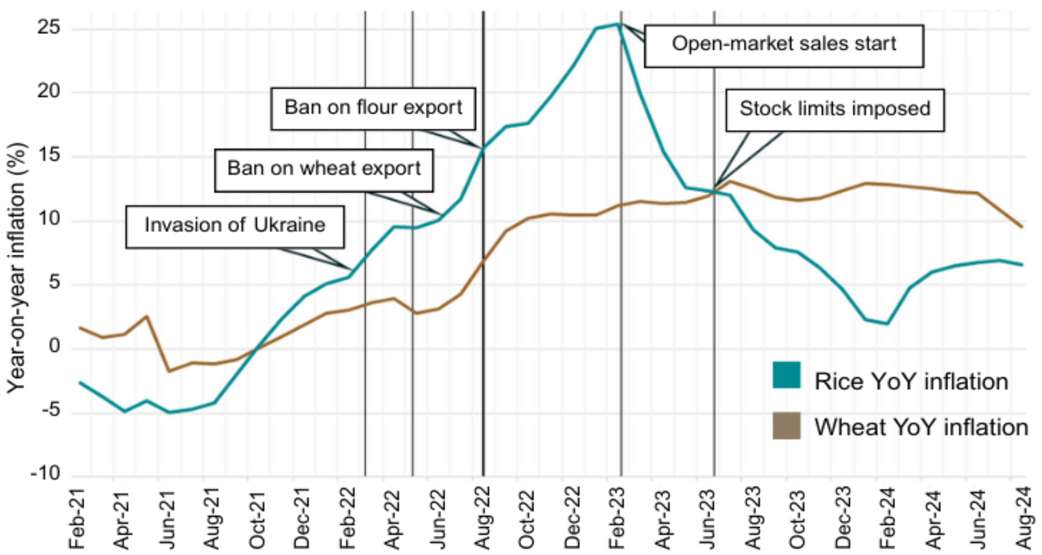
**Before 2019, the Philippines strictly regulated rice imports, leading to high and volatile prices.** As a staple food, rice production was heavily protected, with the NFA as the sole importer. These restrictions led to high import costs and timing issues relative to domestic demand, resulting in price disparities with international markets, smuggling, and discouraging domestic market investment. Rice prices in the Philippines consistently exceeded international export prices from Thailand and Viet Nam, with the gap widening over time. Consequently, the agricultural sector stagnated, with slow productivity growth and limited poverty reduction.

**Passed in February 2019, the Rice Tariffication Act eliminated import restrictions and introduced a transparent tariff regime.** Tariff revenues safeguard local rice farmers and improve productivity. The reform also shifted the NFA's role from market price stabilization to emergency response, reducing NFA stock from 1.8 million tons in 2019 to 127,000 tons in 2023.

**Since the reform, rice prices have declined, but production has continued to grow.** Paddy production rose by 5.2 percent in the five years after the Rice Tariffication Act, i.e., 2019–23, compared to the previous five years. The poorest Filipinos benefited the most (Figure 20). In July 2024, the government lowered the rice import tariff from 35 to 15 percent until 2028 to curb food price inflation, a move that would further reduce market distortions in agriculture in the Philippines.

**Source:** Tolentino and de la Pena (2020), and Balié, Minot and Valera (2021).

FIGURE 14: Rice and Wheat Price Inflation in India, 2021–24




*Source:* Using data from Ministry of Statistics and Programme Implementation, Government of India and Gulati et al. (2023).



**Ghana is currently considering establishing a public stock program that combines elements of an SGR with price stabilization objectives**. A feasibility assessment provides valuable insights into how SGR costs vary depending on the objective and scale of operation. Depending on the coverage, establishing and operating public stocks as an emergency grain reserve could cost US$1–58 million annually (Akudugu and Minot 2024). The least costly option would provide rations to 50,000 people for four months, while the costliest would cover one million people for a year. About 85 percent of costs are for grain, with the rest for storage (Table 6). For maize price stabilization, costs would range from US$3.5 million to US$34 million, which is about 10 percent of the Ministry of Agriculture's annual budget, depending on the program's aggressiveness. The least costly option is a 175,000-ton buffer stock to cap maize prices at 50 percent above the long-term average, while the costliest option is a 1.6-million-ton buffer stock to cap prices at 20 percent above the long-term average. Major cost components include stock financing, warehouse depreciation, and salaries.

**In their exploration of various options for emergency assistance and price stabilization in Ghana, Akudugu and Minot (2024) recommend that the country focus on emergency assistance with more modest goals**. Specifically, they suggest aiming to feed 50,000–100,000 people over four months, which would require a grain reserve of 2,400–4,800 tons. This approach is considered more manageable than price stabilization. In case price stabilization is to be pursued, the most cost-effective goal will be to intervene when long-term real maize prices deviate by more than 50 percent above or below the long-term average. In that case, a reserve of approximately 175,000 tons would suffice.

TABLE 6: Estimated Total Costs of Public Stocks by Function and Capacity in Ghana

| Policy Goals | Commercial Revenue (US$ Thousands) | Storage Costs (US$ Thousands) | Net Revenue (US$ Thousands) |
|---|---|---|---|
| Emergency Grain Reserves (Tons) | | | |
| 2,400 | -828 | 131 | -959 |
| 7,300 | -2,519 | 398 | -2,916 |
| 4,800 | -1,656 | 262 | -1,918 |
| 14,600 | -5,037 | 796 | -5,833 |
| 48,000 | -16.560 | 2,616 | -19,176 |
| 146,000 | -50,370 | 7,956 | -58,326 |
| Maize Price Stabilization (Tons) | | | |
| 175,000 | 6,038 | 9,536 | -3,498 |
| 408,000 | 14,076 | 22,232 | -8,156 |
| 920,000 | 31,740 | 50,131 | -18,391 |
| 1,689,000 | 58,271 | 92,034 | -33,763 |

*Source:* Akudugu and Minot 2024.

**A key driver of fiscal costs for public stocks is often a large gap between procurement and release prices of stocks**. Table 7 shows the cost elements of managing public stocks in Zambia, using the example from 2012. A more recent analysis revealed a continuation of the past approach in Zambia that pursues a policy of buying high and selling low, making the 2012 example still highly relevant (World Bank 2021). A subsidy to finance the difference between high prices paid to farmers and low prices offered to consumers accounts for 42.5 percent of the total costs. The situation is similar in other countries that pursue the same policies, including Indonesia and the Philippines, especially before 2019.

TABLE 7: A Breakdown of the Total Fiscal Costs of Managing the Public Stocks in Zambia

| Cost Elements | US$ Million | Percentage of Total Fiscal Costs |
|---|---|---|
| Storage | 63.0 | 17.9 |
| Financing | 38.0 | 10.8 |
| Transportation of procured maize | 55.0 | 15.6 |
| Bagging and rebagging | 25.1 | 7.1 |
| Subsidy (difference between release and procurement prices) | 150.0 | 42.5 |
| Construction of hard standing silos | 15.0 | 4.3 |
| Rehabilitation of grain silos | 6.7 | 1.9 |
| **Total Costs** | **352.8** | |
| Total costs as a share of the national budget (%) | 8.2 | |
| Total costs as a share of GDP (%) | 1.9 | |

*Source:* World Bank 2012.

**Even when stocks are released for safety nets to assist acute food-insecure and other vulnerable populations, the fiscal sustainability of this justifiable activity should not be ignored**. Grain released for vulnerable populations is provided for free, while grain is purchased at market prices domestically or internationally. If the SGR buys 100,000 tons of maize at US$250 per ton and releases an entire stock as food assistance, the fiscal cost would be US$25 million, without accounting for storage and other handling costs. Increasing the size of the procurements and releases to 1 million tons would escalate the fiscal cost to US$250 million—a very large sum for most developing countries. Ideally, SGRs should buy and release stocks at market prices. If stocks need to be released in-kind, in cases where in-kind food assistance is superior to cash transfers, stocks should be small and well-targeted to vulnerable populations to optimize the fiscal costs.

**Reducing the cost of financing is another area for attention**. In the case of Zambia, the financing costs accounted for 11 percent of total costs (Table 7). In other cases, the cost of financing is much higher. In Pakistan, for example, the procurement, processing, storage, maintenance, and distribution of wheat stocks have been financed through bank loans. The Punjab Food Department borrowed from commercial banks every year, with interest rates of 9–12 percent (World Bank 2017). In more recent years, the interest rate increased to 20 percent. As a result, debt servicing of loans constituted a major component of the total payables. In 2016–17, the amount payable was 245 billion rupees, a threefold increase from 2012–13 (Table 8). For comparison, the subsidy to cover the gap between high procurement price and low release price in 2016–17 was 37 billion rupees (Shahzad, Razzaq, and Qing 2019).



TABLE 8: Bank Borrowings for Wheat Procurement by the Government of Punjab, Pakistan, in Billion Pakistani Rupees

| Year | Old Borrowing | New Borrowing | Total Borrowing | Repayment Made | Balance Payable |
|---|---|---|---|---|---|
| 2012–13 | 109.89 | 73.30 | 183.20 | 104.26 | 79.84 |
| 2013–14 | 78.94 | 110.53 | 189.48 | 97.26 | 92.21 |
| 2014–15 | 92.21 | 112.58 | 204.79 | 39.09 | 165.70 |
| 2015–16 | 165.70 | 105.34 | 271.04 | 75.23 | 159.81 |
| 2016–17 | 159.81 | 128.06 | 323.88 | 78.87 | 24.500 |

*Source:* Shahzad, Razzaq, and Qing 2019.

**Reducing storage costs is also an important dimension to keep the SGR's fiscal costs at bay**. The recent public stock's storage costs are estimated at US$54.5 per ton in Ghana, US$60.0 per ton in India, US$44.30 per ton in Bangladesh, and US$66–72 per ton in Honduras (Rashid and Lemma 2011; Akudugu and Minot 2024).[15] Recent data from the Food Corporation of India suggests that annual storage charges for buffer food stocks are even higher, at 5,000–7,000 rupees per ton (US$80–95). Reducing storage costs should be one of the key priorities of SGR management; Chapter 4 presents recent storage technologies and practices.

**The cost of maintaining grain reserves also varies depending on institutional arrangements**. If the reserves are publicly managed, the government covers the expenses. Conversely, if there is a legal obligation for importers or other private entities to maintain reserves, these organizations may bear the cost, potentially passing it on to consumers. Alternatively, the government might subsidize these costs to ensure compliance and effectiveness. Separating the operations and accounting of different aspects of reserve management can enhance transparency and accountability. For instance, one agency might manage the physical stocks with a dedicated budget, while another, perhaps an agency responsible for social safety nets, could purchase the stocks at market prices during times of need. Additionally, relief programs could use the stocks based on physical loans, with the obligation to replenish stocks after a short period. This separation helps clarify costs and responsibilities, ensuring each entity operates efficiently within its mandate. Finally, the public sector can delegate storage of public stocks to private entities, through public-private partnerships. An example of such a partnership is in Punjab, India (Box 5). Although such examples are still rare, they need to be explored more to crowd-in private investments in expanding the storage infrastructure and reducing the needs for government's capital investments.

[15] These are the estimated total storage costs incurred between procurement and release of stocks. Most countries keep stocks at least for six months.

## BOX 5: GRAIN SILOS PROJECT IN PUNJAB, INDIA

**In 2010, the Punjab State Grain Procurement Corporation (PUNGRAIN) awarded a 30-year concession to LT Foods Limited -** a Delhi-based food processing company with many years of experience in processing, storing, and marketing Basmati rice globally. Under this agreement, LT Foods was tasked with building, owning, and operating 50,000 tons of storage capacity using silos—vertical, sheet-metal structures equipped with automated systems for real-time monitoring of grain temperature and infestation—to store public stocks. The private partner was selected through a competitive bidding process based on technical evaluation and the lowest fixed tariff, with the World Bank Group's International Finance Corporation serving as transaction adviser.

**LT Foods was required to purchase the necessary land, build the facility, and prepare the silos before the concession agreement took effect.** At the end of the concession, the facility will remain with the private operator for private use. The total project cost was estimated at about US$7 million. The project received debt financing from YES BANK and Rabobank.

**At least four factors contributed to the project's success:** (i) the transparent and competitive bidding process, which led to the selection of a qualified, reliable partner on a least-cost basis to the contracting agency; (ii) clear delineation of the roles and risks allocated between PUNGRAIN and the private partner, with objective standards and specifications and monitoring mechanisms; (iii) strong commitment to the project on the part of PUNGRAIN, as evidenced by its willingness to assume the payment and demand risk; and (iv) the parties' willingness and ability to renegotiate the fixed storage fee to ensure the project's viability over the long term.

**Source:** World Bank n.d.

**To summarize, the fiscal costs of public stocks vary widely depending on policy objectives**. Table 9 presents several simplified scenarios of three strategic options. When public stocks are created as a tool for preparedness and response, ensuring food availability during shocks, crises, or supply disruptions, their cost could be contained. With the stock size of 1 million tons and the average storage and associated costs of US$30 per ton, buying grains at market prices and selling only when supply disruption temporarily spikes food prices could save a treasury US$20 million in the first hypothetical case. Yet, when public stocks are used to support farmers and consumers, fiscal costs could quickly increase to US$70 million. If the entire stock is bought at market prices and released at no cost to vulnerable consumers through in-kind food distribution, the cost to the treasury would escalate to US$230 million. That is why clarity of objectives and analysis of fiscal sustainability are critical for sustainable SGR management.

TABLE 9: Examples of Fiscal Costs Incurred from Meeting Various SGR Objectives

| | SGR for Supply Disruption Response (1) | Public Stocks for Price Support (2) | SGR for Emergency Assistance (3) |
|---|---|---|---|
| Market price of maize (US$ per ton) | 200 | 200 | 200 |
| Procurement price of maize (US$ per ton) | 200 | 220 | 200 |
| Release price of maize (US$ per ton) | 250 | 180 | 0 |
| Storage/other SGR costs (US$ per ton) | 30 | 30 | 30 |
| Total gain/loss (US$ per ton) | 20 | -70 | -230 |
| Total gain/loss per 1 million tons (US$) | 20,000,000 | -70,000,000 | -230,000,000 |

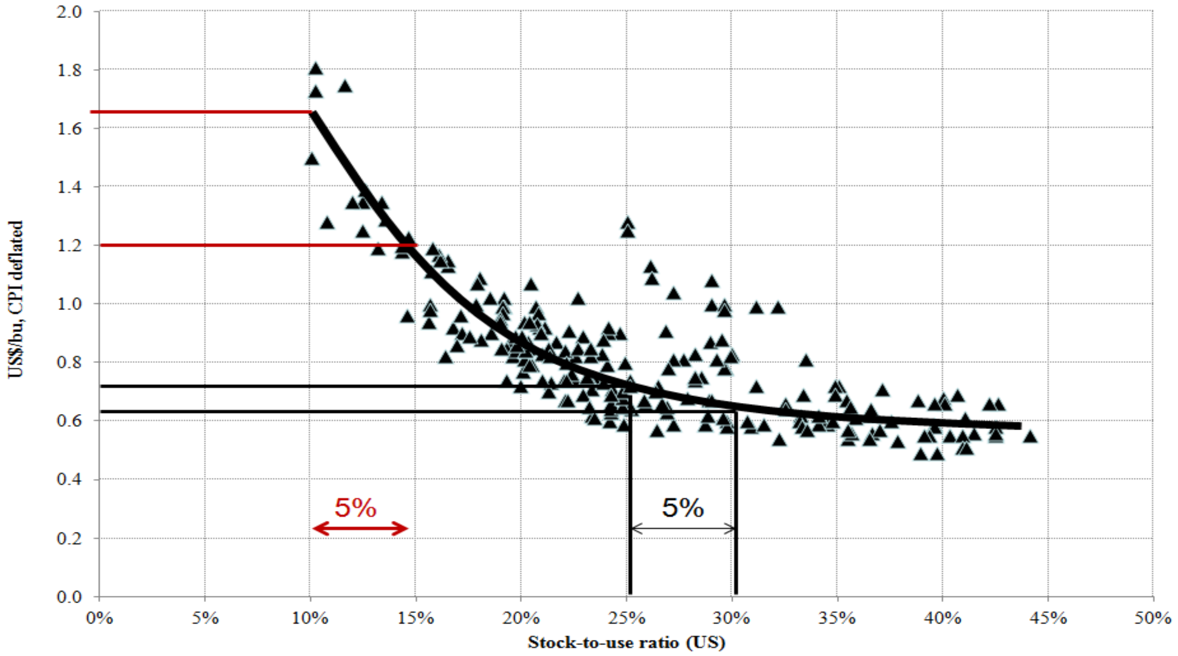
*Source:* World Bank staff.

