



ENDING HUNGER IS POSSIBLE:

An income-generating approach
through value addition

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Vienna
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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION
Progress by innovation



Food and Agriculture
Organization of the
United Nations

ABBREVIATIONS

FLAPP	Food Loss App
GHG	greenhouse gas
GIRSAL	Ghana Incentive-based Risk-sharing System for Agricultural Lending
ICT	information and communications technology
IFRS	International Financial Reporting Standards
ILO	International Labour Organization
IMF	International Monetary Fund
FAO	Food and Agriculture Organization of the United Nations
ODA	official direct assistance
PSL	priority sector lending
PSNP	Productive Safety Net Programme (Ethiopia)
R&D	research and development
REIT	real estate investment trust
SDG	Sustainable Development Goal
SME	small and medium-sized enterprise
STEM	science, technology, engineering and mathematics
UNIDO	United Nations Industrial Development Organization
WFP	World Food Programme

CONTENTS

Abbreviations	ii
Foreword	vii
Acknowledgements	viii
Executive summary	ix
1 Introduction	1
2 Food insecurity and malnutrition in an era of risks and uncertainties	2
2.1 Hunger in numbers	2
2.2 Poverty, rising inequalities and persistent food price inflation	4
2.3 The major drivers of hunger and malnutrition: climate change, economic shocks, conflict and geopolitical instability	6
3 Structural challenges in agrifood systems: The problems	9
3.1 Slowdown in agricultural productivity and supply chain vulnerabilities – limited mechanization and labour shortages	9
3.2 Lack of agrifood processing, distribution and retail: value added industries and skilled labour	11
3.3 Lack of access to finance for the “missing middle”: small-scale producers and agrifood small and medium-sized enterprises	11
3.4 Poor quality and inadequate infrastructure for irrigation, roads, storage and electricity	14
3.5 Weak trade, regional integration and highly concentrated markets dominated by a few lead firms	15
4 An income-generating approach to end hunger and malnutrition: The solutions	18
4.1 Improvements in productivity through agricultural research and development, extension services and farm mechanisation	18
4.2 Value addition and income-generation through agrifood processing and improved skills	22
4.3 Financing the “missing middle”: small-scale producers and agrifood small and medium-sized enterprises	29
4.4 Investment to build and maintain infrastructure for irrigation, roads, storage and electricity	37
4.5 Trade and competition policy, and regional integration	39
4.6 Accelerating income generation through social protection programmes	40
5 Ending hunger and malnutrition: What would it cost?	42
5.1 Estimates of the cost of ending hunger	42
5.2 The cost of inaction	43

5.3	The hidden costs of the agrifood system	44
5.4	Financing the investment gap	44
5.5	The growing humanitarian finance and the need to balance better with long-term development finance	45

6 From recommendations to action **49**

References **51**

FIGURES

Figure 1	Prevalence of undernourishment and acute food insecurity, 2017–2023	3
Figure 2	Prevalence of poverty in the global population compared to income inequality, measured by Gini index, 2003–2022	4
Figure 3	Prevalence of undernourishment for countries with high inequality compared to countries not affected by a major driver of food insecurity and malnutrition, 2013–2023	5
Figure 4	The average prevalence of undernourishment in countries affected by one of the major drivers of food insecurity and malnutrition in 2023	6
Figure 5	Number of recorded natural disaster events, 1900–2023	8
Figure 6	Acute food insecurity driven by weather extremes	8
Figure 7	Total factor productivity evolution in agriculture, 1990–2021	9
Figure 8	Volume of lending by the Council on Smallholder Agricultural Finance (CSAF) by value chain, 2014–2023	12
Figure 9	Supply of financing provided by domestic and regional lenders to agrifood small and medium-sized enterprises in developing countries compared to need, 2022	13
Figure 10	Breakdown of agriculture deals by sub-sector, 2021–2023	13
Figure 11	Food loss from post-harvest to distribution in 2021	14
Figure 12	Price at point of harvest in Zambia, compared with prices at point of sale in Kenya and the United Republic of Tanzania	16
Figure 13	Scope of the Food Loss and Food Waste Index along the supply chain	24
Figure 14	The Food Securities Fund model	31
Figure 15	The Farmfit Fund structure	32
Figure 16	Roots of Impact and Root Capital’s Social Impact Incentives lending model	33
Figure 17	Innovative outcomes-based financing model	34
Figure 18	Cost to end hunger by 2030	42
Figure 19	Additional cost of ending hunger and malnutrition by 2030 according to various modelling exercises	43
Figure 20	G7 official development assistance (ODA) for food security and nutrition as a percentage of all ODA, 2015–2022	45
Figure 21	G7 official development assistance for food security and nutrition compared to emergency food assistance, 2015–2022	46
Figure 22	Evolution of World Food Programme requests for aid, compared with acute and chronic food insecurity, 2017–2023	46

TABLE

Table 1	Effect of cold storage on the perishability of vegetables and fruits in the Sudan	25
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BOXES

Box 1	Resilience of agropastoral populations in Eastern Sudan	18
Box 2	Ethiopia's Integrated Agro-Industrial Parks development	22
Box 3	The Food Loss App	24
Box 4	The Cambodia Programme for Sustainable and Inclusive Growth in the Fisheries Sector: Capture component	28
Box 5	Sustainable pineapple value chain development in Suriname	30
Box 6	Food Securities Fund	31
Box 7	IDH Farmfit Fund	32
Box 8	Roots of Impact	33
Box 9	Innovative approaches to reducing post-harvest losses	38

FOREWORD

The world is not on track in its fight against hunger. Despite promising progress until 2015 and our collective efforts, we have fallen behind on our commitment to end hunger worldwide by 2030. The COVID-19 pandemic, conflicts, and the impacts of climate change have worsened existing challenges, pushing millions more into food insecurity. But a world without hunger is possible! We have the knowledge and the technology, and the financial resources are there; it is merely a question of political will and targeted investments.

Today, 733 million people faced hunger; or one in 11 people in the world. Africa continues to have the highest levels of hunger, with 20 percent of its population affected, compared to 8 percent in Asia and 6 percent in Latin America.

Looking forward to 2030, without additional efforts, 582 million people are expected to be hungry, half of whom will be in Africa. This is approximately 130 million more people than was projected prior to the COVID-19 pandemic. This is unacceptable!

With every year that goes by, the effort and cost required to achieve SDG 2 – Ending Hunger – increases exponentially. In 2020, researchers estimated that it would cost an additional USD 330 billion to end hunger by 2030 in the *Ceres2030: Sustainable Solutions to End Hunger* report. Today, they find that eradicating hunger in this same timeframe would cost an additional USD 540 billion. The lack of sufficient investment during the last four years has thus added an extra cost of USD 210 billion to end hunger by 2030. We can and must do better.

This report, *Ending hunger is possible*, comes at a crucial time. It offers a fresh perspective on how we can offer effective long-term solutions to this global crisis which must be on the top of the global agenda. The approach outlined here focuses on generating income for those affected by hunger and poverty, through local value addition in the agrifood sector. Here we present a value addition strategy that offers a resilient, sustainable, and lasting solution to end hunger: Increasing productivity, expanding food production and processing locally where food is needed the most, and thereby providing the poorest populations the means to buy food. The report highlights six key solutions:

1. Improving on-farm productivity through agricultural research and development (R&D), extension services, mechanisation, and technology adoption.

2. Investing in critical infrastructure for irrigation, electricity, rural roads, and storage.
3. Promoting agrifood processing, particularly by small and medium enterprises (SMEs) in domestic and regional markets.
4. Increasing access to finance for small-scale producers and agrifood SMEs.
5. Leveraging effects of social protection programmes, such as improving access to education and empowering women, but also to reduce risk and build confidence of financial institutions in the human and financial capital of the most vulnerable.
6. Implementing better trade and competition policies alongside stronger regional integration.

I am proud of the work the United Nations Industrial Development Organization (UNIDO) is already doing in these areas, from increasing access to finance and markets for small-scale producers and SMEs through the joint UNIDO–FAO Agrifood Systems Transformation Accelerator (ASTA) programme, to projects supporting cold storage in fishing value chains, and the development of integrated agro-industrial parks.