### 3.3 DETERMINING EFFECTIVE STOCK SIZE

**The size of stocks is one of the most critical decisions when establishing and managing SGRs**. This decision will affect both fiscal cost and the ability of SGRs to achieve their objectives. Estimating the size of required stocks to provide in-kind food assistance is relatively straightforward. It requires data on the frequency of emergencies, i.e., natural and human-made calamities, targeted population, and per capita consumption. For example, in the Philippines, the level of rice inventory that shall be strategically positioned and maintained by NFA at any given time was recently estimated at 300,000 tons or 7 days of consumption equivalent. The assessment used data from the National Disaster Risk Reduction Management Council, covering the population affected and the year, month, region, province, type, and number of days of the disaster. The sheltering period begins from a minimum of 3 days, up to the days of disaster, or where data is unavailable, a maximum of 15 days for major disasters. The rice requirement is calculated by multiplying the sheltering period by 120 kilograms per year (329 grams per day) to obtain 309,268 tons, rounded off to 300,000 tons.

**Estimating the size of stocks required to mitigate short-term supply disruptions is more challenging**. A high level of SGR stocks would cost too much and crowd out private trade and storage, while a low stock level would not cover the food supply shock. The challenge arises in calculating how much is enough, or what is a threshold stock size. One can start with a simple approach using an international experience on a stock-to-use ratio threshold that has been shown to influence the market. Using the example of wheat prices in the United States during 1990–2009, Figure 15 shows that when the ending stocks-to-use ratio[16] was below a threshold of 15 percent, a 5-percent supply shortfall led to a much larger price spike than when initial stocks were higher. Wright (2011) calls food price volatility a symptom of a structural problem of low stocks—that is, "when supplies get to certain low levels, the prices become vulnerable to volatility." Note, however, that ending stocks include both private and public stocks. In the case of the United States, all stocks are private.

FIGURE 15: Low Inventory Periods Signal the Potential for More Volatile Prices: U.S. Real Wheat Prices, January 1990–August 2009




*Source:* Cafiero and Schmidhuber 2011.

**Defining an adequate level of stocks to reduce grain price volatility is not a new challenge**. In the mid-1970s, following the world food crisis, the Intergovernmental Group on Grains adopted the level of SGR stocks as the lead early warning indicator for monitoring global food security. The Group defined a level of 17–18 percent of cereal stocks (relative to annual consumption) as adequate to influence markets. The Committee on World Food Security later endorsed this definition. Many experts, including AMIS,[17] an inter-agency platform to enhance food market transparency and policy response for food security, still use this threshold for their forecasts and early warning system (AMIS 2012). While any exact threshold estimate should be treated cautiously—for example, to account for changes over time, such as a lower propensity to keep national reserves because of a more liberalized trade environment—there is general agreement that higher stock-to-use ratios are associated with more comfortable market situations, while low rates can

[16] The ending-stock-to-user ratio is calculated by dividing the ending stocks by domestic consumption.
[17] For more information, see https://www.amis-outlook.org/home



be an indicator of market risk (AMIS 2021). Thus, having about 20 percent of the stock-to-use ratio in the country, for both private and public stocks, would have less impact on price volatility than having a much lower ratio, providing helpful information for policymakers when deciding about SGR size.

**A good example of the gradual reduction in the size of public stocks vis-a-vis private stocks comes from Uzbekistan**. The liberalization of wheat markets in 2022 also included a change in the role of public stocks. Their role was historically to buy 3 million tons of wheat annually, equivalent to half the annual output, and release these stocks at subsidized fixed prices to the state-owned flour mills. After liberalization, their role shifted to procuring a small volume of wheat and selling stock at market prices, mainly to mitigate the wheat supply shortfalls due to export restrictions or logistical challenges in importing wheat from Kazakhstan. In 2024, the SGR in Uzbekistan procured 0.8 million tons of wheat, covering 11 percent of annual food wheat consumption (Table 10). This amount was to supplement the ending stocks held by the private sector, maintained at about 10 percent of food wheat consumption. The reduced public stock level and market-based procurement and release of stocks, i.e., public stocks are managed as SGRs, have contributed to the relatively low volatility of domestic wheat prices, which are well aligned with import prices of wheat from Kazakhstan (Figure 16).

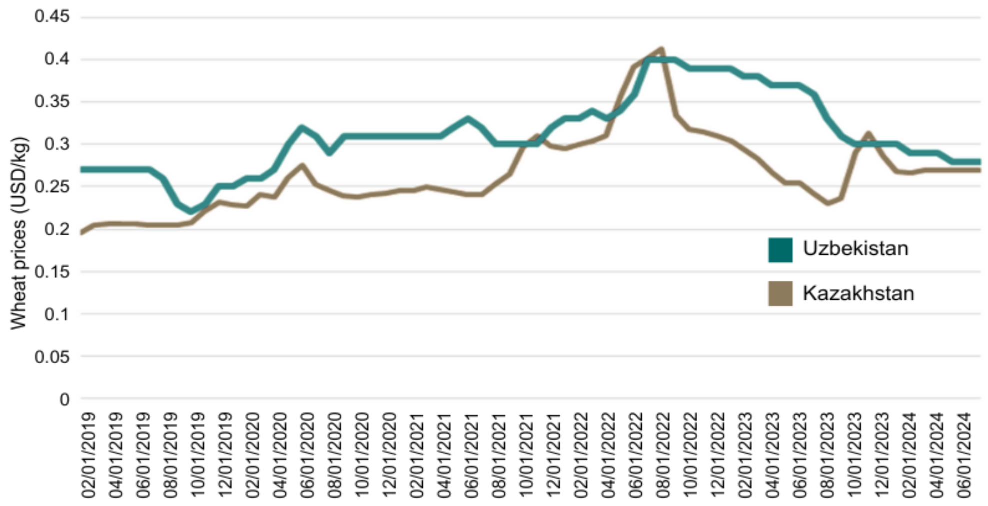
TABLE 10: Gradual Decline in SGR Size in Uzbekistan

| | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|
| Size of wheat stocks (thousand tons) | 3,000 | 1,794 | 1,323 | 837 |
| In % of total wheat consumption | 50 | 29 | 20 | 12 |
| In % of food wheat consumption | 43 | 25 | 18 | 11 |
| Value of stocks (US$ million) | 537 | 558 | 337 | 198 |
| Gross cost of stocks as % of GDP | 0.8 | 0.7 | 0.4 | 0.3 |

*Source:* Authors' estimate based on the data provided by the Ministry of Economy and Finance of Uzbekistan.

**Notably, the presence of SGRs in Uzbekistan helped the government risk pursuing wheat price liberalization reforms in the first place**. The availability of the SGR and safety net programs helped overcome political resistance to wheat price liberalization, even in the face of an unfavorable external environment. As a result, wheat prices remained stable after the reforms. Before the reform, the average price volatility was 12 percent. After June 2022, it slightly increased to 14 percent, like the extent of price volatility in Kazakhstan, the sole wheat exporter to Uzbekistan. This containment of price volatility can be attributed to several factors: the careful management of SGRs and their adherence to market principles have been key to minimizing market distortions and keeping prices in Uzbekistan aligned with those in Kazakhstan. Careful SGR management has also had a calming effect on wheat market participants, who know that SGRs are available during emergencies.

FIGURE 16: Wheat Prices in Kazakhstan and Uzbekistan, 2018–24




*Source:* Authors' estimate using the FAO FPMA Tool price data.

## 3.4 REDUCING PRICE DISTORTIONS AND OTHER ECONOMIC COSTS

**Well-designed SGRs should have a strategy for reducing market price distortions and other economic costs from its operations**. In addition to the size of stocks, a release of stocks in response to supply disruptions by itself could affect food market prices, even if price stabilization is not a primary objective. In this context, it is important to consider the following implications:

a. As discussed, SGR grain released when supply markets are disrupted and markets autarkic is least likely to change private sector behavior, since the released supplies replace grain the markets were expected to supply. The role of SGRs in such a case is primarily to hedge against the time it takes the disruptions to dissipate and traders to import. Even so, while there are good reasons to expect that private storage markets will not fully account for low-probability events, even minimalist interventions could crowd out private storage at the margin. This is a recommended approach for the SGR management.

b. A release of stocks at times of when there is a *significant deviation* of domestic price from import parity price would be least distortive when governments need to respond to high food prices. A significant deviation could be defined as two or three standard deviations from the historical average price. Cost and storage requirements would be relatively small, as the extreme levels of domestic and international price spikes are usually short-lived and arbitrage activities not immediate. Such an approach would leave seasonal price cycles largely unaffected, permitting private sector to participate profitably in storage and trade.

c. A *narrower price trigger* would require costly large annual purchases and releases of stocks, managed as buffer stocks. This approach would reduce both interannual and seasonal fluctuations of prices, making private storage of grain less profitable and requiring greater public storage to maintain a given level of total storage. If the price ceiling is set too low, the public stocks will be sold more often than bought, eventually exhausting public stocks and making it impossible to impose a price ceiling (Wright 2009).



d. At the extreme, all price instability could be eliminated by *setting the procurement and release prices arbitrarily close to each other.* Doing so would certainly be infeasible from both the cost and management point of view, as the public stocks would be forced to purchase or sell a large share of production. Furthermore, complete stabilization is undesirable from an economic point of view, as seasonal and spatial price fluctuations help farmers and consumers respond to surpluses and deficits, thus encouraging arbitrage and bringing the market to equilibrium.

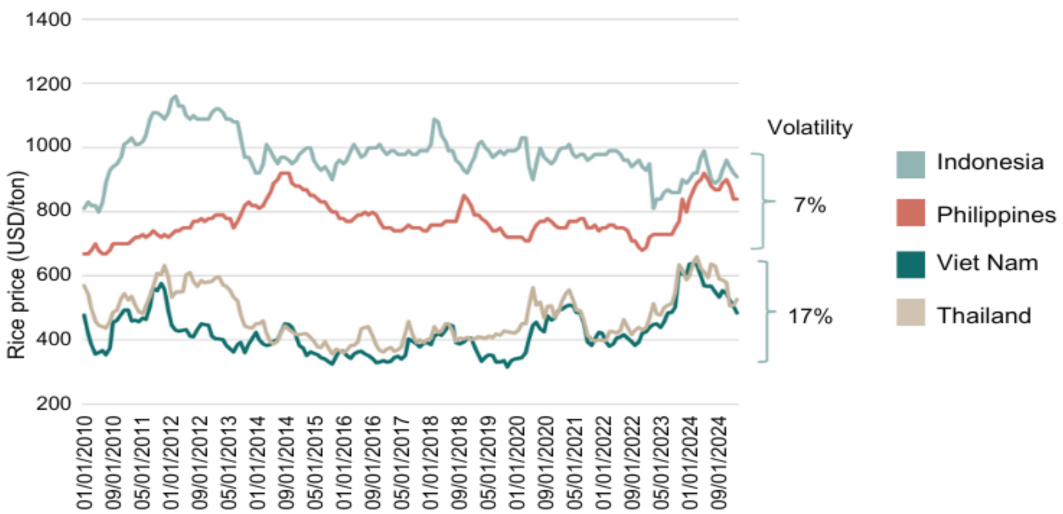
**Even short-term price stabilization efforts, if not managed well, have proven to be costly**. In Haiti, for example, the short-term gains for consumers from price stabilization in 2008–09 (achieved by subsidizing the sale of rice at below-market prices) ended up being lower than medium-term costs created by this stabilization (Aries and Carneus 2011). Haiti imports 70 percent of the rice it consumes. Before the 2008–09 global food price spike, the price of rice in the local markets was directly determined by import price, with no distortions. In March 2008, after the global rice price spike caused a domestic price spike, the government announced a subsidy to keep the price of rice for consumers below import parity at a fixed US$43 per 50 kilogram bag. The subsidy was provided only for three months, costing US$17 million. Yet, a year after the subsidy program ended, the rice prices paid by consumers were estimated to be higher than they would have been without the subsidy program, costing Haitian consumers an additional US$23 million. The reason behind this unintended consequence was that importers and distributors factored future losses from uncertainty about government policies into their profit margins. Thus, the visible benefit of fixing prices for consumers at the price tag of US$17 million was overshadowed by the invisible cost of US$23 million created by interventions in trade. It was estimated that the US$17 million of public resources spent in the subsidy program would have translated into a food voucher of over US$4 per month per household for 5 months for families living under the US$2-a-day poverty line. US$4 per month represents 40 percent of the monthly rice expenditures of a low-income household in Haiti.

**The level at which prices are stabilized is also important for assessing the economic costs of price stabilization**. Several East Asian countries have pursued rice price stabilization through high import protection, enabling them to keep average rice prices well above the world market levels (FAO 2021).[18] Examples are Indonesia and the Philippines, which have used high import tariffs and state controls over imports to stimulate domestic rice production. Such an approach helped reduce rice price volatility yet created substantial visible and invisible economic costs. During 2010–24, the rice wholesale price volatility in both countries averaged 7 percent in relation to 17 percent in net exporting Thailand and Viet Nam (Figure 17). Such stabilization has likely helped farmers keep farmgate output prices up in the short run. Yet, in the long run, even farmers lose if little is done to raise productivity and reduce production costs. Consumers lose in any case as they must pay higher food prices, compromising their food security. In developing countries, food constitutes a large share of total household

[18] While less frequently than in Asia, countries in other regions have also been using public stocks to stabilize prices at high levels. In Latin America, for example, the Dominican Republic used the rice price support mechanism under SGRs and trade restrictions to stabilize prices above import parity. In Eastern and Southern Africa, Malawi and Zambia were doing the same but have been less successful in keeping domestic prices more stable than international ones.

consumption (Table 5), and the poorest are affected the most when higher incomes do not offset higher food prices.