This report is a call to action for governments, international organizations, the private sector, and civil society to work together in new and innovative ways. Above all, the countries of the industrialized world must follow through on their obligation and agreed commitments to support ending hunger globally. With global solidarity, we can create a world where no one goes hungry. I invite you to join us in this most important task. Together, we can build a world where hunger is a thing of the past and no one is left behind.



A handwritten signature in blue ink that reads "Gerd Müller". The signature is written in a cursive, flowing style.

Gerd Müller
UNIDO Director General

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The publication was carried out under the direction of David Laborde, Director of the Agrifood Economics and Policy Division (ESA) of FAO and Carin Smaller, Executive Director of the Shamba Centre for Food & Climate, and the overall guidance of Máximo Torero Cullen, FAO Chief Economist. The writing team includes Mali Eber Rose, Research and Policy Analyst, Shamba Centre for Food & Climate; Oshani Perera, Director of Programmes, Shamba Centre for Food & Climate; Kamal El Harty, Advisor on Sustainable Finance, Shamba Centre for Food & Climate; Lysiane Lefebvre, Senior Policy Advisor, Shamba Centre for Food & Climate; Luciana Delgado, Technical Adviser, ESA, FAO; and Elsa Olivetti, Research Analyst, ESA, FAO.

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About Hesat2030: Ending Hunger Sustainably, Nutritiously, and Equitably

Hesat2030: Ending Hunger Sustainably, Nutritiously, and Equitably, is a joint project of FAO, Centre for Agriculture and Biosciences International (CABI), and the Shamba Centre for Food & Climate. The project leverages evidence-based research, innovative technologies and coordinated action to provide donor agencies and policymakers with the resources and tools necessary to make informed and scientifically based decisions. The project partners committed to catalysing transformative change in global policies, programs and investments to end hunger while protecting the climate, improving nutrition, empowering women and advancing the well-being of the poorest and most vulnerable communities.

Hesat2030 builds upon the foundation of Ceres2030: Sustainable Solutions to End Hunger. Ceres2030 focused on how international donors can effectively and efficiently end hunger, double the incomes and productivity of small-scale producers, while protecting the climate. In Hesat2030, the research question has been expanded to include the current challenges of climate change adaptation, malnutrition, and gender inequalities. The research tools have been updated to benefit from the recent advances in data mining and machine learning.

EXECUTIVE SUMMARY

The development community has not delivered on the goal that it set in 2015 to end hunger by 2030. Today, 733 million people face hunger; or one in 11 people in the world (FAO *et al.*, 2024). If we continue with business as usual, by 2030, hunger will be higher than it was in 2015 when the world committed to eradicating it under United Nations 2030 Agenda for Sustainable Development. According to current projections, we will barely reach pre-COVID-19 hunger levels by 2030, let alone achieve any progress, despite economic recovery in many countries.

Today, it would cost an additional USD 540 billion to end hunger by 2030, largely through social protection programmes (von Braun *et al.*, 2024). In 2020, it was estimated that it would cost an additional USD 330 billion to end hunger by 2030 (Laborde, Smaller and Parent, 2020). The lack of investment during the last four years contributed to this additional cost of USD 210 billion to end hunger by 2030.

Recent global shocks and more immediate drivers of hunger and malnutrition have also intensified underlying structural challenges, making the hunger crisis worse. Driving the rise in hunger are economic shocks and downturns, conflicts, and climate variability and extremes. Economic vulnerabilities are exacerbated by high dependency on food imports making countries particularly susceptible to global price fluctuations. Additionally, climate variability and extremes, such as the record-breaking temperatures and severe flooding in 2023, have significantly impacted food production and availability, further deepening the food crises in affected regions (FAO *et al.*, 2024).

It did not have to be this way. The shocks of the past decade did not need to lead to the current hunger crisis. If the public and private sectors had responded differently, if the development community had committed the additional resources needed, and if global solidarity had been stronger, the hunger crisis could have been averted.

A world without hunger is possible. The world continues to produce more food per inhabitant every year. The problem is not the lack of food at the global scale, but the discrepancies between where it is produced, and where it is consumed, and the lack of economic means for vulnerable population to buy it. We know how to end hunger, and we know how much additional money is needed. One simple way is to give people money,

through cash transfers; the most common type of social protection programme. If we end hunger this way, it will cost an extra USD 540 billion to end hunger by 2030, with nearly half associated with large and recurrent payments every year, making this option not fiscally sustainable for most countries and partners.

Another way to end hunger is through income-generation, especially among the agrifood systems.

This is the focus of this report. An income-generating approach, based on growth in productivity and incomes for the poorest and most vulnerable through value addition, is the most resilient, sustainable and lasting way end to end hunger (UNIDO, 2023a, 2023b): it combines expanding food production and providing the economic means for population to buy food; this is the most effective way to redistribute production and consumption to where it is needed most.

For value addition to play its vital role towards increasing food security and ending hunger, a number of intervention areas are highlighted below.

First, additional investments are needed to improve productivity and incomes on the farm through agricultural research and development (R&D), extension services, farm mechanization and technology adoption such as information and communications technologies (ICTs). Second, there is also still a significant need for investment to build and maintain infrastructure for irrigation, electricity, rural roads, and storage to reduce post-harvest losses.

Less well explored is how to generate income for people affected by hunger and poverty through value addition in agrifood processing, distribution and retail.

The most effective investments are in agrifood processing, particularly by small and medium-sized enterprises (SMEs) in domestic and regional markets. Agrifood processing can expand opportunities for producers, enhance food security, and facilitate the development and transformation of the food system at large. More specifically, it can reduce post-harvest losses for more nutritious foods through better handling practices, improved packaging and cold storage. This can simultaneously improve food safety through measures such as basic food preservation methods (e.g. drying and fermentation), or advanced industrial processes (e.g. pasteurization and food fortification). To complement these investments and meet the labour demands of the food processing sector, there is a need for more vocational training and increased academic

enrolment in science, technology, engineering and mathematics (STEM).

None of these investments, and technology adoption, is possible without innovative and equitable solutions to scale up finance. One of the biggest challenges in the agrifood sector is access to finance, particularly for the “missing middle”: small-scale producers and agrifood SMEs looking for loans of between USD 25 000 and USD 2 million. These actors can support the productivity and income growth needed to end hunger and poverty. Several innovative solutions that emphasize the value of relationships and trust between farmers, SMEs and their buyers, traders and wholesalers are: (i) factoring; (ii) supply chain finance or reverse factoring; (iii) outcome financing; (iv) real estate investment trusts; (v) priority sector lending (PSL); (vi) asset monetization; and (vii) guarantees. Critical to all seven solutions is the need for increased participation by domestic governments and investors.

But how to reduce risk and create confidence in the human and financial capital of the poor and hungry?

Here, social protection programmes can play a transformative role: not just as a tool to give people money, but also to give people insurance, and to give lenders confidence, backed by government-financed programmes. The role of social protection programmes, particularly cash plus programmes, which combine cash transfers with economic interventions, such as road building or improved farming techniques. For banks or other financial institutions, the regular flow of cash, could act as an insurance policy and an incentive to an otherwise risky client.

Finally, **better trade and competition policy, combined with stronger regional integration** are essential to ensure that the additional income generated benefits small-scale producers and agrifood SMEs. This includes reforming harmful trade policies, trade facilitation, and better enforcement of competition law and policy by regulators.

Many of these priorities are essentials for the Food and Agriculture Organization of the United Nations (FAO) and United Nations Industrial Development Organization (UNIDO). For example, the joint FAO and UNIDO Agrifood Systems Transformation Accelerator (ASTA) programme working in eight countries to improve access to finance and markets for the missing middle. The Food Loss App, developed by FAO, is an innovative technological advancement in the fight against food loss. The UNIDO CAPFISH-Capture project in Cambodia generates additional income for fishery processors and SMEs by investing in fishery value chains, through

innovative blended finance mechanism including grants, guaranteed loans and enterprises' own investment. The joint UNIDO-International Trade Centre Trade, Competitiveness and Market Access Programme (TCMAP) builds trade and productive capacities, and promotes intra-African trade aligning closely with the Regional Economic Communities' regional integration agendas and the African Continental Free Trade Area (AfCFTA). UNIDO is also supporting the development of rural infrastructure through integrated agro-industrial parks, such as in Ethiopia.