FIGURE 17: Level and Volatility of Rice Prices in Selected Asian Countries, 2010–24



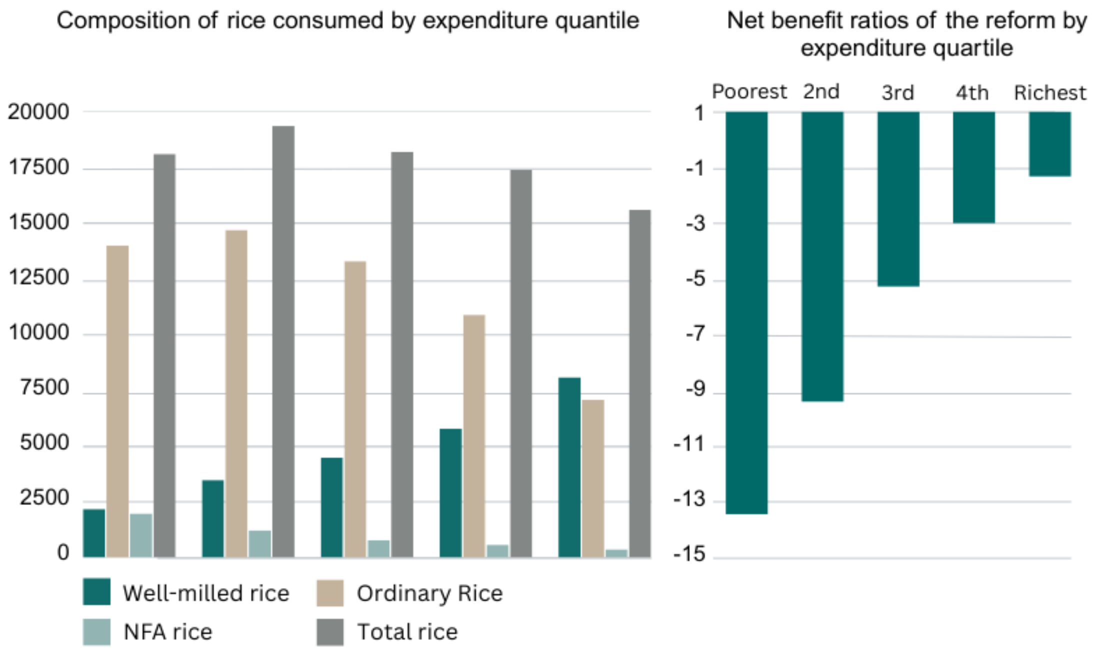

*Source:* Authors' estimate using the FAO FPMA price data.

**In-kind food distribution programs do not necessarily offset the effects of high food prices, with implications for poverty**. The recent experience of the Philippines from the 2019 rice tariffication and liberalization of rice import confirms these points. The NFA's subsidized rice accounted for a small share of the country's rice consumption (Figure 18, left), with the first two poorest quantiles suffering the most from high rice prices. When rice prices declined by 17 percent due to the reforms, the poorest households benefited the most (Figure 18, right).

**Ironically, high prices do not necessarily translate into benefits for farmers, as higher output prices tend to inflate production costs**. This phenomenon is not unique to Asia and has also been observed in HICs, which have a long history of keeping food prices high. The unintended cost-pushing effects of high output prices were among the main reasons for agricultural reforms in the United States and the European Union in the 1990s that aligned domestic prices with world market prices and shifted support to farm incomes rather than prices. In Asia, rice production costs are highest in countries with high rice prices, usually in net-importing countries, such as China, Indonesia, and the Philippines. Production costs in rice net exporting countries, such as India, Thailand, and Viet Nam, are almost half of that in net-importing countries (Figure 19). The key driver of the cost difference is labor cost, which is much higher in net-importing countries. In the Philippines, for example, where rice alone accounts for 20 percent of the food component of the Consumer Price Index, high rice prices place upward pressure on wages. According to the research carried out by Lasco (2005), in the short run, a 1 percent increase in rice prices causes a 0.35 percent increase in wages in the Philippines. In the longer run, the elasticity is above one. Thus, a high price policy for food staples is costly for the economy.

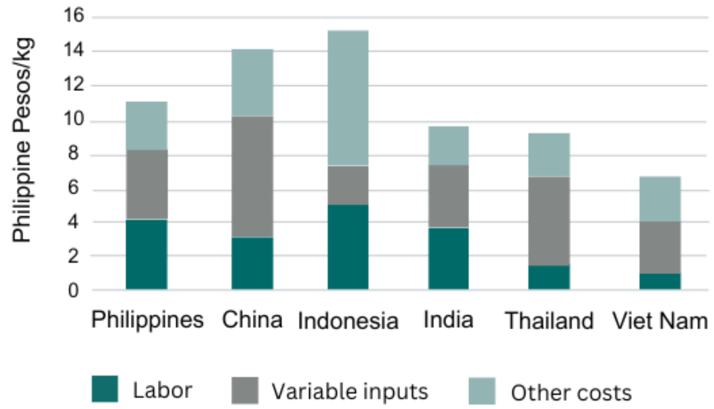


FIGURE 18: Rice Consumption and the Impact of the Rice Price Reduction on Poverty in the Philippines




*Source:* Balié, Minot, and Valera 2021.

FIGURE 19: Breakdown of Production Costs of Rice Paddy in Selected Asian Countries, High-Yield Crop Season, 2013–14




*Source:* Bordey *et al.* 2016.

**In Indonesia and the Philippines, i.e., the countries with more stable but higher rice prices, the marketing costs between producers and consumers are also high, partly due to high rice prices.** In these countries, marketing costs are nearly twice as high as in Thailand, mainly due to higher transport costs and the cost of working capital (Table 11). High rice prices in the Philippines and Indonesia increase the amount of working capital required to buy and store the same quantity of rice as in Thailand and Viet Nam. In countries with lower rice prices, even when they are more volatile, support for farmers tends to focus on reducing farm production and marketing costs while reducing consumer prices. This focus helps reduce poverty and enhance competitiveness. In contrast, countries with high rice prices support farmers by providing continuously rising output prices, which leads to the cycle of higher production and marketing costs and, thus, the continued taxation of consumers, who then pay the bill.

**Artificially high prices paid by public stock programs tend to slow agricultural diversification and reduce agricultural growth**. Farmers respond to high prices offered by public stocks by producing more of the supported crops, even in areas unsuitable for their production. In Asia, rice dominates the agricultural sector but generates low returns. Rice is a food staple for nearly 690 million Southeast Asians and accounts for a significant portion of harvested land in the region, e.g., 75 percent in Cambodia and 60 percent in Viet Nam. Rice is cultivated by over 100 million farmers, most of whom are smallholders, occupying not more than two hectares of land each. However, rice yields in various East Asian countries have decelerated, stagnated, or even declined over the past two decades. Farmers' incomes have remained low, often below the poverty line. The average daily earnings of rice farmers in East Asia vary between US$2 to US$6 per day. As such, smallholder (rice) farmers constitute a disproportionate share of the bottom 40 percent of the income distribution. In contrast, non-rice production systems generate higher revenues and employment and are associated with lower poverty levels. The situation is similar in eastern and southern Africa with the production of white maize. In Malawi and Zambia, offering incentive prices to producers of white maize on a pan-territorial basis encouraged its production in places that were better suited to more drought-resistant crops, such as millet and sorghum, and in areas that were previously under cotton and sugarcane production.

TABLE 11: Breakdown of Marketing Costs and Margins for Milled Rice in Selected Asian Countries, Philippine Pesos per Kilogram

| | Philippines | Indonesia | Thailand | Viet Nam |
|---|---|---|---|---|
| Total marketing costs: | 4.63 | 4.97 | 2.73 | 3.78 |
| Drying | 0.26 | 0.62 | 0.33 | 0.52 |
| Transport | 2.09 | 2.22 | 1.08 | 1.76 |
| Milling | 1.38 | 1.22 | 0.89 | 0.93 |
| Storage | 0.19 | 0.40 | 0.20 | 0.23 |
| Packaging | 0.45 | 0.24 | 0.14 | 0.22 |
| Cost of working capital | 0.27 | 0.28 | 0.09 | 0.11 |
| Gross marketing margins | 9.06 | 5.61 | 4.55 | 3.45 |

*Source:* Bordey *et al.* 2016.

**Thus, avoiding the use of SGRs as buffer stocks is an important precondition to generating value for money from using public stocks**. A distinction between SGRs and buffer stocks lies in their intended purpose and the expected operational outcomes. While buffer stocks are designed to intervene regularly and smooth price fluctuations, SGRs focus on mitigating the impact of food supply disruptions and providing relief during crises without aiming to generate profits or stabilize prices for too long. This pragmatic approach ensures minimal disruption to the market, allowing the reserves to operate as a last-resort safety net in emergencies rather than as a continuous market participant. For example, if imports are unexpectedly delayed by several months, releasing grain from SGRs to prevent local price spikes could be appropriate, as this would alleviate temporary supply constraints without distorting overall market dynamics. These principles also mean that SGRs are not designed to combat global price spikes, as it would be futile for governments to intervene when facing broader market pressures. By adhering to these principles, SGRs maintain compatibility with liberalized grain markets, avoiding large-scale interventions typically involved with buffer stock policies yet offering a pragmatic response to supply disruptions.

## 3.5 REDUCING THE COST OF STOCK PROCUREMENT

**Establishing clear replenishment rules is one crucial aspect of managing SGRs**. Such rules are essential for minimizing fiscal costs and market disruptions. Transparent, clear, and consistent practices involving SGR replenishment ensure effective public and private food security efforts. Effective replenishment strategies must address transparency in procurement methods, price-setting mechanisms, timing and location of procurement activities, procurement size, types of sellers, and transportation, and storage capacities. Therefore, well-defined strategies in these areas are vital to reduce procurement costs and ensure efficient management of reserves.

**Transparent procurement strategies and effective communication on procurement size, strategy, process, and execution are vital for ensuring smooth SGR operations with minimal disruptions in grain markets**. Transparent management builds trust with the private sector, which can be wary of government intentions due to past interventions. By making operational procedures publicly available and announcing changes in a timely manner, governments can ensure that all parties have the necessary information to adjust their expectations and actions accordingly. Clear rules should protect the SGR's management authority from undue influence, ensure fair operations, and prevent lobbying pressures and costly stock accumulation.

**Unpredictable changes in procurement policies increase market risks and discourage private investment in grain storage systems**. Uncertainty on the volume, prices, and timing of stock replenishment makes it difficult for the private sector to make decisions on their level of engagement in grain markets. In Zambia, for example, the FRA's practice of announcing minimum procurement volumes, then often exceeding them, creates market uncertainty. For instance, in 2023, the FRA announced a minimum purchase target of 500,000 tons of stocks. In 2024/25, its target decreased to 300,000 tons, but the actual stock procurement was higher. Such a procurement approach often results in the FRA buying more than needed and selling excess stocks at lower prices, which disrupts markets and creates a fiscal burden.

**Stocks should be acquired at market prices, without undue influence from lobbies, and with disposals limited to emergencies**. For example, Bangladesh and Uzbekistan buy grains for SGRs at market prices. However, many countries buy grains at above-market prices. The gap between procurement and release prices drives up the fiscal costs of public stockholding, as discussed in subchapter 3.2. Thus, procurement strategies for SGRs should focus on ensuring reserves are sufficient to meet emergency needs rather than public stocks being a tool for minimum price support to farmers. To avoid market disruptions, procurement and release prices should align with export and import parity prices.

**Replenishing SGRs through open tenders can ensure grain procurement at competitive market prices, reducing fiscal costs and allowing the private sector to operate profitably**. In contrast, if grain is procured at an administratively determined pan-territorial price higher than the prevailing market price, it crowds out private traders. Private traders are often excluded when replenishments are not conducted through open tenders, particularly in the case of large procurements at high prices. For instance, in India, where minimum procurement prices are generally above market levels and procurement volumes reach 25–30 percent of domestic production, the private sector's role in trading wheat and rice is limited (Chatterjee *et al.* 2024; Chand 2009). Similarly, in Zambia, the FRA plays a key role in grain markets, accounting for about 30 percent of the market surplus, and private sector activities are heavily reliant on FRA activities. This dependency limits market activity and denies farmers essential market services from private entities.

**A well-defined sourcing strategy is also crucial for cost-effective SGR replenishment**. This strategy should consider both local and international sources to mitigate risks such as price volatility, geopolitical challenges, trade/supply, and climate-related disruptions. A structured and continuous market monitoring approach to strategically time purchases can significantly lower procurement costs. For example, procuring during the harvest season or surplus periods when prices are low and avoiding large purchases during the lean deficit season help ensure cost efficiency for the SGR operations. Additionally, delivery terms are vital for cost-effective sourcing, and supply-chain assessments should address potential risks for both local and international purchases, and account for the capacities of the involved suppliers. Sourcing grains for public stocks in FCV contexts can be particularly challenging. The WFP supports the design of sustainable procurement strategies and is crucial in the procurement of food commodities in some of these countries, leveraging its global supply-chain expertise, market intelligence, logistical infrastructure, and procurement networks. In recent years, WFP has procured commodities for public stocks on behalf of several governments. Examples include Ethiopia (400,000 tons), Sudan (200,000 tons), and, more recently, Burkina Faso (70,000 tons).

**Although the procurement strategy for SGR replenishment should generally follow market and cost minimization principles, two exceptions may be considered for their potential developmental benefits**. First, where possible, strategies should integrate smallholders into value chains, as smallholders often face challenges such as limited market access and aggregation capacity. Second, procurement strategies could focus on regions with less private sector activity to avoid crowding it out.

**In many instances, public procurement for SGRs tends to favor larger farms over smallholders, exacerbating inequality within the agricultural sector**. In Kenya, about 10 percent of the farms sell 74 percent of maize surplus and regularly benefit from National Cereals and Produce Board procurement (Jayne *et al.* 2008; World Bank 2012). In Zambia, about 5 percent of all farmers account for half of the maize surplus and benefit from high prices (Fung *et al.* 2015). In Pakistan, only 5 percent of farming households are estimated to have a marketable wheat surplus. It is this subgroup that benefits from an increase in the procurement price of wheat (World Bank 2015). Thus, integrating smallholder farmers into SGR procurement mechanisms can support their livelihoods, contribute to fair price transmission and boost productivity. Box 6 presents examples of such WFP initiatives.



## BOX 6: WFP'S LOCAL AND REGIONAL PROCUREMENT STRATEGY

**WFP's local and regional purchase strategy is designed to support local farmers** and their livelihoods, and specifically for the purpose of operations, reduce reliance on imported commodities to shorten lead times and reduce cost. By leveraging policy instruments, the amount purchased locally has steadily increased, up to 59 percent of WFP's global food procurement in 2024.

**In operationalizing Local- and Pro-SHF Food Procurement approaches WFP has implemented indirect innovative contract modalities to address this, allowing procurement through traders or traditional suppliers.** This approach provides the necessary flexibility while ensuring that smallholder farmers are included. In 2024 alone, the WFP sourced US$59 million worth of food from smallholder farmers, and investing directly into those businesses. Beyond the support to smallholders, such initiatives have proven to promote inclusivity, women empowerment, and gender equality. This is significantly important when in developing countries the agricultural sector is dependent on the labor from marginalized groups, including women farmers, with some farmer organizations comprising 60 percent female members. In South Sudan, a woman-led business winning a contract to supply 3,000 tons of sorghum – the largest quantity contract awarded to a woman-led business by WFP in the country.  Furthermore, a woman-led group that has been a key partner of WFP in Burkina Faso was the largest supplier of beans, maize, millet and sorghum (12,700 tons) in 2023. This strategy improved the livelihoods of these farmers while integrating them into corporate procurement programs, offering essential market access and sustained demand.

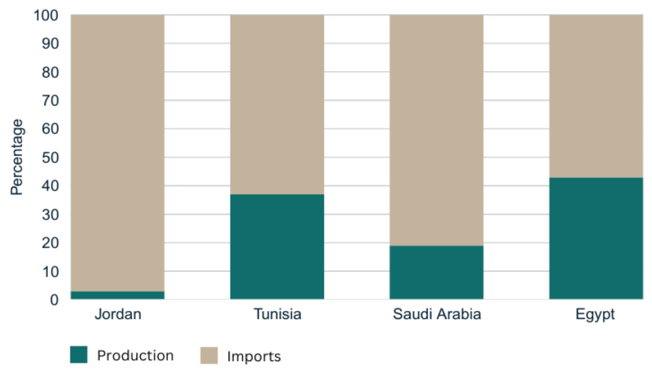
**A second example of successfully connecting smallholders with institutional demand comprises Madagascar Home-Grown School Feeding Programme.** WFP Madagascar has leveraged local procurement to support smallholder farmers. By the 2024-25 school year, this grew to cover 530 schools, reaching 160,000 students as compared to 106 schools previous year. The scale-up was made possible by implementing the Local and Regional Food Procurement Policy, through indirect contract modalities. A total of 5,300 smallholder farmers contributed around 6,000 tons of food for WFP-supported programs in the country, with nearly 50 percent of the farmers being women. The implementation of long-term contracts has provided both traders and smallholder farmers with greater visibility on demand, fostering a sustainable market for smallholder farmers.

**Source:** WFP, various reports.

**A sourcing strategy for SGR replenishment could also prioritize procuring from regions with limited private sector presence, where feasible. This effort could limit crowding out of the private sector and benefit farmers in the region**. The public procurement to replenish SGR should avoid competing with private buyers in well-served areas and instead concentrate on remote regions where private sector activity is limited. By acting as the buyer of last resort and buying at the market's tail end, the stock procurement can support farmers when they struggle to find buyers or when market prices fall very low, while keeping the pressure on the fiscal costs of SGR low. Ensuring grain procurement from these areas would provide crucial market access for smallholder farmers. In Zambia, the FRA's significant size of procurement for public stock replenishment has crowded out some major market players; it has negatively impacted private sector participation and reduced investments in the maize sector (World Bank 2021). Thus, the FRA should consider adopting a strategy to restrict its grain purchases to the required stock amount and to source these stocks from areas where the private sector is less likely to operate.

**In countries that rely on imports to replenish grain stocks due to limited domestic production, the cost of maintaining public stocks is heavily affected by the efficiency of supply chains and the effectiveness of tendering procedures**. Such countries are mainly located in the MENA region, where the natural environment is not favorable for agricultural production. Most MENA countries rely on imports of wheat and other food to satisfy domestic demand, and the share of imports is often above 50 percent of wheat consumption. In Jordan, it is more than 90 percent (Figure 20). In terms of volume, the largest wheat importers in the region are Egypt, Algeria, Morocco, and Saudi Arabia. In 2024–25 alone, these countries are projected to import 32 million tons of wheat. When the costs of transferring grains from exporting countries to ultimate consumers are high, public stocks need to be larger.

FIGURE 20: Production and Import of Wheat in Selected MENA Countries, Averages 2020–24




*Source:* Authors using the USDA PSD data (2025).

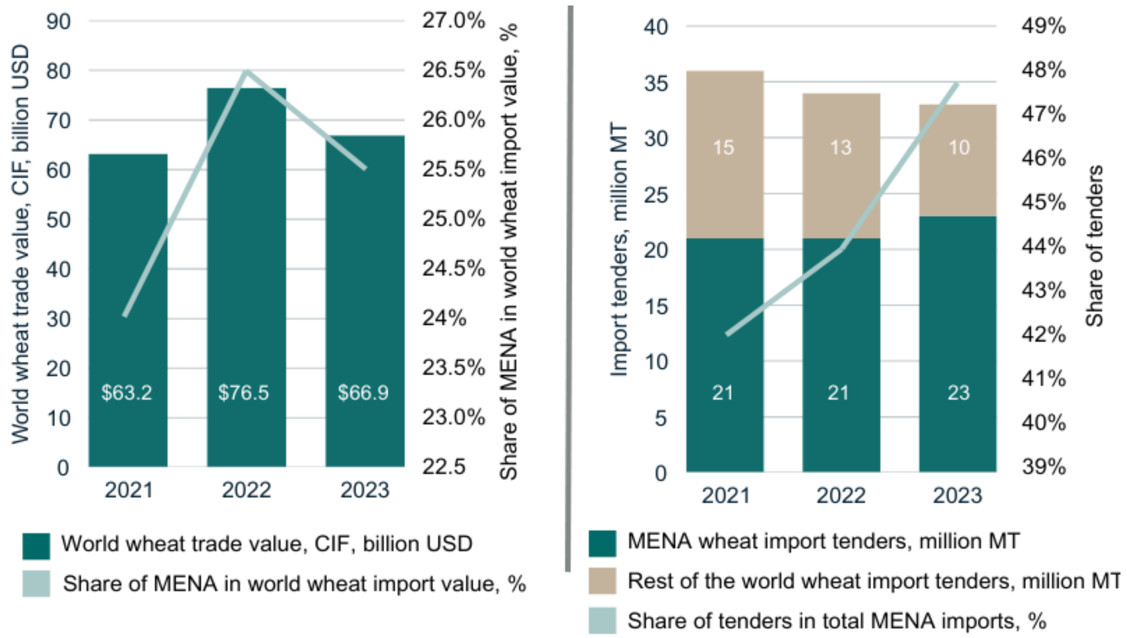
**Improving grain import efficiency in MENA countries often means improving the tender efficiency, i.e., buying good quality grain at the lowest cost**. During 2021–23, the value of wheat imported by MENA countries averaged US$67 billion per year, with about 25 percent of this volume bought through tenders (Figure 21).[19] In 2023 alone, the MENA governments spent US$23 billion on wheat purchases through tenders, which is twice the amount spent by other governments and private sector

[19] The results presented here come from the ongoing work under the FAO cooperation with the European Bank for Reconstruction and Development that focuses on improving grain sector import efficiency, particularly in the European Bank for Reconstruction and Developmen's Southern and Eastern Mediterranean region, under a joint Food Security technical assistance package.



companies elsewhere in the world. Thus, a transparent process of tenders is crucial for MENA governments, ensuring fair and competitive procurement. While large public expenditures through tenders allow for securing wheat supplies, they also present an opportunity for even small improvements in tender terms to save public finances.

FIGURE 21: Tenders in Wheat Procurement in the MENA Region, 2021–23

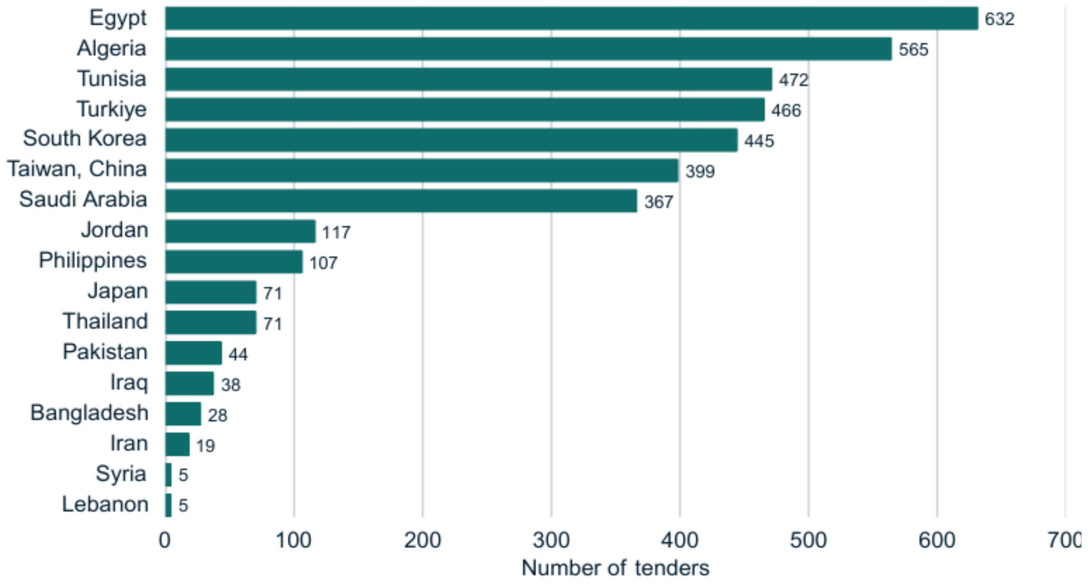



*Source:* FAO Investment Center using Agricensus data.

**Tenders for importing wheat are large in the MENA region**. During September 2017 and January 2025, Egypt is estimated to have had 632 wheat import tenders, using the normalized monthly observations (Figure 22).[20] In Tunisia and Algeria, the number of such tenders was 565 and 472, respectively. Saudi Arabia had 367 tenders.

[20] The dataset was obtained from Agricensus/Fast Markets, and included 3,859 tenders conducted from September 2017 to January 2025 by 38 tendering agencies globally. These agencies encompass both government bodies and private industry associations, such as the Flour Mills Industrial Association in South Korea, the Thai Feed Mills Association and others. The dataset comprises 146 supplying companies and a total shipment volume of 190 million tons of wheat for the period concerned.

FIGURE 22: Number of Wheat Import Tenders, 2017–25




*Source:* FAO Investment Center using Agricensus data.

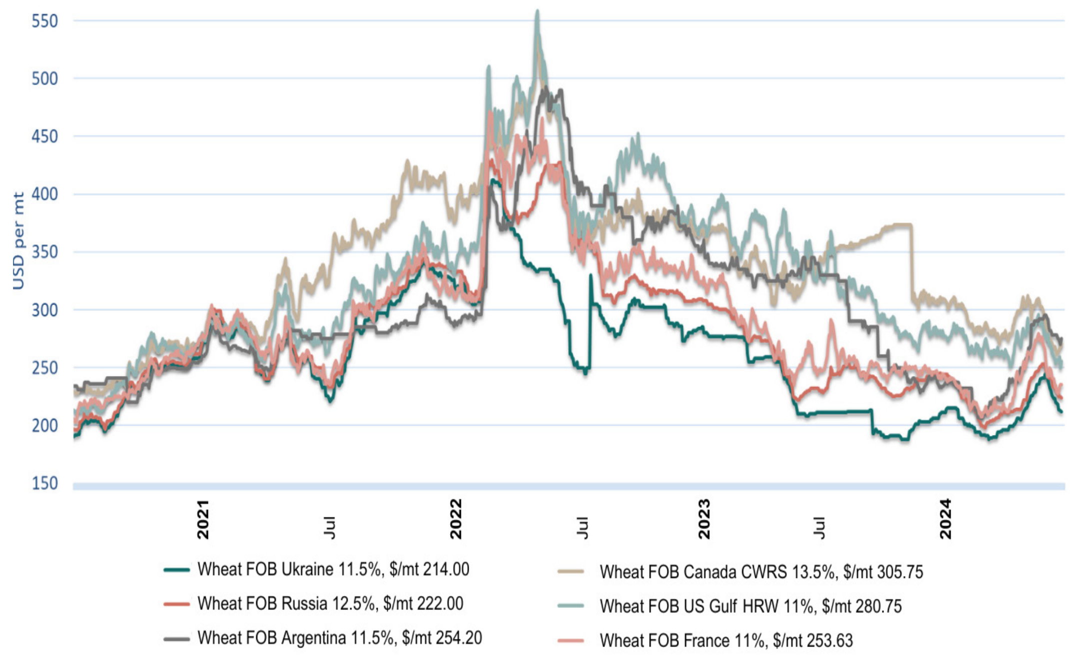
**Analysis was undertaken to determine what drives the prices of these tenders.** The analysis was carried out employing a Two-Stage Least Squares model to determine how specific import tender variables affect wheat prices paid. The model includes a base scenario focusing on demand-side variables set by importing agencies in their tender terms, such as protein content, average size of tender, urgency of delivery, and other factors affecting prices. An additional scenario that replaces the average tender volume with two supply-side variables, i.e., average volume per company and the number of companies submitting bids, adds considerations of both competition in tenders and economies of scale of supplier companies. In both scenarios, the import price is the dependent variable. The R-squared value for the base scenario is 0.705, indicating that the model explains 70.5 percent of the variance in wheat prices.

**The value of wheat protein plays a critical role in determining wheat prices.**[21] Available exporter price data shows that wheat protein content is a primary price determinant (Figure 23). Higher-protein wheat consistently commands a price premium, as seen in the case of Canadian wheat (13.5 percent protein). In contrast, lower protein wheat, such as Ukrainian wheat (11.5 percent), is priced significantly lower, reflecting the specific demand for protein qualities of wheat for different uses in the global market. The price divergence between different wheat origins and protein levels has widened significantly from mid-2020 to mid-2024. Even as wheat prices stabilized into 2023 and early 2024, the premium on higher-protein wheat persisted, reinforcing its role as a crucial pricing factor.

[21] Protein content is one of the most important quality parameters of wheat, which defines its final use for bread, crackers, pasta, and other uses.



FIGURE 23: Prices and Protein Content in Different Wheat Origins




*Source:* Agincentives.

**From the importers' perspective, wheat protein content plays an important role also during tenders**. An increase in protein content requirement by 1 percentage point raises the wheat price by an average of US$11 per ton. Protein content is the most significant price driver in the model. This finding confirms that higher protein content may limit wheat supply availability, implying that careful consideration of protein content in tender specifications is essential to balancing cost efficiency and food security objectives.

**Other tender terms also affect prices**. In the base scenario, the volume of the tender, as a unit of demand, varies greatly on a monthly level (Table 12). For example, Algeria has an average monthly tender volume of 519,000 tons, while Tunisia has 107,000 tons. An increase of 100,000 tons appears to decrease the average price by US$8.67 per ton. However, the actual price change may deviate from this average depending on the country's demand needs, availability of finance to buy, and port and storage infrastructure.

**Reducing the urgency of deliveries can also lower prices**. Reducing the time from bid closing to the start of delivery increases the price by US$1.05 per ton. Improved tender planning can enhance predictability, allowing suppliers to better coordinate export logistics and potentially expand sourcing options by considering longer shipping routes. The number of days between the bid close date and the delivery start date (urgency window) varies greatly: Jordan allows for 118 days to arrange delivery, while Egypt allows 45 days, showing the opportunity to reduce tender costs.