Only through an integrated, properly sequenced and well-financed approach will it be possible to eliminate hunger. The income-generating approach can only be achieved if the different interventions mentioned above are all financed and deployed through coordinated international efforts.

1 INTRODUCTION

In 2023, 152 million more people were undernourished than five years prior (FAO *et al.*, 2024). This is not a problem caused by a lack of global supply, but rather, by uneven productivity growth across the globe and a series of shocks that have disrupted national and international food supply chains. Structural challenges such as the slowdown of agricultural productivity and rising inequalities combined with disruptors such as economic slowdowns, climate change, weather extremes, and conflict have led to uneven food availability and access in a world of plentiful food supply. Exacerbated by two major shocks – the COVID-19 pandemic and the war in Ukraine – 15 years of progress in reducing hunger worldwide have been wiped out.

With passing every year, the efforts and costs required to achieve Sustainable Development Goal (SDG) 2, Zero Hunger, increase exponentially, making the likelihood of eradicating hunger by 2030 an ever-distant reality. Current projections show that 582 million people will be affected by hunger in 2030. This is an increase of approximately 130 million people compared to pre-pandemic projections (FAO *et al.*, 2024). Eradicating hunger by 2030 would cost an additional USD 540 billion compared to the current level of spending, largely (45 percent) through social protection programmes (von Braun *et al.*, 2024). In 2020, it was estimated that it would cost an additional USD 330 billion to end hunger by 2030 (Laborde, Smaller and Parent, 2020). The lack of investment during the last four years contributes to this additional cost of USD 210 billion to end hunger by 2030.

The escalating costs of ending hunger underscore the urgent need for immediate and decisive action. And we must do it in a world where the commitments from high-income countries to poorer ones have not been delivered, trust is fragile, and development cooperation still too one-sided, where a few donors tend to dictate to the global majority what needs to be done. True partnerships have to be driven by the needs of the beneficiaries.

Historically, many lower- and middle-income countries have experienced remarkable progress in transforming agrifood systems over the past five decades, combined with sharp declines in hunger and poverty. However, progress has been uneven across regions and countries. Africa is the region with the highest prevalence of hunger and malnutrition in the world and the greatest need to accelerate the transformation of the agrifood systems to end hunger and poverty.

The most expensive way to end hunger is through social protection programmes such as cash transfers. Another way is through job creation and income-generation. The two approaches are not mutually exclusive. But an income-generating approach to ending hunger can simultaneously enable productive investments in agrifood systems and facilitate a redistribution of production and consumption to where it is needed most. It will also accelerate the adoption of new and cleaner technologies, aimed to increase productivity sustainably. Addressing the imbalances of the system while ensuring that the world is free of hunger in an economically, socially and environmentally sustainable way is at the core of the global challenges faced by agrifood systems, as per the FAO Roadmap to achieve the SDG 2 without breaching the 1.5 °C threshold (FAO, 2023).

There are interventions that are known to work best, such as agricultural research and development (R&D), extension services and farm mechanization. We also know that incomes and productivity do not grow without adequate infrastructure for irrigation, roads, storage and electricity. Less is known about how to generate income through value addition in agrifood processing, distribution and retail.

This report identifies effective interventions to support the agro-industrialization process, emphasising the critical role of skilled labour to meet the demands of an industrial sector. The biggest challenge to achieving this agenda is access to finance, particularly for the “missing middle” – small-scale producers and agrifood SMEs looking for loans or collaterals. Here is where social protection programmes can support the income-generating approach. Cash plus programmes have a strong body of evidence supporting their impact on income (Wouterse and Taffesse, 2018). They provide regular cash transfers in combination with economic programmes to boost growth and production, particularly to increase the productivity and build infrastructure. The Productive Safety Net Programme (PSNP) of the Ethiopian Government is one of the most successful interventions to date (Wouterse and Taffesse, 2018). Finally, trade and competition policy, together with stronger regional integration are essential to ensure that the benefits of growth are equitably distributed to those who need it most.

2 FOOD INSECURITY AND MALNUTRITION IN AN ERA OF RISKS AND UNCERTAINTIES

2.1 HUNGER IN NUMBERS

Despite important international efforts, the world remains significantly off-track in ending hunger by 2030. The biggest setback on hunger and poverty in the past few years has been from the impacts of the COVID-19 pandemic, exacerbated by the war in Ukraine, hostilities in Gaza and conflicts in Ethiopia, the Sudan, Syria, Yemen and the Sahel region. At the current trajectory, hunger levels in 2030 would be higher than it was in 2015 when the world committed to SDG 2 to eliminate hunger by 2030.

Today, 733 million people face hunger, or one in 11 people in the world (FAO *et al.*, 2024). The level of undernourishment has persisted at the same level for the past three years. In 2019, 7.5 percent of the population was undernourished. By 2023, it increased to 9.1 percent, i.e. by 152 million people who faced hunger (FAO *et al.*, 2024).

Looking forward to 2030, without additional efforts, 582 million people are expected to be hungry, half of whom will be in Africa. This is approximately 130 million more people than was projected prior to the COVID-19 pandemic. Although this is a decrease in the absolute number of people that will be affected by hunger between 2023 and 2030, this projection reflects the same level of hunger as in 2019 (FAO *et al.*, 2024).

Regional disparities in hunger

When observing global numbers, the varying dynamics of hunger and food insecurity across different regions and countries are hidden. Africa continues to experience the highest levels of hunger, with 20 percent of its population affected, or one in five people, compared to 8 percent in Asia and 6 percent in Latin America. Despite the clear trend of rising hunger in Africa in absolute terms, Asia is still home to more than half of all those facing hunger in the world, at 385 million people. Comparatively, in Africa, 298 million people were hungry in 2023, and 41 million in Latin America and the Caribbean (FAO *et al.*, 2024).

Despite this clear trend of rising hunger in Africa, the prevalence of undernourishment has remained relatively unchanged in Asia, while significant progress has been made in Latin America and the Caribbean. Between 2022 and 2023, hunger increased in most African subregions, Western Asia, and the Caribbean.

The largest increase in hunger globally was in Middle Africa, which rose 3.3 percentage points to 30.8 percent undernourishment (62.2 million people); half of the people facing hunger in Africa in 2023 live in Eastern Africa (FAO *et al.*, 2024).

In Asia, there was a sharp increase in hunger between 2019 and 2021, which has remained largely unchanged, mirroring the global trend. Southern Asia has shown positive developments in reducing hunger for two consecutive years. After a significant increase from 2019 to 2021, the prevalence of undernourishment in the region declined from 14.5 percent in 2021 to 13.9 percent in 2023, i.e. 7.7 million fewer individuals experienced hunger. Conversely, Western Asia has been experiencing a steady increase in hunger levels since 2015. This trend has continued, with the prevalence of undernourishment reaching 12.4 percent in 2023 (FAO *et al.*, 2024).

In Latin America and the Caribbean, recovery post-COVID-19 has been impressive. Following an increase from 5.6 percent in 2019 to 6.9 percent in 2021, hunger has been decreasing over the past two years, to 6.2 percent in 2023. This decline represents a reduction of 4.3 million people experiencing hunger, largely due to progress in South America. Although this progress is promising, the level of hunger remains significantly higher than it was before COVID-19. Further, the level of hunger in the Caribbean exceeds that of Latin America threefold: from 15.4 percent in 2021 to 17.2 percent in 2023 (FAO *et al.*, 2024).

These regional disparities, both within and between continents, underscore the need for tailored interventions that address the specific challenges and contexts of each region. It is estimated that Africa will be home to 53 percent of the global population facing hunger by 2030 (FAO *et al.*, 2024).

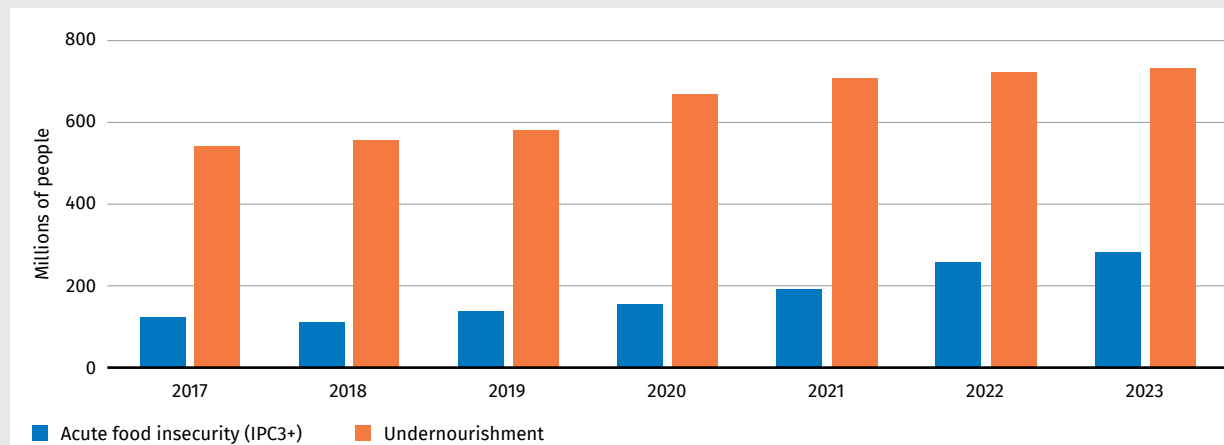
Acute food insecurity and acute malnutrition

Considering acute food insecurity, where populations face food deprivation that threatens their lives or livelihoods, the situation is alarming (FSIN and GNAFC, 2024). Globally, nearly 282 million people in 59 countries were affected in 2023, an increase of 24 million from the previous year (FSIN and GNAFC, 2024). This situation is particularly dire for children,

with over 36 million children under five acutely malnourished in 2023. Conflict remains a major driver, affecting 135 million people in 20 countries,

while extreme weather events and economic shocks also play significant roles (see Section 3.3) (FSIN and GNAFC, 2024).

FIGURE 1 Prevalence of undernourishment and acute food insecurity, 2017–2023



Sources: Authors' own elaboration based on FSIN (Food Security Information Network) & GNAFC (Global Network Against Food Crises). 2024. *Global Report on Food Crises 2024*. Rome. <https://www.fsinplatform.org/sites/default/files/resources/files/GRFC2024-full.pdf> for data on acute food insecurity and FAO, IFAD, UNICEF, WFP & WHO. 2024. *The State of Food Security and Nutrition in the World 2024 – Financing to end hunger, food insecurity and malnutrition in all its forms*. Rome. <https://doi.org/10.4060/cd1254en> for data on undernourishment.

Food insecurity consists of a complex interplay between acute and chronic forms, especially in the context of protracted crises; acute food insecurity is often triggered by shocks such as conflict, weather extremes, economic downturn, and structural vulnerabilities, or a combination of these factors (GNAFC, 2024); and chronic food insecurity (often used interchangeably with chronic undernourishment) refers to the persistent inability of households to consistently produce or otherwise gain access to the basic food needs of the household. This can stem from a lack of adequate income, assets and/or resources, often resulting from structural problems.

When protracted crises occur in vulnerable countries, a vicious mutually reinforcing cycle is created where acute shocks exacerbate chronic vulnerabilities while chronic issues undermine resilience to new acute challenges. This convergence of acute and chronic food insecurity in protracted crises demands a comprehensive approach that addresses both immediate needs and underlying structural causes.

Access to healthy diets: poverty and healthy food costs

Beyond hunger and acute food insecurity, healthy diets across the world continue to be out of reach for large proportions of the population. Throughout 2022, food prices rose due to a combination of inflationary pressures and disruptions from COVID-19 and the war

in Ukraine, pushing up the average cost of a healthy diet both globally and in all regions of the world. In 2022, the global cost of a healthy diet was estimated at USD 4 per person per day at purchase price parity (PPP), the highest it has ever been since 2017, when estimates first became available (FAO *et al.*, 2024). This increase in the cost of healthy diets spanned across all regions and country income groups, with variation.

The cost of a healthy diet is highest in Latin America and the Caribbean, which saw an increase of nearly 12 percent in one year, to USD 4.50. Similarly, Africa experienced a 10 percent increase from USD 3.40 in 2021 to USD 3.75 in 2022. In Asia, the cost rose from USD 3.85 in 2021 to USD 4.20 in 2022; Eastern Asia and Southern Asia recorded USD 5.35 and USD 4.30, respectively. Comparatively, the cost of a healthy diet in Northern America and Europe increased by 14 percent, from USD 3.10 in 2021 to USD 3.45 in 2022. Looking at the cost of a healthy diet across income groups, lower- and upper-middle-income countries faced the highest average cost, at USD 4.20 per day in 2022. High-income countries had an average cost of USD 3.80 per day, and low-income countries, USD 3.50 (FAO *et al.*, 2024).

Despite the increase in the cost of healthy diets, the global number of people unable to afford a healthy diet decreased to pre-pandemic levels, largely due to economic growth since COVID-19. Globally, an estimated

2.8 billion people (35.4 percent) were unable to afford a healthy diet in 2022, compared with 2.9 billion (36.4 percent) in 2021 (FAO *et al.*, 2024). This marks significant global variation, due to the uneven post-pandemic economic recovery.

In Asia, Northern America and Europe, the number of people unable to afford a healthy diet returned to pre-pandemic levels, whereas in Africa, the number rose substantially to 925 million in 2022, up by 25 million from 2021. Most of the people who were unable to afford a healthy diet lived in Eastern Africa (349 million) and Western Africa (298 million). Although the absolute number of people unable to afford a healthy diet in Asia is still higher than in Africa, at 1.7 billion, the number has been declining for two consecutive years. This also represents a smaller proportion of the population, with 35 percent of the population in Asia unable to afford a healthy diet compared to 65 percent in Africa. In Latin America and the Caribbean and Northern America

and Europe, 183 million (28 percent) and 54 million people (5 percent), respectively, were unable to afford healthy diets (FAO *et al.*, 2024).

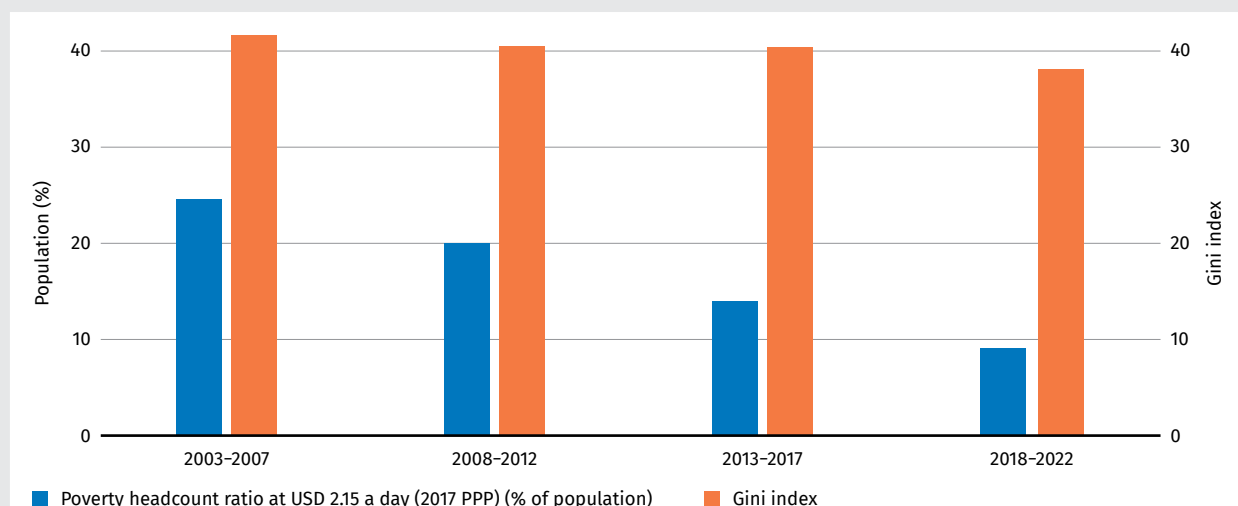
The disparity is even more evident between country income groups. Low-income countries recorded the largest percentage of the population that could not afford a healthy diet (72 percent) in 2022. Lower-middle income countries had 53 percent, upper-middle-income countries had 22 percent, and high-income countries had 6 percent. Indeed, while the number of people unable to afford a healthy diet dropped below pre-pandemic levels in upper-middle- and high-income countries, low-income countries had the highest levels since 2017, the first year for which estimates are available (FAO *et al.*, 2024). This slower recovery is mostly due to a halt in economic growth combined with sharply rising food prices, compared to higher-income countries, which had a stronger rebound in economic growth and the ability to introduce fiscal policies that minimized the economic impact of the crisis.