TABLE 12: Determinants of Wheat Price Tenders in Selected MENA Countries

| Variables | Algeria | Egypt | Iraq | Jordan | Saudi Arabia | Tunisia | Results |
|---|---|---|---|---|---|---|---|
| Average tender volume, '000 tons | 519 | 323 | 124 | 111 | 161 | 107 | +100,000 tons decreases the price by US$8.67/ton |
| Delivery window (start-end), days | 36 | 31 | 42 | 15 | 45 | 20 | +7-day and price increases by US$2.5/ton |
| Urgency window (bid close-delivery start), days | 38 | 45 | 69 | 118 | 82 | 40 | +7-day and price decreases by US$1.05/ton |
| *Number of tenders analyzed* | *565* | *632* | *38* | *117* | *367* | *472* | - |
| Supply-side scenario | | | | | | | |
| Average volume of supply per company per country, '000 tons | 140 | 134 | 125 | 69 | 220 | 61 | +10,000 tons decreases the price by US$2.45/ton |
| Number of supplying companies per country, month | 6.4 | 5.2 | 1.2 | 1.7 | 4.6 | 3.7 | +1 company per country/month decreases the price by US$1.82/ton |

*Source:* FAO Investment Center's calculations.

**In the supply-side (additional) scenario, the model showed that the number of companies supplying wheat per country per month also varies**. Variation could be due to a combination of company size, specialization, and interest of companies to participate in tenders, with potentially restrictive access to tenders by some tender agencies. Algeria has 6.4 companies participating in tenders per month, while Jordan has 1.7 companies. An increase of one company per country per month has the potential to decrease the price by US$1.82 per ton, reflecting higher competition (Table 12). This finding denotes the importance of allowing wider access to tenders with periodic reviews of tender and access terms.

**Improving tender transparency and improving dispute resolution also reduces the cost of wheat tenders**. The World Bank-financed Emergency Food Security Response and Resilience Support Project facilitated procurement of 1.15 million tons of wheat through four competitive tenders conducted between December 27, 2022, and February 22, 2023. The average lowest bid prices were consistently lower than those of similar tenders in the MENA region. Furthermore, the margin between the selected benchmark prices and the lowest bid prices decreased with each subsequent tender, as shown in Table 13. The interviews with wheat suppliers revealed that the reduction in the margin was attributed to the lower risks associated with more secured tenders, notably guaranteed finance, improved dispute resolution, beneficiary ownership disclosure (transparency), and fast payment terms. Policymakers should note these and other above-mentioned drivers of tender prices as they make a big difference in multibillion spending on stocks.



TABLE 13: Price Performance of Four Tenders in Egypt Financed by the World Bank Project

| Date | Project-Financed Purchase Volume (tons) | Price Offered (US$/ton)* | Price Offered in a Comparable Regional Tender | MATIF Wheat Price (US$/ton)** | CBOT Financially Settled Black Sea Wheat Price (US$/ton)*** | Spread Between Tender Price and MATIF Price (US$/ton) | Spread Between Tender Price and CBOT Price (US$/ton) |
|---|---|---|---|---|---|---|---|
| Dec-27, 2022 | 200,000 | 339.0 | 461.0 (a) | 337.4 | 309.4 | 1.6 | 30.0 |
| Jan-10, 2023 | 120,000 | 337.0 | 351.9 (b) | 317.3 | 307.3 | 19.7 | 30.0 |
| Feb-2, 2023 | 535,000 | 322.8 | 329.0 (c) | 310.5 | 304.8 | 12.3 | 18.1 |
| Feb-22, 2023 | 240,000 | 317.0 | 333.0 (d) | 299.6 | 315.0 | 17.4 | 2.0 |

**Note:** * bid evaluation reports; ** www.euronext.com; *** www.barchart.com

Source of comparable regional tenders: (a) Dec-21, 2022 Grain Board of Iraq, Australia wheat 100,000 tons; (b) Jan-5, 2023 Tunisia OdC, European wheat (French and Romanian) 50,000 tons; *** Feb-9, 2023 Algeria OIC Russian wheat 400,000 tons; and (d) Feb-21, 2023 Jordan MIT Russian or Ukrainian wheat 60,000 tons.

**Source:** Authors based on World Bank project data.

## 3.6 INCREASING THE IMPACTS OF STOCK RELEASES

**Stock releases also play an important role in achieving the SGR's intended outcomes**. Stock releases can occur through auctions and commodity exchanges, i.e., untargeted releases and targeted distributions. Auctions, conducted in small or varied batch sizes to ensure competition and limit market concentration, are effective in urban areas with well-functioning markets. They quickly increase market availability without needing pre-established distribution systems, which is crucial during sudden price surges. Moreover, there is an increased expectation to release stocks through commodity exchange to enhance the commodity exchange's viability and contribute to transparent price discovery mechanisms. Even for the purpose of stock rotation, using the commodity exchange is recommended.

**Some countries have already been using commodity exchanges to release stocks, while others aim to do it soon**. Uzbekistan has been releasing stocks through commodity exchanges since 2021, and it has successfully minimized market distortions by doing so. Zambia has committed to increasing the sales of stocks through a commodity exchange (ZAMACE) as a part of the Zambia Growth Opportunities Program. The program was launched in 2022 with the support of the World Bank to improve price discovery, attract private sector participation, and increase the volumes of commodities traded. Transparently releasing stocks via commodity exchanges is expected to encourage the FRA to utilize less market distortive maize stock trading operations and increase the transparency of trade decisions, which could incentivize farmers to diversify their crop production systems while enhancing productivity and competitiveness.

**Stock releases through commodity exchanges can be complemented by policies such as temporary subsidized storage facilities for farmers and cash payments for safety net beneficiaries**. This approach has led to a significant decrease in the size of procured wheat stocks in Uzbekistan and supported wheat price liberalization reforms there, ensuring more stable prices despite external challenges. In Uzbekistan, the SGR size has declined gradually as an outcome of the government's deliberate policy. The policy sought to give more space to the private sector, reduce the role of the state, and lower the fiscal costs as part of the market liberalization reforms. Uzbekistan paired SGR with other policies, such as providing farmers with temporary storage facilities for up to six months[22] and offering free storage for 500,000 tons of wheat if farmers cannot sell their produce immediately after harvest. Additionally, cash payments to beneficiaries of safety nets helped reduce SGR management costs by minimizing administrative expenses associated with the release of physical stocks to those in need. This approach allowed the release of grains through commodity exchange. This combination of policies has significantly reduced the size of procured wheat stocks from 50 percent of total production in 2021 to just 12 percent in 2024. As a result, the SGR's fiscal cost decreased from US$537 million or 0.8 percent of GDP in 2021 to US$197 million or 0.3 percent in 2024 while still maintaining more stable wheat prices in recent years (Table 10).

**However, auctions and commodity exchanges could be less effective in countries with poor marketing systems**. In such cases, targeted in-kind food distributions would be more efficient. These should be managed through social safety nets or aid relief agencies, including food-for-work programs, food stamps, school meal programs, or supplementary feeding programs, to ensure vulnerable populations receive necessary food supplies during emergencies. In Ethiopia, the Strategic Food Reserve Agency (SFRA) partners with donors and government bodies to supply grains and implement emergency activities in high food insecurity regions. The SFRA maintains a rotating stock of cereals that can be borrowed by organizations like the WFP, with repayment on arrival of the pledged supplies, reducing the time between pledges and distribution. Another limit of auctioning stocks is that the benefits of SGR can spill over to foreign markets through reduced imports or reexports of released stocks. Appropriate trade policies must support SGRs to prevent this leakage. If stocks are released through in-kind transfers to insolvent populations, the risk of leakage to foreign markets is naturally mitigated.

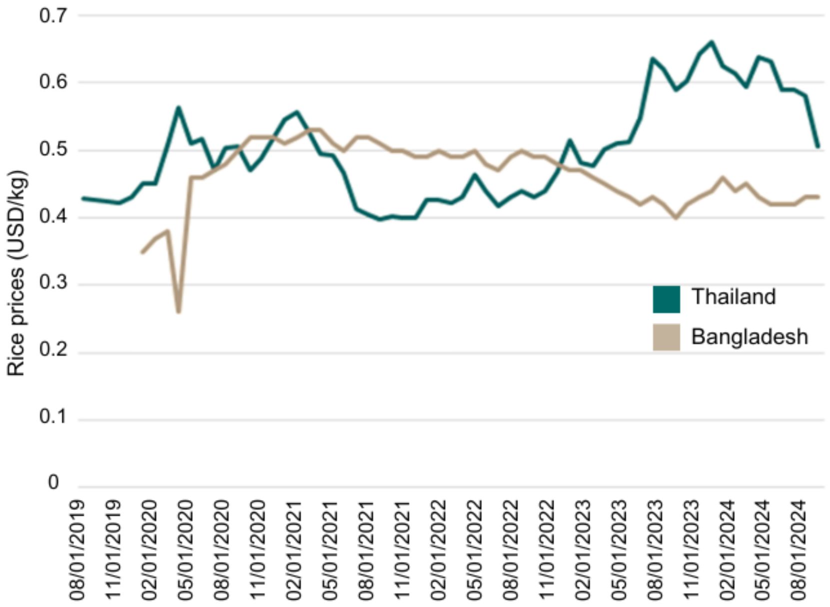
**Thus, in some instances, in-kind food distribution could still be justified for releasing SGR stocks**. Yet, the effectiveness of in-kind food distribution is largely determined by the integration of SGRs into well-functioning safety net programs that ensure effective targeted releases. Countries like Ethiopia, Mali, and Bangladesh have implemented such systems to support vulnerable populations during food emergencies. The Emergency Food Security Reserve in Ethiopia, the Programme pour la Réstriction du Marché de Céréales in Mali, and the Public Food Grain Distribution System in Bangladesh all target the poor through small, efficient reserves of typically 3–10 percent of domestic consumption. These reserves use early warning systems to determine optimal stock sizes, ensuring flexibility and responsiveness. The programs emphasize transparency through open tendering and effective stock management. Ethiopia, for example, maintains 62 percent of its reserves as fresh stock. Rather than relying on universal food distribution, which has proven to be very costly and ineffective in reaching the intended population (World Bank 2012), these reserves integrate safety nets like food-for-work and school feeding, often in partnership with NGOs, which ensures that aid reaches those most in need. In Ethiopia, the Productive Safety Net Programme and the government's emergency operations distribute SFRA stocks. This collaboration boosts the safety net program's efficiency, with SFRA maintaining robust inventory management and coordinating with local and international partners to support the country's most vulnerable populations during crises.

**The primary source of funding for SFRA comes from the Ethiopian government, which allocates the budget annually**. This funding is crucial for maintaining the agency's operational capacity, including covering the costs associated with storage, transportation, and distribution. However, the SFRA also has funding through donor contributions, which significantly reduces the fiscal burden on the government. Many organizations, such as the Canadian International Development Agency, British Official Development Assistance, the United States Agency for International Development, WFP, and the EU, have supported SFRA. These funds are used to reimburse loans, manage food stocks, and cover operational expenses. The agency also receives locally purchased food aid and imports, which are critical for maintaining adequate reserve levels. SFRA manages stocks and meets operational expenses by engaging in cost-sharing arrangements with international partners, which help spread the financial burden and ensure sustainability. For example, the WFP often provides technical support and covers part of the operational costs during emergency responses. This collaborative approach enhances the financial stability of SFRA and improves its capacity to respond to food security crises effectively.

**In addition to integrating SGRs into safety net programs, some countries showed that following supportive trade and market policies could increase the impact of the SGR's releases**. In Bangladesh, for example, the strategy of reducing duties on rice imports and maintaining adaptive public stocks with flexible pricing has proven more cost-effective for price stabilization than aggressive buffer stock policies used in the past (Minot *et al.* 2021). The public food distribution system's role in price stability was found to be insignificant, but integrating SGRs with social safety net programs and liberalized trade regimes helped stabilize rice prices (Figure 24). Bangladesh's public reserve system is integrated with safety nets and managed with three key objectives: (a) distributing foodgrains to chronically food-insecure communities, (b) distributing foods during emergencies and natural disasters, and (c) stabilizing market prices during short-term shocks. In 2023, Bangladesh spent US$1.6 billion on its SGRs, an equivalent of 0.25 percent of GDP, complemented by a US$3.5 billion cash-transfer program for the vulnerable.

[22] To prevent disruptions from reduced public procurements and ensure farmers have safe storage for their wheat, the government of Uzbekistan introduced a transition support program. The program included free storage space for farmers for 500,000 tons of wheat for up to two months. By 2024, the program was expanded to 1.5 million tons for six months, but with the government covering only storage costs. Farmers were responsible for covering the costs of transporting wheat to storage and loading and unloading. In 2025, the government phased out this transitional support for farmers.

FIGURE 24: Rice Prices in Bangladesh in Relation to International Prices




*Source:* FAO FPMA price data.

**Linking SGR to social safety nets can ensure that food reaches those in need. However, rapidly scaling such programs in emergencies can be logistically challenging, making it crucial that they can be adjusted during crises.** This need for social safety net preparedness implies that there are complementarities between policies addressing chronic and acute hunger. The flexibility to switch from chronic to acute hunger programs is essential. Boosting existing in-kind programs or income support during crises could be a more cost-effective response than releasing untargeted reserves. The repetition of shocks in the last two decades has led to the emergence of adaptive social protection (World Bank 2018), a tendency even reinforced by the COVID-19 pandemic (Gentilini 2022) and the inflation shocks that have followed (Gentilini *et al.* 2022). It is crucial to capitalize on these efforts so that SGRs can be managed efficiently.

## THE BOTTOM LINE

Market distortions, high fiscal costs, corruption, and enforcement issues can all undermine an SGR's effectiveness. Thus, designing and implementing interventions that minimize these failures is crucial to ensure the reserve's benefits outweigh the drawbacks. SGRs can deliver results when clear and manageable objectives underpin them, when they are managed prudently in terms of fiscal costs, and when they are used smartly to mitigate the impact of temporary food supply disruptions. Successful SGRs use market channels such as commodity exchanges, maximize development impacts by supporting smallholder commercialization, and are embedded in targeted safety net programs where in-kind food assistance works better than cash assistance. Yet, SGRs fail when managed as buffer stocks that aim to address too many and often conflicting objectives. There are numerous causes of SGR failure, including lack of clarity of objectives, high fiscal costs, price distortions, and crowding out of private storage and trade. Countries need to carefully consider these factors to use SGRs effectively.

# 4

# HARNESSING INNOVATIONS AND TECHNOLOGIES FOR EFFICIENT SGRS

**Dependent on the reserve's sourcing and distribution strategies, the enabling transport, storage and distribution networks must be reviewed and established to meet their objectives**. Given the capital-intensive nature of physical infrastructure, the design of logistics network to support SGRs should be informed by detailed assessments. In addition to warehousing, which is covered in this chapter, grain safety and quality (Box 7) and port and road infrastructure will be fundamentally important as this will directly impact the efficiency of moving grain from procurement points to storage facilities and eventually to distribution points. Critical considerations in this process include complementarity with existing infrastructure and SGRs, existing logistics network and proximity to critical port/land access points, market access (both for procurements and releases), social, environment and cultural impacts, establishment and maintenance costs, and the use of technology. Similar to the grain procurement process, it is recommended that infrastructure projects are awarded based on a tender process to ensure competitive pricing and transparency.