2.2 POVERTY, RISING INEQUALITIES AND PERSISTENT FOOD PRICE INFLATION

Persistent global inequality exacerbates the vulnerabilities of already disadvantaged populations and compounds the impacts of the other major drivers of food insecurity and malnutrition. While poverty has declined around the world in the past 20 years, income inequality has persisted.

Figure 2 shows the average percentage of the population living below the poverty line of USD 2.15 a day and the average level of income inequality by five-year periods. The analysis is shown for 119 low- and middle-income countries with available prevalence of undernourishment information.

FIGURE 2 Prevalence of poverty in the global population compared to income inequality, measured by Gini index, 2003–2022

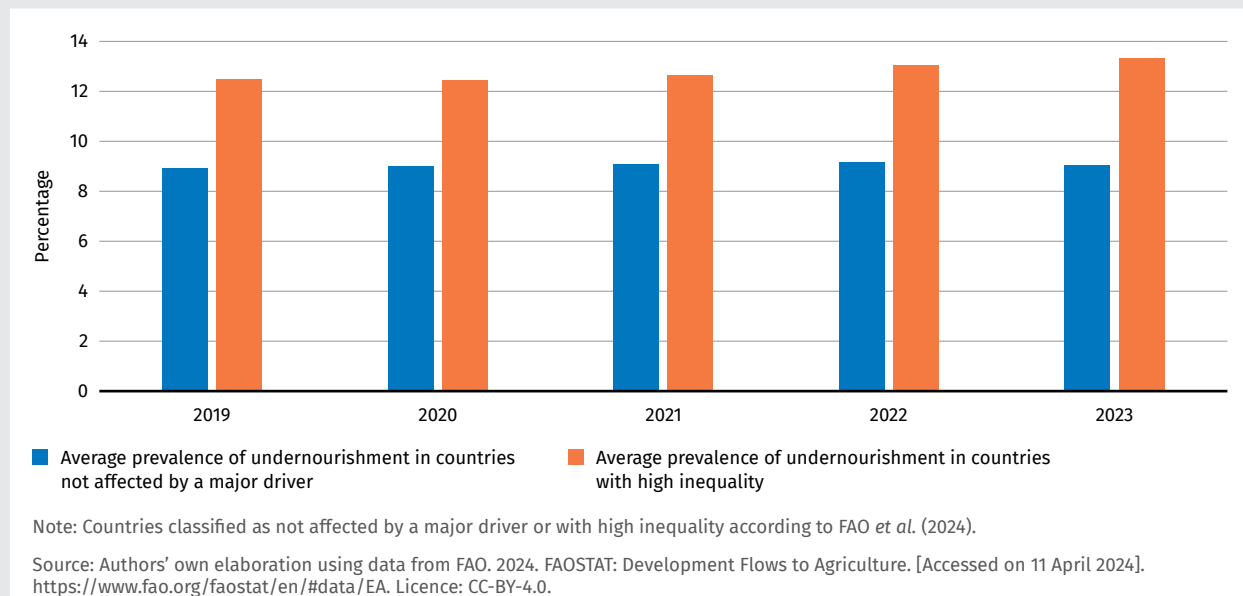


Source: FAO, IFAD, UNICEF, WFP & WHO. 2024. *The State of Food Security and Nutrition in the World 2024 – Financing to end hunger, food insecurity and malnutrition in all its forms*. Rome. <https://doi.org/10.4060/cd1254en> for data on undernourishment.

Economic disparities indicate that poorer communities have less access to resources, education and opportunities, which directly affects their ability to access food. The vulnerability created by inequality also leaves poorer population groups at greater risk from the other drivers of hunger, especially economic downturns, the worsening impact of climate variability, rising food prices and conflict. Where incomes are already struggling, if not failing, to cover basic needs, the impact of limited food availability and raised food prices can be detrimental and push households into hunger.

Inflationary pressures, in particular, increases in the relative prices of food, continue to erode economic gains for many people's access to food in many countries, as the world is still struggling to recover from the global pandemic (FAO *et al.*, 2024). According to the FAO Food Price Index, global food price inflation was 4 percent in 2024,¹ largely due to changes in shipping costs and grain prices (FAO, 2024). While this represents a significant slowdown from the peak inflation rates seen in 2023 (12.5 percent), food prices remain significantly higher than pre-pandemic levels. Regional disparities are evident, with Africa experiencing food price inflation of 5.8 percent in 2024, compared to 0.4 percent in Asia and 5 percent in Europe.

FIGURE 3 Prevalence of undernourishment for countries with high inequality compared to countries not affected by a major driver of food insecurity and malnutrition, 2013–2023



Due to gender disparities and inequality, women face disproportionate disadvantages in agrifood systems, which limit their productivity and economic opportunities. There are persistent gender gaps in access to critical resources such as land, livestock, technology, financial services and agricultural inputs. For example, women are less likely than men to own land or have secure land tenure rights. They also have less access to improved seeds, fertilizers and mechanized equipment than male farmers. These inequalities in resources and inputs directly impact women's agricultural productivity and incomes (FAO, 2023a).

Women also face barriers in employment and wages within agrifood systems. While women make up a large share of agrifood system workers, they are more likely to be in vulnerable forms of employment. There is also a significant gender wage gap, with women earning only 82 cents for every dollar earned by men in agriculture. Since the COVID-19 pandemic, the gap between women's and men's food insecurity has grown to 4.3 percentage points, with rural women experiencing significantly higher food insecurity. This underscores how gender inequalities directly translate into greater hunger and food insecurity for women and their households (FAO, 2023a).

¹ Data refer to median food price inflation for January of the relevant year, according to FAOSTAT data on consumer price indices. Data were extracted on 2 October 2024.

The COVID-19 pandemic has exposed and exacerbated fault lines, creating new challenges and vulnerabilities that disproportionately affect women, especially those from marginalized groups. For instance, women experienced increased unpaid care work, higher risks of gender-based violence, and greater financial precarity during the pandemic. These burdens are often more severe for women in low- and middle-income countries. An intersectional

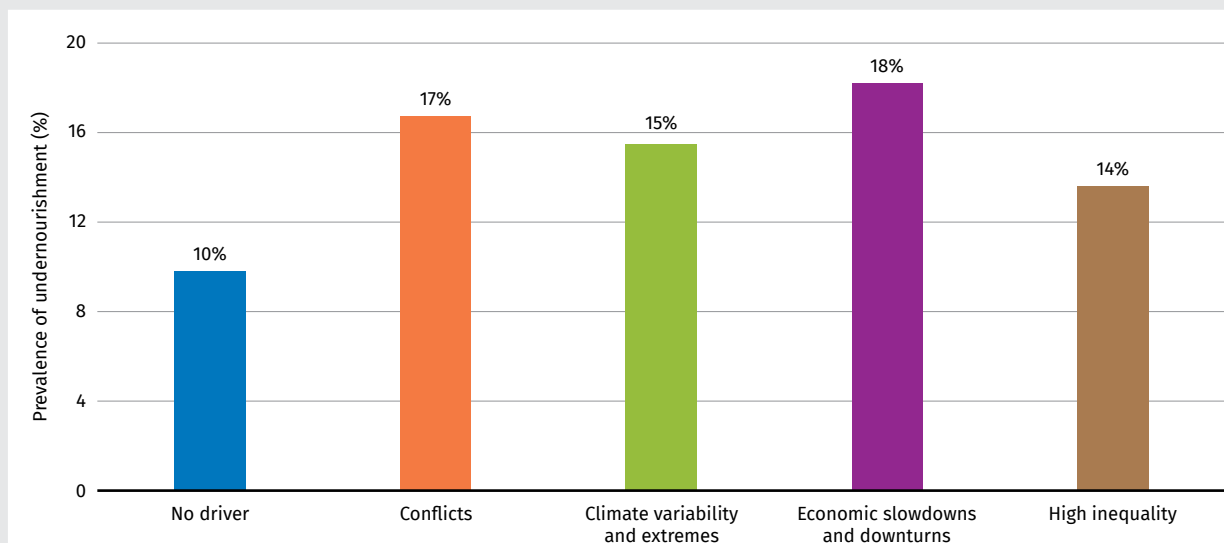
analysis reveals that the most vulnerable groups, often at the intersection of multiple marginalized identities, face the greatest risks of hunger and food insecurity. These groups include women who are ethnic minorities or migrants, or from lower socioeconomic backgrounds. The overlapping crises have also highlighted disparities in access to healthcare, information and safety measures, which can indirectly affect food security (Sultana, 2021).

2.3 THE MAJOR DRIVERS OF HUNGER AND MALNUTRITION: CLIMATE CHANGE, ECONOMIC SHOCKS, CONFLICT AND GEOPOLITICAL INSTABILITY

Recent global shocks and more immediate drivers of food insecurity and malnutrition have intensified these underlying structural problems, making the hunger crisis worse. Largely driving food insecurity in low- and middle-income countries are three major shocks: economic shocks and downturns, conflicts, and climate variability and extremes (Figure 4). Economic vulnerabilities are exacerbated by high dependency on food imports, making these countries

particularly susceptible to global market fluctuations. Additionally, climate variability and extremes, such as the record-breaking temperatures and severe flooding in 2023, have significantly impacted food production and availability, further deepening the food crises in affected regions (FAO *et al.*, 2024). These three major drivers of food insecurity have distinct characteristics and impacts, yet often intersect, exacerbating one another to the detriment of food security and nutrition.

FIGURE 4 The average prevalence of undernourishment in countries affected by one of the major drivers of food insecurity and malnutrition in 2023



Sources: FAO. 2024. FAOSTAT: Development Flows to Agriculture. [Accessed on 11 April 2024]. <https://www.fao.org/faostat/en/#data/EA>. Licence: CC-BY-4.0 for the prevalence of undernourishment and FAO. 2024. Indicator 12.3.1 - Global Food Loss and Waste. In: *SDG Indicators Data Portal*. [Cited 2 October 2024]. <https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/1231-global-food-losses/en> for data on the countries affected by drivers.

Of particular concern is that most low- and middle-income countries are grappling with at least one of these major drivers while structural changes are rendering their agrifood systems more vulnerable.

In situations where multiple drivers coincide, their combined impact is even more severe, resulting in the most dramatic increases in hunger and food insecurity levels. Countries affected by two or more

of the drivers of food insecurity and malnutrition saw the most significant increase in hunger between 2019 and 2023, and countries affected by all three major drivers, on average, recorded the highest prevalence of undernourishment (FAO *et al.*, 2024). This compounding effect highlights the intricate and often devastating relationship between these drivers and the vulnerability of food systems in less economically developed nations (FAO *et al.*, 2024).

Critical change since the launch of the Ceres2030 project: the acceleration of climate shocks and geopolitical instability

Today, 152 million more people are affected by hunger than before the COVID-19 pandemic in 2019 (FAO *et al.*, 2024). This is the magnitude of the impact of the pandemic that no one expected but that was forewarned. In June 2020, it was estimated that an additional 95 million people would fall into extreme poverty and hunger over the course of 2020, mostly in sub-Saharan Africa, but also in South Asia, as a result of the COVID-19 pandemic (Laborde and Smaller, 2020). At that time, it was recommended that, to avert a poverty and hunger crisis, an additional USD 10 billion be spent on social protection programmes targeting the groups of people that would be most affected (Laborde and Smaller, 2020). While some additional public investment was committed, and some countries effectively and rapidly established cash transfers and other social protection schemes, this was insufficient to avert a hunger and poverty crisis, and the situation has only been exacerbated by recent conflicts.

Conflicts, such as those in Ukraine, Gaza, Syria, the Sudan, Yemen and the Sahel, have severely impacted food, fertilizer and energy markets, leading to increased volatility and higher prices. These conflicts often result in the destruction of agricultural infrastructure, the displacement of populations and a seizure of resources, which disrupts food production and distribution (FAO, 2023b; FSIN and GNAFC, 2024). The number of countries affected by conflict has risen sharply, from 121 in 2000 to 170 in 2021, highlighting the growing prevalence of geopolitical instability (FAO, 2023b; FSIN and GNAFC, 2024). This instability not only disrupts local food systems, but also has far-reaching impacts on global markets. For example, due to the close links between the energy market and agrifood systems globally (e.g. for irrigation, farm machinery, agrifood processing and production of fertilizers), the impact of the conflicts on rising energy prices translates into higher production costs and food costs, among other negative consequences for agriculture and food industries. Import-dependent countries, particularly

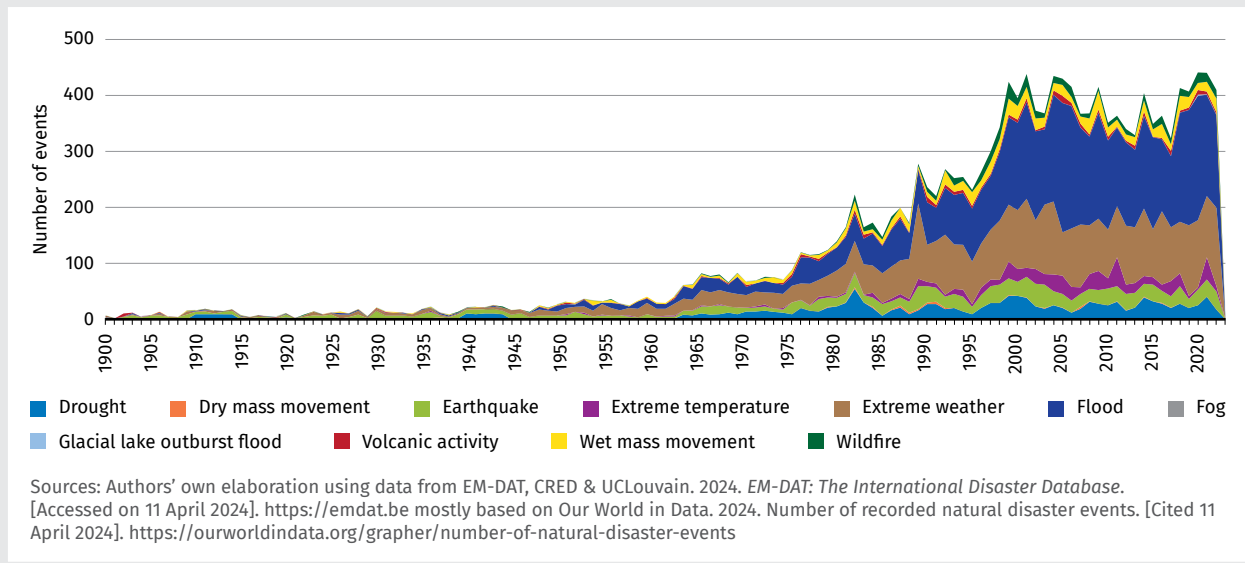
in Africa and Asia, and small-scale farmers are most vulnerable to these rising costs and potential fertilizer shortages, which lead to reduced usage and negatively impact future crop yields (Levi and Molnar, 2022). Heightened geopolitical instability and conflicts are therefore a significant barrier to achieving food security and reducing hunger worldwide (FAO, 2023b; FSIN and GNAFC, 2024).