### BOX 7: IMPORTANCE OF GRAIN SAFETY AND QUALITY

**Alongside infrastructure and technology, effective management of food safety and quality (FSQ) is crucial for the operation of SGRs.** Best practices for development of a comprehensive FSQ process should emphasizes risk-based approaches to ensure safety and quality of food across the whole supply chain. WFP's global experiences indicate that a tailored approach, integrated with the existing infrastructure, is most appropriate in embedding FSQ. The integrity of grain reserves starts with the selection and monitoring of suppliers. FSQ guidelines must stress the importance of a robust supplier approval process to ensure that all suppliers meet the highest standards of food safety and quality. Inspection and spot testing are vital for ensuring that grains entering and stored in reserves remain safe and of high quality. Proper storage and handling are critical to maintaining the quality and safety of grains. The recommended practices include pest control, temperature and humidity monitoring and control, and reconditioning and repackaging to restore quality in the cases of minor spoilage or damage.

**Along the grain supply chain, traceability is essential for managing food safety risks in grain reserves.** Such a system should include lot identification and food incident management protocols ensures that any safety or quality issues are swiftly identified, contained, and resolved. The transport of grains from procurement sites to storage facilities and ultimately to distribution points must also adhere to stringent FSQ standards. Key considerations include transport conditions (inspection of trucks and containers prior to loading), minimal handling and the prioritization of direct routes, and monitoring during transit.

**Regular quality assessments and continuous improvements are also vital for SGRs.** Recommendations include routine assessments, the establishment of feedback mechanisms with third parties including suppliers and transporters, and continuous training and capacity development for staff involved in the operation of grain reserves, including warehouse managers, transporters, and procurement officers. These steps help adapt to evolving risks and ensure a proactive approach to FSQ management.

**High losses from improper storage and handling of grain stocks are among the major reasons for the high costs of public stockholdings**. Avoiding grain loss during prolonged storage is one of the most practical ways to increase an SGR's attractiveness. This chapter explores innovative technological solutions for designing and managing grain storage facilities, including digital solutions that have evolved rapidly in recent years. It covers various aspects of technologies, including how SGRs can improve efficiency, quality preservation, and cost-effectiveness, looking at trade-offs for silos, flat warehouses, and bagging systems. It highlights the advantages and disadvantages of various methods, the risks associated with each technology, and the advanced monitoring solutions that can be implemented to mitigate these risks to ensure high and sustainable quality of stored grain. Adopting the technology solutions discussed in this chapter would increase the value for money of SGRs and follow the good practices described in the previous chapter.

**Storage often accounts for a large share of postharvest grain loss**. The choice of storage technologies is context-dependent, but using the right technologies can reduce grain loss, improve the durability of stored grains, and ultimately lower the fiscal costs of managing SGRs. Grain loss occurs throughout the whole supply chain, starting from harvesting. A key challenge in reducing grain losses is that the magnitude of postharvest grain loss varies significantly depending on factors such as geographic location, climate, and the prevalence of pests. The magnitude of losses at the storage level could be up to 40 percent of total losses at the postharvest level (Table 14).

**Exposure to pests, temperature variation, and moisture (leading to mycotoxin formation) leads to high grain loss during storage**. High levels of grain loss during storage highlight the importance of proper grain storage and monitoring. The use of the right storage technologies and effective stock monitoring and management solutions is critical. Combining on-farm storage technologies with financial products, group commitment devices, and flexible storage options while addressing both credit and loss constraints can offer a holistic solution to encourage effective grain storage investments in communities and farms (Ricker-Gilbert, Omotilewa, and Kadjo 2022).



TABLE 14: Postharvest Losses Along the Value Chain

| Value chain step | What causes losses at this stage? | Magnitude of losses for selected grains and regions, percentages up to | |
|---|---|---|---|
| Harvesting | Poor harvest timing (crop harvested before fully mature or when moisture content is too high) | 8 | In areas of sub-Saharan Africa |
| Threshing | Grain spillage, incomplete separation of grain from chaff, grain breakage, or moisture | 3 | Maize threshing losses in areas of Africa |
| Drying | Grain exposed to birds and insects, damage from rain, or contamination from dirt and insects | 3 | 0.4% with machine drying; 3.1% with open-sun drying (Bangladesh)[1] |
| Storage | Exposure to pests, temperature variation, and moisture (leading to mycotoxin formation) | 40 | 1% in well-controlled environments; 40% in humid tropical conditions for maize[2] |
| Processing | Cracked kernels, introduction of foreign matter, and high moisture | 30 | Losses of 5 to 30% depending on milling type (village milling or commercial milling) |
| Transport | Spillage due to low-quality bags | 2.5 | Up to 2.5% for cereals in Southeast Asia[3] |
| Marketing | The process of removing crops from the field | 2.5 | Up to 2.5% if grain stored in poor conditions at the market in sub-Saharan Africa[4] |

[1]Ashraful Alam et al., "Performance evaluation of power-operated reapers for harvesting rice at farmers' fields," *Journal of Bangladesh Agricultural University*, February 2018, Volume 16, Number 1, pp. 144–50, banglajol.info.
[2]Prasanta Kalita and Deepak Kumar, "Reducing postharvest losses during storage of grain crops to strengthen food security in developing countries," *Foods*, January 2017, Volume 6, Number 1, ncbi.nlm.nih.gov.
[3]*ADMI 2019 annual report*, Institute for the Prevention of Postharvest Loss, 2019, postharvestinstitute.illinois.edu.
[4]"Value chain: All countries—Maize—2020," The African Postharvest Losses Information System (APHLIS), 2020, aphlis.net.

*Source:* Authors based on Alam *et al.* (2028), Kumar and Kalita (2017), ADMI (2019), and APHILS (2020).

## 4.1 STORAGE TECHNOLOGIES

**The significant losses observed during storage underline the importance of proper grain storage and control**. Several available approaches and technologies, both traditional and innovative, can be deployed to minimize losses. For example, at the grain harvesting stage, technologies such as mechanical reapers may be more effective in reducing losses than manual harvesting. At the grain drying stage, mechanical drying may have the greatest impact compared to open-air drying. Grain storage can be achieved in various ways, depending on the type of grain, geographical location, local conditions, and available resources:

a. **Silos can reduce losses by 40–50 percent.** They represent a more sophisticated storage solution than traditional storage methods, offering enhanced protection against environmental factors and pests. Cylindrical structures commonly made of steel or concrete differ in size and primary function. One key advantage of silos is their ability to maintain stable internal conditions, preserving grain quality over extended periods. Modern silos are equipped with integrated systems for monitoring and controlling temperature and moisture levels. These systems help mitigate spoilage risks by ensuring that the internal environment remains within optimal parameters. This capability is particularly valuable in regions with extreme temperatures or high humidity, where traditional storage methods might be risky and insufficient. They are mainly used in North America, Europe, Argentina, and Australia. A current trend is increasing the share of silo storage as it is best for long-term storage and is being adopted as countries modernize their agricultural infrastructure. The World Bank has been supporting several countries, including Bangladesh and Egypt, with financing and technical assistance to shift from traditional storage systems to modern silos (see Box 8 and Box 9 for more details).

b. **Flat warehouses can reduce losses by 25–35 percent.** These structures consist of large, horizontal open spaces where grain is stored in bulk or bags, often stacked in layers. They are particularly predominant in regions where land is abundant and inexpensive and have been widely utilized for grain storage due to their relatively low construction costs and the simplicity of their design. Flat warehouses are common in Russia, Ukraine, India, and parts of Africa as they are cost-effective for large volumes, especially where land is plentiful. Even there, however, this storage technology is being replaced by more loss-reducing options such as silos.

c. **Silo bags can reduce losses by 10–15 percent.** These plastic, tube-shaped grain storage bags vary in length and diameter, with a holding capacity of about 200 tons of maize, wheat, or soybean. The main advantage of silo bags is their adaptability. They can be used in diverse locations, making them ideal for remote or temporary storage. Silo bags are particularly useful during harvest seasons when the volume of grain exceeds the capacity of permanent storage facilities, provided that the grain moisture levels permit their use. Silo bags are widely used in Argentina, Brazil, and some African countries, where flexible and low-cost temporary storage is needed. The trend is increasing in regions lacking permanent infrastructure.

d. **Ground storage can reduce storage losses by 5–10 percent.** As the name suggests, ground storage involves storing grain directly on a prepared ground surface, often with soil or other material wall above 0.5 meters and covered with tarps to protect against rain and pests. It offers the most direct method for grain storage in regions with limited resources. Ground storage is used in rural Africa, South Asia, and generally in developing countries as a short-term solution. However, its use is declining as better storage options become more available.

e. **Other methods, including hermetic storage, can help reduce storage losses by 10 percent or less.** Hermetic storage is largely used in rural areas of Southeast Asia, SSA, and Latin America. Traditional methods like bagging are still used in small-scale farming, but modern solutions like silo bags and hermetic storage are slowly replacing these. Hermetic storage is a relatively recent innovation in grain storage, offering a high level of protection against spoilage and pests. A key benefit of hermetic storage is its ability to create an anaerobic environment that reduces spoilage risk. Hermetic storage removes the need for chemical fumigants and so reduces the cost and environmental impact associated with traditional pest control methods. This feature makes it an attractive option for regions with high humidity or heavy pest pressures, where other storage methods are unavailable or might be inefficient in maintaining grain quality.



## BOX 8: BANGLADESH FOOD STORAGE MODERNIZATION PROJECT

**Bangladesh is modernizing its grain storage infrastructure to improve food security and reduce losses.** Most of the country's SRG is stored in old and poorly maintained warehouses, leading to inefficiencies and spoilage. With support from the World Bank, Bangladesh is investing in modern storage facilities and implementing innovative storage practices.

**The Bangladesh Food Storage Facilities Project (MFSFP) is constructing seven state-of-the-art silos with a total capacity of 487,300 tons.** Five of these silos are to store milled rice, and two are for wheat storage. Individual storage capacities of these modern silos range from 45,000 to 111,000 tons, and they come equipped with innovative technology to avoid grain loss and optimize storage conditions.

**New silos incorporate innovative technologies to enhance efficiency, safety, and grain longevity.** These modern facilities are designed to optimize storage volume, cooling efficiency, pest control, and cost considerations. Silos are also being built with temperature and moisture control, fumigation systems, automated mechanical handling, and central computerized control systems for grain longevity and safety. Each silo will contain two drying systems for moisture control, activated when moisture exceeds 12.5 percent.

**The project also supports small-scale storage solutions to protect household grain stocks.** In addition to building silos, the MFSFP provided 500,000 household with silos (90 kilogram food-grade plastic bins with watertight lids designed to prevent water intrusion from floods) in cyclone-prone areas. This initiative helps households safeguard their food supplies and enhances resilience against extreme weather events.

**Bangladesh is strengthening its institutional capacity by implementing a nationwide digitized monitoring system for grain stocks.** This system enables real-time tracking and management of grain stocks, supporting better oversight, improved food distribution, and greater efficiency in national food security planning.

## BOX 9: THE EXPERIENCE OF MODERNIZING STOCK MONITORING SOLUTIONS IN EGYPT

**Wheat is the primary grain staple in Egypt, forming the backbone of the country's food security and social safety net**. Egypt consumes approximately 20 million tons of wheat annually, importing around half of this to meet demand. Bread produced from wheat is a staple food, with nearly 70 million people relying on it as their main food source.

**Modern steel silos have improved Egypt's wheat storage capacity and reduced grain losses**. As of 2023, the public stock capacity stood at 4.7 million tons, with

3.3 million tons stored in modern steel silos, which offer superior grain preservation and lower loss rates than traditional barns. Imported wheat for subsidized bread is stored in these advanced silos, while locally produced wheat is stored in both barns and silos.

**Since 2015, Egypt has implemented the National Project of Silos to increase storage capacity and secure its stocks.** Currently, the World Bank is financing the upgrade, extension, and construction of an additional 700,000 metric tons of capacity to expand stocks and reduce grain losses, contributing significantly to the National Project of Silos. Through this project, the modern storage capacity increased from 1.2 to 3.3 million tons between 2014 and 2023, significantly reducing wheat losses and preserving quality for extended periods.

**Advanced technologies are enhancing storage efficiency and minimizing wheat losses.** Egypt employs various technological solutions to minimize grain losses during storage and handling. Advances in sensor technologies have improved precision, and closed-loop fumigation systems have been implemented to maintain the integrity of stored grains. Monitoring grain quantities in storage bins relies on sensors, including laser-based measurement systems. Maintenance and consistent data collection are essential for ensuring the efficiency of storage systems.

**While technological solutions have allowed improvements, safety tools in the country's grain storage management system remain underused.** The widespread use of tools such as carbon dioxide monitors could enhance operational efficiency and the safety of silo storage complexes. Increased implementation of such technologies would reduce spoilage risks and improve overall grain management.

**Strategic grain storage locations and digital integration are strengthening the country's wheat value chain**. Egypt strategically positions its grain storage complexes near transport routes and production sites to improve management and reduce import dependence. With support from the World Bank and other donors, Egypt is also upgrading its storage information system to link complexes, mills, and bakeries into a unified network. Upgrades would allow more efficient management of the wheat value chain, particularly for subsidized bread, which remains a major part of the country's social safety net.



**Each method has advantages and disadvantages, which must be considered when choosing a long-term storage solution**. Table 15 details the advantages and disadvantages to consider for each technology solution.

TABLE 15: Main Storage Types and Their Advantages and Disadvantages

| Storage Type | Advantages | Disadvantages |
|---|---|---|
| **Open-air ground bunkers** | • Low initial cost<br>• Easy to establish and dismantle<br>• Can store large quantities of grain<br>• Flexible storage option for short-term needs | • High risk of grain spoilage due to exposure to weather elements<br>• Requires very dry grain (12 percent moisture for wheat) and frequent monitoring and maintenance<br>• Susceptible to pest infestations, birds, and rodent attacks; not suitable for fumigation<br>• Limited protection against moisture build-up and spoilage<br>• Substantial land allocation requirements (480–500 square meters for 600 tons of wheat) |
| **Gas-tight sealable silo** | • Allows phosphine and controlled at-mosphere fumigation<br>• Fumigation with one-off use<br>• Easily aerated with fans<br>• Capacity from 10 to 3,000 tons<br>• Can be used year-round<br>• Up to 25-year lifespan | • Requires maintenance and more experienced labor<br>• Seals must be tight to be effective<br>• Regular checks required<br>• Requires foundation to be constructed precisely as required by the manufacturer |
| **Non-sealed silo** | • Cheaply erected within ten days<br>• Easily moved where there is flat space<br>• From 10 to 3,000-ton capacity | • Requires regular checks for leaks, rust, etc.<br>• Possible water penetration in monsoon or other heavy rains<br>• Not suitable for fumigation unless sealed at extra cost |
| **Grain storage bags** | • Low initial cost<br>• Can be laid on a prepared pad and easily shaped<br>• Provide harvest logistics support<br>• Can provide segregation options<br>• Ground operated<br>• Can accommodate high-yielding seasons | • Requires substantial labor for bagging/unbagging and/or the purchase or lease of loader and unloader<br>• Increased risk of insect damage from jute bags<br>• Limited insect control options; fumigation is possible only under specific protocols and airtight sheds<br>• Aeration of grain in bags is limited to research trials Must be fenced /walled off and covered with tarpaulin or plastic<br>• Prone to attack by mice, birds, foxes, etc.<br>• Limited wet weather access if stored in a paddock<br>• Need to dispose of bag after use<br>• Single use only |
| **Grain storage sheds** | • Can be used for dual purposes<br>• 30-year plus service life<br>• Low cost per stored ton | • Aeration systems require a specific design<br>• Risk of contamination from dual-purpose use<br>• Difficult to seal for fumigation<br>• Vermin control is difficult<br>• Limited insect control options without sealing<br>• Difficult to unload. |

*Source:* Authors' assessment.