Agriculture relies heavily on energy for irrigation, machinery, processing and transportation, with energy costs accounting for 40–50 percent of total variable cropping costs in advanced economies. Rising natural gas prices have led to a tripling of fertilizer prices since mid-2020, as natural gas is crucial for producing nitrogen fertilizers, which make up 70–80 percent of operating costs for ammonia and urea production (Levi and Molnar, 2022). This situation has been worsened by supply chain disruptions following the Russian Federation's invasion of Ukraine, affecting food and fertilizer exports from major producers. Import-dependent countries, particularly in Africa and Asia, are the most vulnerable to these rising costs and potential fertilizer shortages, which could lead to reduced usage and negatively impact future crop yields (Levi and Molnar, 2022). As production expenses rise, consumers face higher food prices, putting millions at risk of food insecurity. These interconnected challenges highlight the urgent need for coordinated international efforts to address both energy and food security issues while improving nutrient use efficiency and transitioning to more sustainable energy sources within the agrifood sector.

Weather shocks have emerged as a significant driver of food insecurity in recent years, with climate variability and extreme weather events increasingly affecting agricultural productivity and agrifood systems globally (FAO *et al.*, 2024). Some areas have already surpassed 1.5 °C, and climate scientists are now predicted that global temperature will surpass 1.5 °C by 2030 or earlier (IPCC, 2021). According to FAO's Roadmap (FAO, 2023c), the world has already exceeded the safe limits of six out of nine planetary boundaries, majorly tied to agrifood system. These planetary crises are now the drivers of hunger (FAO *et al.*, 2024).

The frequency of natural disasters has already risen dramatically since 1990 (Figure 5). Furthermore, the precipitation variance is likely to increase as a result of the El Niño-Southern Oscillation (ENSO) effect – a climate phenomenon that periodically fluctuates between three phases: Neutral, La Niña or El Niño (IPCC, 2021). This will lead to significant changes at a regional scale (IPCC, 2021).

FIGURE 5 Number of recorded natural disaster events, 1900–2023

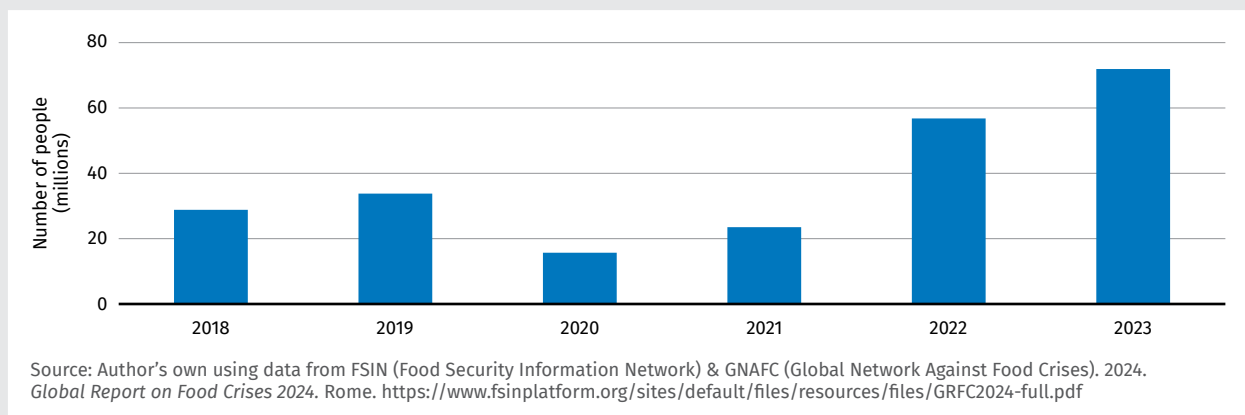


Climate variability and extreme events, such as floods, droughts and extreme temperatures, have far-reaching consequences on food security: they not only directly impact crop yields and livestock production, but also disrupt food supply chains, leading to price volatility and reduced access to food for vulnerable populations (FAO, 2023b). In 2023 alone, weather extremes were identified as the main driver of food insecurity in 18 countries, affecting approximately 72 million people (Figure 6). As climate change continues to intensify, the frequency and severity of these weather shocks are

expected to increase, posing a growing threat to global food security and making it more difficult for countries to achieve sustainable agricultural production and ensure stable food supplies (FAO, 2023b).

Agrifood systems are both a contributor and a victim of climate change, contributing 30 percent of anthropogenic greenhouse gas (GHG) emissions, and a key driver for increased food insecurity (FAO *et al.*, 2024). Ending hunger cannot be achieved unless the safe limits of the planetary boundaries are addressed.

FIGURE 6 Acute food insecurity driven by weather extremes



If the world continues with business as usual, it will take until 2030 to return to the hunger levels prior to COVID-19 and the war in Ukraine, let alone make any progress towards achieving zero hunger by 2030.

Increasing food prices, growing inequality, highly concentrated markets and heightened geopolitical instability are making it harder for many people and many countries to bounce back.

3 STRUCTURAL CHALLENGES IN AGRIFOOD SYSTEMS: THE PROBLEMS

Many lower- and middle-income countries have experienced remarkable progress in transforming agrifood systems over the past five decades, combined with sharp declines in hunger and poverty (Laborde *et al.*, 2019). In Latin America, many countries made progress by pushing agriculture as the driver for economic transformation, and by increasing agricultural productivity (Laborde *et al.*, 2019). In Asia, many countries made progress by pulling people out of agriculture and prioritized productivity growth in industry and services (Laborde *et al.*, 2019). The remaining low-income countries, particularly in Africa, have not experienced the same levels of progress, facing challenges in infrastructure, mechanization, processing, and technical and skills development that continue to slow their progress (Daum, 2022; Laborde *et al.*, 2019). Weak trade, competition and regional integration compound these underlying structural challenges while chronic lack of access to finance inhibit opportunities and potential for growth.

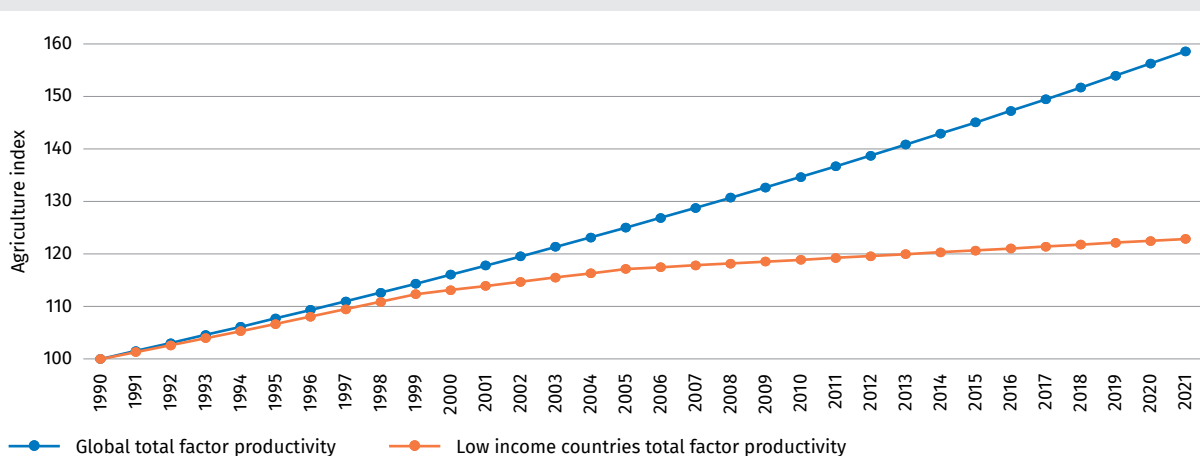
The evolution from predominantly rural, low-productivity agricultural societies to diversified, urban-centric economies with high agricultural and non-agricultural productivity is a multifaceted process. Central to this broader economic restructuring is the pivotal role of agriculture. Agricultural growth can expand employment opportunities beyond the farm and throughout the entire agrifood system from production to processing, distribution and retail. Therefore, improvements in agricultural productivity through modernization and increased efficiency can generate powerful ripple effects throughout economies, serving as a cornerstone for overall societal development and economic diversification (Laborde *et al.*, 2019; Yeboah and Flynn, 2021). A balanced approach of improving productivity in both agricultural and non-agricultural sectors allows for the simultaneous advancement of agricultural efficiency and the diversification of the economy, creating a more robust and sustainable path to overall national development (Laborde *et al.*, 2019).