**Investing in better storage infrastructure can significantly reduce the risk of grain losses**. In Zambia, for example, silos account for only 1.4 percent of the SGR's storage capacity. Replacing sheds with concrete sheds or, even better, silos would reduce the loss of stored goods by at least half. Table 16 shows the storage types and capacities of Zambian SGR, while Table 17 summarizes the types of losses associated with specific risks and mitigation solutions.

TABLE 16: Types of Storage Facilities and Capacity of the FRA in Zambia

| Storage Facility | Capacity (Tons) |
|---|---|
| Sheds | 973,760 |
| Concrete slabs | 74,000 |
| Silos | 15,000 |
| **Total** | **1,062,760** |

*Source:* World Bank 2021.

TABLE 17: Types of Grain Losses Associated with Each Risk and Mitigation Solution

| Risk Factor | Type of Loss | Mitigation Solutions |
|---|---|---|
| **Moisture** | Mold growth, mycotoxin contamination | Moisture sensors, proper drying, aeration |
| **Temperature** | Condensation, insect infestation, combustion | Temperature sensors, automated aeration, cooling |
| **Pests** | Direct consumption, contamination, spoilage | Fumigation, pest monitoring, IoT systems |
| **Structural Integrity** | Flooding, water damage, contamination | Regular maintenance, robust infrastructure |
| **Operational Mismanagement** | Theft, spoilage, misallocation | Improved security, IoT-based monitoring |

*Note:* IoT, Internet of Things

*Source:* Authors' assessment.

## 4.2 MONITORING SOLUTIONS FOR EFFICIENT STOCK MANAGEMENT

**Alongside infrastructure, an effective monitoring system of grain condition and storage environment is essential for minimizing the risks and maintaining the quality and safety of stored grains**. Monitoring systems help detect early signs of spoilage, pest infestation, and environmental changes that could negatively affect grain quality. Monitoring systems can continuously track key environmental parameters and storage conditions to detect potential issues and take corrective action before significant losses occur. The choice of monitoring solution will depend on the specific needs of the storage facility and the available budget and infrastructure. Currently available monitoring solutions include wired systems, wireless Internet of Things (IoT) systems, and manual inspections. Traditional wired systems offer reliability and data security; however, wireless IoT systems provide the flexibility, scalability, and real-time monitoring capabilities needed for modern grain storage. Solar-powered silos and cooling systems can reduce energy costs and improve sustainability, especially in off-grid areas.

**The optimal monitoring system depends on the specific storage method used, the specific storage environment, the scale of operations, and the need for data accessibility and flexibility**:



a. **Silos:** Wired sensor systems are ideal for large, permanent installations where data reliability and stability are paramount, especially if the system has been installed during construction. However, wireless IoT systems are gaining more share thanks to their flexibility and ease of installation, particularly in facilities that require frequent monitoring of multiple parameters like CO2 levels.

b. **Flat warehouses:** Wireless IoT systems are the best option due to the ease of installation and flexibility in sensor placement, making them suitable for large, open spaces. Wired systems are a viable alternative in static layouts, while manual inspections can be a supplementary monitoring method.

c. **Silo bags:** Given their portable and temporary nature, wireless IoT systems are the most effective monitoring solution, offering scalability and real-time data access. Manual inspections can be used for quick checks, but wired systems are generally impractical.

d. **Hermetic storage:** Wireless IoT systems are recommended for their ability to monitor critical parameters like CO2 without compromising the airtight seal. Manual inspections are usually unnecessary, and wired systems are not always suitable.

e. **Ground storage:** Manual inspections are the most practical method for monitoring, especially in short-term or low-cost scenarios. Wireless IoT systems offer a modern alternative, especially for monitoring moisture and temperature, while wired systems are unsuitable.

**Through several recommendations, grain storage facilities can significantly reduce the risks associated with long-term storage, safeguarding the economic value of grain and food security**. The first recommendation is to adopt a hybrid monitoring approach combining wired systems with wireless IoT solutions. This hybrid approach can provide a robust and adaptable monitoring strategy, allowing facilities to leverage the reliability of wired systems while benefiting from the flexibility and scalability of wireless solutions. The second recommendation is to prioritize CO2 monitoring, which allows monitoring of CO2 in large-scale facilities or regions with high spoilage risks to ensure early detection and prevention. CO2 monitoring is particularly valuable in hermetic storage systems, where it can provide early warning of spoilage and allow for timely corrective action. The third recommendation is to leverage predictive analytics, which integrates artificial intelligence-driven predictive analytics into monitoring systems to optimize resource use and improve decision-making. Predictive analytics can identify patterns and predict potential issues before they occur, allowing for proactive rather than reactive management. The fourth recommendation is to invest in training and security to ensure that personnel can use advanced monitoring technologies and that robust security protocols can protect against data breaches. Regular training and updates on best practices in grain management can help minimize the risk of operational errors and ensure consistent quality.

**Like storage technologies, each monitoring solution has its advantages, disadvantages, and varying compatibility with different storage systems**. These factors must be considered when selecting a long-term monitoring solution, as presented in Table 18.

## THE BOTTOM LINE

One of the most practical ways to increase an SGR's attractiveness is to avoid grain loss and quality deterioration during prolonged storage through better infrastructure and technologies. Innovative technologies for managing grain storage facilities have evolved rapidly in recent years, including advanced digital solutions to monitor stocks and ensure high-quality stored grain. The various technologies and methods for stock monitoring have their advantages and disadvantages, to be considered when selecting solutions. In any case, investing in technology solutions discussed in this chapter is critical to ensure the SGR's high value for money.



TABLE 18: Review of Stock Monitoring Methods

| Storage Method | Recommended Monitoring Type | Advantages | Disadvantages | Suitability |
|---|---|---|---|---|
| Silos | **Wired Sensor Systems** | Highly reliable data transmission | High installation and maintenance costs | Best suited for large-scale, long-term storage where consistent and accurate data is critical |
| | **Wireless IoT Systems** | Flexibility and easy installation | Potential signal interference in steel silos | Suitable for dynamic or reconfigurable facilities; ideal for monitoring multiple parameters |
| | **Manual Inspections** | Direct, hands-on observation | Safety risks in confined spaces | Can complement automated systems but are not recommended as the main monitoring method |
| Flat Warehouses | **Wireless IoT Systems** | Easy deployment without extensive infrastructure changes | Battery maintenance required | Ideal for large, open spaces where flexibility in sensor placement is needed |
| | **Wired Sensor Systems** | Stable data trans-mission, especially in large facilities | Difficult and costly installation in expansive areas | Not many practical wired solutions are available |
| | **Manual Inspections** | Low cost and accessible | Labor-intensive and less effective for large areas | Suitable for smaller warehouses or as a secondary monitoring method |
| Silo Bags | **Wireless IoT Systems** | Portable and scalable monitoring | Higher upfront costs compared to manual methods | Best for temporary or short-term storage with minimal infrastructure |
| | **Manual Inspections** | Cost-effective | Limited ability to detect internal issues | Useful for quick, external checks but less effective for continuous monitoring |
| | **Wired Sensor Systems** | Reliable but impractical | Impractical due to lack of fixed structure | Not suitable due to the portable nature of silo bags |
| Hermetic Storage | **Wireless IoT Systems** | Enhanced monitoring of CO2 levels for spoilage detection | Requires robust security protocols for data protection | Excellent for high-value or long-term storage where airtight conditions are maintained |
| | **Manual Inspections** | Limited need due to sealed environment | Difficult to implement without breaking the seal | Typically unnecessary, as automated systems handle most monitoring needs |
| | **Wired Sensor Systems** | Stable monitoring but limited use | Difficult to integrate without compromising the hermetic seal | Possible, but less common due to the need for airtightness; wireless is preferred if monitoring is necessary |
| Ground Storage | **Manual Inspections** | Simple and low-cost method | High risk of missing internal spoilage | Suitable for short-term, low-cost storage; regular inspections are necessary |
| | **Wireless IoT Systems** | Easier to deploy in temporary setups | Battery life concerns, especially in harsh environments | Best suited for monitoring moisture and temperature where quick setup is required |
| | **Wired Sensor Systems** | Impractical due to lack of structure | Difficult to install and maintain in open, unstructured areas | Not recommended for ground storage due to installation challenges |

*Note:* Best options are highlighted in green.

*Source:* Authors' assessment.

# 5

# REGIONAL AND GLOBAL RESERVES

**Regional and international reserves have been proposed as tools for stabilizing food prices during spikes**. Suggestions for global reserves included international coordinated reserves, emergency reserves, and virtual reserves managed through futures and options trading[23] (von Braun *et al.* 2009; Robles and Torero 2009; Weber and Schulken 2024). Several efforts have been made to establish regional grain reserves in East Asia, South Asia, and West Africa, with the aim of allowing countries to access grains during emergencies and severe shortages. In East Asia, the ASEAN reformed its emergency rice reserves, which were established in 1979 by launching the ASEAN Plus Three Emergency Rice Reserves (APTERR) in 2011, pooling grain reserves from the ASEAN countries plus China, Japan, and Korea. In South Asia, the South Asian Association for Regional Cooperation (SAARC) launched a food bank in 1988 to support member countries during emergencies and food shortages. In West Africa, the ECOWAS, with technical support from the WFP, established the Regional Food Security Reserve (RFSR) in 2013 to address food insecurity in the region.

**In ideal settings, regional reserves can offer some advantages over country-level reserves**. The main argument for global and regional grain reserves is the potential for countries to pool resources, saving costs through economies of scale. This approach spreads the financial burden more evenly rather than having each country maintain its own SGRs. Further advantages of regional reserves include: (a) independent management, which prevents governments from using the reserves for political purposes; (b) a regional platform for collective agreements to avoid trade disruptions during major food crises; and (c) enhanced effectiveness of food security policies, particularly in regions with similar risks and porous borders, where controlling trade flows can be challenging (Porteous 2017). Regional reserves can also lead to efficiency gains. For example, it was estimated that in the late 1990s, regional stockpiles in Southern and Eastern Africa could be 41 percent smaller than the combined national stocks required if there was no cooperation (Koester 1986). More recently, the required size of the regional reserves in ECOWAS countries was estimated to be 35 percent smaller than the combined national stocks needed to provide 30 days of consumption for most vulnerable people (WFP 2011). The estimates of the optimal stocks for ECOWAS in 2016 concluded that with regional cooperation, the required stocks in a regional reserve could be 40 percent lower than without cooperation (Kornher and Kalkuhl 2016).

**The use of global or regional reserves to stabilize food prices, however, has been contentious due to the historical failures of many international reserve efforts**. Since World War II, various international programs have been devised to manage commodity prices. In 1949, the International Wheat Council negotiated a stabilization agreement among major wheat producers and consumers. Similar agreements were reached under UN auspices for commodities such as sugar, tin, coffee, cocoa, and rubber. These agreements included buffer stock operations to stabilize prices. In 1969, the International Monetary Fund created the Buffer Stock Financing Facility to assist countries with their contributions to these international buffer stock arrangements. However, historical evidence suggests that, while such agreements may offer short-term stability, they often distort markets and eventually collapse (Table 19). The Organization of the Petroleum Exporting Countries is a notable exception, yet it also faces similar challenges. The lessons

[23] The review of virtual grain stocks was beyond the scope of this report.

learned from past failures of international commodity programs are still relevant. Countries today might be tempted to form similar grain reserve agreements, but these would likely face the same issues. Global reserves encounter challenges such as coordination, setting objectives, budget sharing, currency fluctuations, cross-border stock movements, and determining triggers and release mechanisms (Wright 2009). Moreover, reducing food price volatility at the global level does not guarantee more stable food prices at the country level, as discussed in Chapter 2. This fact adds to the limitations of global reserves. The experiences of regional reserves that are still operational indicate that they face similar challenges.

TABLE 19: International Agreements to Stabilize Commodity Prices

| Commodities | Year Initiated | Year of Collapse | Nature and Impact of Agreement | Mechanism (Members) |
|---|---|---|---|---|
| **Wheat** | 1949 | 1971 | **International Wheat Agreement:** Failed to stabilize prices and collapsed shortly before the 1970s price boom. | Export and import quotas (5 exporters and 36 importers) |
| **Sugar** | 1953 | 1984 | **International Sugar Agreement:** Failed to stabilize prices despite being renewed three times. | Export and import quotas (26 exporters and 18 importers) |
| **Tin** | 1954 | 1985 | **International Tin Agreement:** Raised and stabilized prices, but new entrants and substitution by aluminum led to its insolvency. | Buffer stocks and export quotas (7 exporters and 18 importers) |
| **Coffee** | 1962 | 1989 | **International Coffee Agreement:** Raised prices, but disagreements among members resulted in its termination. | Export quotas (42 exporters and 7 importers) |
| **Cocoa** | 1964 | 1965 | **International Cocoa Agreement:** Lasted only one year due to a bumper crop. | Export quotas (6 exporters) |
| **Cocoa** | 1972 | 1993 | **International Cocoa Agreement:** Limited impact on prices despite being extended four times. | Buffer stocks and export quotas (9 exporters and 35 importers) |
| **Rubber** | 1979 | 1999 | **International Natural Rubber Agreement:** Failed to stabilize prices and collapsed during the East Asian Financial crisis. | Buffer stocks (13 exporters and 49 importers) |

*Source:* Baffes, Nagle, and Streifel 2024.



**While East Asia has seen the most notable effort to establish regional rice reserves, the use of ASEAN reserves during emergencies remains modest**. Established in 1979 with 87,000 tons from voluntary commitments, the ASEAN Emergency Rice Reserve provided limited support due to complex procedures and small stockpiles (Shepherd 2011; Dano and Peria 2006). In response to the 2008–09 global price spikes, ASEAN reformed the reserve with technical assistance from the Asian Development Bank, and added Japan, China, and South Korea. The aforementioned APTERR now maintains an earmarked emergency rice reserve of 800,000 tons (700,000 tons from China, Japan, and Korea) for crises. While the use of the reserve for market intervention was discussed initially, APTERR primarily focuses on humanitarian food relief during emergencies rather than market intervention (Briones 2011). The reserve operates through three programs: Tier 1 – special commercial contracts or sales; Tier 2 – emergency grants and loans; and Tier 3 – donated rice delivery during emergencies (Belesky 2014; Kim and Plaza 2018).

**Despite the growing frequency of disasters and uncertainties in food production, APTERR's reserve usage has remained limited**. Over the past 12 years, member countries have withdrawn only 38,000 tons of rice under APTERR's Tier 3 program to support people affected by emergencies, especially in the Philippines, Viet Nam, and Myanmar (APTERR Secretariat 2021). Notably, in response to the COVID-19 pandemic, 2,130 tons of rice were delivered to Cambodia, Myanmar, and the Philippines. A lack of clarity in defining emergency conditions and the consensus-based decision-making process have hindered the wider use of APTERR during emergency responses (Kim 2021). Concerns about the timeliness and speed of response for Tier 3 releases following a disaster remain high (ADBI 2018). For example, after Super Typhoon Bopha in 2013, it took up to 18 months to fulfill the Philippines' request for support. However, APTERR has played an important role in providing technical support to member countries regarding food security. Established in 2016, the Food Emergency Monitoring and Information System is a critical decision-support tool that offers detailed information on food security, and rice supply and demand. Publications such as the Weekly Update and Quarterly and Annual Reports provide insights into rice supply, price trends, and disaster impacts, enabling rapid response and informed strategies.

**In South Asia, the SAARC Food Security Reserve has faced numerous operational challenges and, in its current form, remains largely ineffective.** SAARC was established in 1988 to create a reserve of food grains for member countries during food emergencies. The reserve held 241,580 tons by 2002 and was managed by the SAARC Food Security Reserve Board. However, procedural issues and other challenges prevented member countries from accessing these food stocks (SAARC Secretariat 2024).[24] The reserve's lack of utilization has been a persistent concern for the Association. For instance, during Bangladesh's severe food grain shortage from 1997 to 1998, the country could not access the reserve due to these procedural hurdles. Despite various attempts to resolve these issues and even relaunching the SAARC Food Bank in 2013, the reserve remained largely ineffective. It was not until May 2020 that Bhutan utilized food grains from the SAARC Food Bank Reserve in India, marking the first successful use of the reserve since its

[24] For further information, see https://www.saarc-sec.org/index.php/areas-of-cooperation/agriculture-rural-development

inception in the late 1980s. However, no other countries could use the reserve to address the food emergencies following the COVID-19 pandemic.

**Similar efforts to use regional stocks for emergencies have been undertaken in West Africa**. With assistance from the WFP, ECOWAS designed the RFSR, a targeted and cost-effective emergency food reserve system. This system includes small, regionally prepositioned stocks that are organized and operated with the active participation of the involved countries and regions (WFP 2011). The RFSR comprises the 15 ECOWAS member countries, as well as Chad and Mauritania, due to their membership in other regional bodies. The RFSR is based on the West Africa Regional Storage Strategy of 2012 and collaborates with national SGR agencies to integrate local and national storage systems. The World Bank and other donors provide support to the management of these reserves.

**The RFSR is part of a broader food security framework in West Africa that includes safety nets, early warning systems, market monitoring, and crisis response plans**. In response to a food crisis, the reserve is activated upon request from an ECOWAS member, aiming to approve and deliver food within 45 days. Stock deployments are triggered based on four criteria: (a) beneficiaries are in IPC Phase 3 or higher on the 'Cadre Harmonisé' scale; (b) local and national stocks cover less than 66 percent of the need; (c) a national crisis response plan is in place, and (d) there is a commitment to replenish the stock. Once these criteria are met, the RFSR releases stocks to the designated national counterparty without engaging in beneficiary targeting or distribution. Additionally, the RFSR provides technical assistance, develops national storage policies, harmonizes procedures, and offers extensive training and capacity building.

**Despite having a well-designed technical strategy, effectively implementing RFSR has been challenging**. Issues include recent political changes in Sahelian countries, failure to meet stock targets, limited stock deployment, restricted cross-border mobility, and unmet replenishment commitments. The RFSR's physical stock holdings have reached a maximum of 27,000 tons, falling short of the target of 60,000 tons for the first four years. In fact, stock holdings have often been less than 45 percent of the target, dropping to 18 percent in 2023 (Table 20 and 21). The target has since been increased to 100,000 tons for Years 5–7 and 140,000 tons from Year 8 onward. However, the scale of food insecurity in West Africa has dramatically increased since these targets were set in 2012–13. The failure to meet targets is due to difficulties in meeting country-level commitments, over-reliance on donors, and the inability to replenish stocks due to recurring food crises. As of 2023, the RFSR had deployed a total of 54,563 tons of stock to five countries[25] in 14 deployments over seven years.

TABLE 20: RFSR Stock Targets, Tons

| | Years 1–4 | Years 5–7 | Year 8 Onward |
|---|---|---|---|
| Physical Stock | 60,000 | 100,000 | 140,000 |
| Financial Reserve | 116,380 | 193,967 | 271,554 |
| Total Reserve | 176,380 | 293,967 | 411,554 |
| National Reserves | 360,464 | 600,774 | 841,083 |
| **Total Stocks** | **536,824** | **894,741** | **1,252,637** |

*Source:* Authors' assessment.

[25] These are Burkina Faso, Ghana, Mali, Niger and Nigeria.



TABLE 21: RFSR Stocking Over Time, Tons

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|
| Total Stock | 11,179 | 22,394 | 16,611 | 13,192 | 27,144 | 19,268 | 10,720 |
| Deployment | 1,130 | 13,581 | 7,856 | 5,529 | 14,971 | 8,425 | 2,178 |
| Final Stock | 10,049 | 8,913 | 8,755 | 7,663 | 12,173 | 10,843 | 8,542 |
| Stock Awaiting Replenishment | 1,130 | 14,711 | 22,567 | 24,516 | 23,836 | 25,968 | 28,146 |
| *Final stock/60,000 MT Target (%)* | *17* | *15* | *15* | *13* | *20* | *18* | *14* |

*Source:* Authors' assessment.

**Despite the original intentions, the RFSR has shown limited regional cooperation**. Initially, the idea was for national SGRs to allocate 5 percent of their stock for regional solidarity purposes, but this target has not been met. The regional aspects of the RFSR include budget allocations by regional organizations like ECOWAS and the West African Economic and Monetary Union, as well as the European Union, and the sharing of public stock information among countries. However, the movement of goods between countries has been limited during procurement and release processes that aim to aid food-insecure populations where needed. Since 2020, cross-border transportation of goods for RFSR stock deployment has only occurred five times.[26] To strengthen the RFSR, it must expand storage capacity, enable real-time stock reporting, hold countries accountable, and integrate disaster risk finance tools.

## THE BOTTOM LINE

Historically, international price stabilization schemes through agricultural commodity agreements have proven ineffective; there is no reason to assume that international grain reserves could succeed in the near future. The performance of regional reserves has been below expectations, even though regional reserves could, in theory, complement country-level SGRs. While there is potential, regional reserve efforts have been hampered by coordination challenges and trust issues among participating countries. Lessons from existing regional reserves underscore the need for more robust coordination and agreements that consider the diverse crisis contexts and socio-economic factors. Stronger regional cooperation can generate benefits related to early warning and information sharing, technical trainings, and other capacity building on public stock management. Still, regional reserves are unlikely to replace country-level SGRs.

[26] According to the RFSR Technical Division, cross-border stock transfers included 205 tons of enriched flour from Togo to Niger in 2020; 2,000 tons of cereals from Nigeria to Niger, 1,000 tons from Togo to Niger, and 177.5 tons from Ghana to Burkina Faso in 2022; and 8,313 tons of cereals from Burkina Faso to Ghana in 2024.

# 6

# GUIDING PRINCIPLES FOR SGRS

**SGRs can help improve food security as a risk management tool and are most effective when integrated with broader food security strategies, where trade, private storage, and safety nets play important roles**. Climate change, conflicts, and economic shocks are likely to continue bringing uncertainty, supply disruptions, and price volatility to global and local food markets, contributing to food insecurity. These challenges have exposed vulnerabilities in existing food security strategies, prompting the necessity for SGRs, where relevant, to play a role in reducing food security risks. Despite frequent spikes in global food prices in the last two decades, long-term factors continue to dominate global food price changes, which SGRs cannot revert. The report highlights that SGRs, as a food security intervention, are particularly effective in the short run, addressing local food supply shocks and providing a critical buffer against sudden supply disruptions, particularly in vulnerable and isolated regions, by ensuring an adequate food supply during emergencies and bridging the time needed for food imports.

**Implementing SGRs, however, demands careful consideration of fiscal constraints and market distortions, especially in developing countries with limited resources and high import dependency**. The report uses country examples to highlight best practices and potential pitfalls, deriving guiding principles for SGR management. The design of details will vary from country to country, with stocks playing a larger role in net food-importing nations. SGRs are not a one-size-fits-all solution, and each country's situation is unique, necessitating tailored analyses. This global report, therefore, does not provide country-specific recommendations and has not analyzed trade-offs among various food crisis response instruments using country typologies, leaving these analyses to country-specific studies. This report provides guiding principles for policymakers and development practitioners to design and manage SGRs effectively, based on good practices, enhancing food security without undermining it.

**Country-level SGRs are the likeliest to succeed. International price stabilization schemes for agricultural commodities have historically failed, and there is no reason to assume that international grain reserves could succeed in the near future**. Regional reserves, despite their potential, face coordination challenges and trust issues among participating countries. Lessons from existing regional reserves underscore the need for more robust coordination and agreements, considering the diverse crisis contexts and socio-economic factors. Stronger regional cooperation can generate benefits related to early warning and information sharing as well as technical trainings and other capacity building on public stock management. Still, regional reserves are unlikely to replace the country-level SGRs.

**The list of guiding principles for managing public stocks is demanding but essential for ensuring high value for money and associated improvements in food security outcomes**. There are numerous causes of SGR failure, including lack of clarity of objectives, high fiscal costs, and the crowding out of private storage and trade, in addition to other market distortions. These need to be carefully considered by countries to be able to use SGRs effectively. SGRs could be difficult to manage efficiently, especially in countries with weak public institutions or FCV countries. To maximize their impact, SGRs should be small, simple, and smart, focusing on cost-effective and efficient management to complement other food security efforts.

The following guiding principles are critical in this respect:

- **Ensuring good governance, transparency, and communication:** Transparency and clear communication are essential for SGRs, with objectives, stock size, procurement, and release decisions to be based on market principles and limited public interventions. The institutional setup for managing SGRs can vary, with public stocks being common, but private-public partnerships can also be effective if release decisions remain a public responsibility. Clear criteria help ensure that SGRs serve their intended purpose without distorting market signals. Changes in operation and management decisions need to be timely and clearly explained to market participants to avoid overreactions by market participants.
- **Avoiding multiplicity and unclear SGR objectives:** SGRs' success hinges on having clear and well-defined objectives. Too many or conflicting objectives can undermine the reserve's ability to improve food security, with many public stock initiatives failing for these reasons. Therefore, setting strategic goals, adhering to them, and communicating clearly with market participants is essential.
- **Keeping SGRs' fiscal costs manageable:** SGRs are inherently costly, particularly due to the uncertainty of emergencies, and the fiscal costs of maintaining very large SGRs are often unsustainable. To reduce fiscal costs, it is advisable to maintain relatively small reserves, optimize the timing of stock replenishment, procure and release stocks at market prices, and reduce the costs of financing, storage, transportation, and distribution. The public funds spent on SGRs should not be excessively diverted from other critical agriculture and food security investments.
- **Determining an effective size for SGRs:** The size of stocks should carefully balance fiscal cost and effectiveness. High stock levels can be costly and disrupt private trade, while low levels may fail to cover food supply shocks. When deciding about the size of public stocks, analyze the size of private stocks and what can be done to incentivize the private sector to increase them. For more accurate calculations, adjust thresholds over time and account for the trade environment and likelihood of shocks.
- **Reducing price distortions and other economic costs:** To minimize price distortion, SGRs should focus on mitigating food supply disruptions and providing relief during crises rather than aiming to generate profits or stabilize prices. SGRs should act as a last-resort safety net in emergencies, intervening only when necessary to alleviate temporary supply constraints without distorting overall market dynamics. For instance, releasing grain from SGRs at market prices at times of temporary import delays can be effective. Governments should also avoid using SGRs to combat the impact of global prices on local prices, as intervening in broader market pressures is usually futile. By adhering to these principles, SGRs can maintain compatibility with liberalized grain markets and avoid large-scale interventions while providing a pragmatic response to supply disruptions.
- **Reducing the cost of SGR replenishment:** To minimize fiscal costs and market disruptions, having clear and transparent replenishment rules for SGRs is crucial. Effective strategies should include transparent procurement methods at market prices, appropriate timing and locations for purchases, and efficient storage and transportation. Acquiring stocks at market prices through open tenders ensures competitive pricing and involves private traders, which benefits farmers. However, two exceptions may be considered for their potential developmental benefits, even if they increase the direct cost of procurement: (a) where possible, integrating smallholder farmers into the SGR's procurement mechanisms can support local economies and smallholder commercialization; and (b) where relevant, prioritizing procurement from regions with limited presence of private traders can limit crowding out the private sector and benefit farmers in the region. In countries with large import volumes to replenish public stocks, such as those in the MENA region, large budget savings could be achieved by procuring wheat through open tenders and increasing tender efficiency. Choosing slightly lower wheat protein content, increasing the average size of tender, paying on time, reducing the urgency of wheat delivery, and ensuring competition among sellers all could help reduce the cost of grain procurement, saving billions of valuable public funds.
- **Improving outcomes of stock release:** Where markets function, stocks should be released through market channels, including auctions and commodity exchanges. Auctions are effective in urban areas with strong markets, rapidly increasing food availability during price surges. Commodity exchanges also enhance market functionality and are recommended for price transparency and stock rotations.
- **Integrating SGRs into social safety net programs:** In countries with weak marketing systems, targeted distributions via safety nets, such as food-for-work programs and school meals, would still be necessary. Effective integration of stock releases with safety net programs, in this case, would ensure that vulnerable populations included in safety nets receive necessary food supplies during emergencies. Yet, because safety net support and emergency food assistance are given as grants, fiscal and other costs could quickly escalate unless kept targeted and small-scale.
- **Pursuing complementary trade policies:** Even amid heightened geopolitical tensions and climate change, food importers must continue trading to receive timely food supplies. Aligning SGRs with trade policies would enhance the effect of SGR releases. Reducing trade protection levels, eliminating barriers for the private sector to import grains, and improving information systems and trade infrastructure can all help lower domestic food price volatility and levels.
- **Investing in infrastructure, storage technology solutions and innovations:** Investing in modern grain storage solutions and innovations such as silos, flat warehouses, and advanced digital monitoring technologies can further lower the cost of managing SGRs by reducing grain losses and maintaining FSQ. Rapidly developing technologies help detect early spoilage and pest infestations, thereby preserving the economic value of reserves. However, selecting the right technology requires careful consideration of each method's advantages and disadvantages within specific country contexts.

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