3.1 SLOWDOWN IN AGRICULTURAL PRODUCTIVITY AND SUPPLY CHAIN VULNERABILITIES – LIMITED MECHANIZATION AND LABOUR SHORTAGES

The slowdown in agricultural productivity growth has emerged as a significant structural problem contributing to hunger and malnutrition. Globally, agricultural productivity has continued to increase over the past

30 years. However, in low-income countries, where food production is most critical, agricultural productivity has largely stagnated since the early 2000s (Figure 7).

FIGURE 7 Total factor productivity evolution in agriculture, 1990–2021



Source: Authors' computation based on the United States Department of Agriculture, Economic Research Service. International Agricultural Productivity data product, December 2023.

Weak labour productivity in particular drives down profitability in the agrifood sector. Employment in agriculture is not intrinsically less remunerative than other sectors (Kubik, 2022), but seasonality and low productivity also drive down profitability. On average, farmers in sub-Saharan Africa work 26 hours a week, in comparison to 39 hours in non-farm activities (Kubik, 2022). Furthermore, smallholder farmers face a number of constraints in production and marketing, and in accessing services such as credit and effective extension (Yeboah and Flynn, 2021). Consequently, agricultural economies mainly comprising smallholder farmers, such as those in Africa, still perform below capacity (Kubik, 2022).

One of the main reasons for the slowdown in agricultural growth, particularly in Africa, is a slower pace of structural transformation and mechanization. With labour moving out of agriculture, and urbanization rates increasing slower than in other countries, mechanization progress has been slow and focused on the most power-intensive activities such as land preparation, transportation and processing. Currently, African agrifood systems are the least mechanized of all world regions, with around 10 percent of crop farmers estimated to use tractors (Daum, 2022). In certain countries, it is estimated that the use of tractors is below 1 percent (Daum, 2022). Conversely, animal traction is widespread in some countries, with 15 percent of farmers estimated to use animals for land preparation in Africa in 2018 (Daum, 2022).

Mechanisation is particularly pertinent in Africa, where local labour markets in primarily agrarian economies face strenuous conditions characterized by high levels of informality, underemployment and working poverty. The projected influx of new labour market entrants will further strain the already insufficient number of decent jobs available (Kubik, 2022). Agrifood systems are increasingly recognized as potential catalysts for employment creation due to their prospects and labour-intensive nature. In particular, rural areas of Africa, farming and self-employment in the agrifood sector dominate youth employment; however, labour productivity in Africa remains low compared to other regions, leading to declining real wages (Kubik, 2022).

High yields are theoretically possible without mechanization if farm labour is skilled and abundant (see Section 4.2), but this is often not the case. Seasonal labour bottlenecks and shortages undermine land preparation and crop management, reducing yields. This is particularly the case in rainfed agriculture, specifically in arid and semi-humid regions where timely planting is crucial for maximizing yields.

Delayed planting can reduce yields by up to 1 percent per day, and in Ethiopia, labour constraints account for as much as 50 percent of yield gaps. Additionally, a lack of farm power contributes to these gaps in Eastern and Southern Africa (Daum, 2022; Daum and Birner, 2020).

The consequences of this productivity slowdown are far-reaching and multifaceted. Low productivity limits the income potential of smallholder farmers, trapping them in cycles of poverty and food insecurity. This situation is particularly acute in regions like sub-Saharan Africa and parts of Asia, where agriculture remains a primary source of livelihood for a significant portion of the population. In sub-Saharan Africa, agriculture is the main source of employment in most countries and particularly for the more than 60 percent who live in rural areas (Gollin, 2023). Agricultural growth can both expand employment opportunities beyond the farm and throughout the entire agrifood system from production to processing, distribution and retail.

The impacts of low agricultural productivity extend beyond immediate food availability and farmer incomes. Countries with consistently low agricultural output often become increasingly reliant on food imports, exposing them to the volatilities of global markets and potential supply disruptions (Gollin, 2023). This is true not only for primary products, but also and increasingly for processed food products.

Moreover, to compensate for low yields, farmers resort to unsustainable practices such as deforestation or overuse of chemical inputs, leading to environmental degradation that further threatens future food production capacity. As populations continue to grow, especially in low- and middle-income countries, the gap between food supply and demand widens, leading to higher food prices and reduced accessibility for vulnerable populations. Factors such as soil degradation, climate change and water scarcity exacerbate the situation, limiting the capacity of farming systems to increase yields. Addressing these structural issues requires substantial investments in agricultural research, technology transfer and sustainable farming practices to revitalize productivity growth and ensure long-term food security.

3.2 LACK OF AGRIFOOD PROCESSING, DISTRIBUTION AND RETAIL: VALUE ADDED INDUSTRIES AND SKILLED LABOUR

Today, food processing industries in Africa comprise around a third of total manufacturing employment in a number of African countries (Ellis, Fang and McMillan, 2022). But demand is rising faster than supply, with the share of processed foods in Africa's imports rising from 28 percent in 2000 to 33 percent in 2020 (UNCTAD, 2024). And despite this growth in the production and value of processed agrifood products, these markets are dominated by a few large firms (Nakitto *et al.*, 2024), keeping prices for consumers high and creating barriers to entry for agrifood SMEs.

Skills shortages are also an obstacle to the growth and development of the agrifood processing sector in Africa (ILO, 2022). Agrifood processing companies experience high turnover and struggle to find workers and skills needed to operate processing equipment (AgriSETA, 2021). Overall, the combination of the gap in skills, lack of access to processing technologies, and inadequate financing have undermined the innovation capacity and income-generating potential of African's agrifood processing markets (Badiane *et al.*, 2022).

The growth of agrifood processing is heavily dependent on the adoption of improved technologies. However, several factors hinder this progress, including the high costs associated with machinery, spare parts and repair services, as well as the subpar quality of locally manufactured equipment. These challenges significantly impede the growth of domestic firms in the sector and the growth of domestic firms to compete with foreign products (Baumüller, Kubik and Getahun, 2023). To address these issues, governments need to take a more strategic approach to nurturing a domestic equipment manufacturing sector (see Section 4.5). Furthermore, limited access to financial services prevents local equipment manufacturers from scaling up their

operations or investing in quality improvements (see Section 4.3) (Nakitto *et al.*, 2024).

The shortage of comprehensive training programmes for mechanical engineers and local equipment fabricators also contributes to the low quality of domestically produced food processing equipment. In food processing firms, there is a high level of employee turnover due to difficulties finding workers with sufficient technical knowledge to operate the equipment (AgriSETA, 2021). The lack of workers with the necessary skills is partly due to the low participation in science, technology, engineering and mathematics (STEM) education in developing countries and in technical and vocational education and training (TVET) courses (AfDB, 2022; Nakitto *et al.*, 2024).

Where farmers are entering the food processing sector, barriers to entry are high forcing them to select low-quality products for which there is high competition and a limited target population of consumers. This results in a general decline in profits, because only a few food processing enterprises are able to capture the market for processed foods (often the larger firms); most food processing enterprises remain small with limited profitability (Nakitto *et al.*, 2024). Most food processing enterprises driving the transformation of Africa's staple food value chains are small-scale and informal, typically employing only a few workers (Badiane *et al.*, 2022).

One of the main barriers to the development of a productive agrifood sector and to productive employment, especially for youth in developing countries, is therefore a lack of training and a mismatch in skills and qualifications, which exacerbate the structural deficiencies of local economies, inadequate infrastructure and public services in rural areas.

3.3 LACK OF ACCESS TO FINANCE FOR THE "MISSING MIDDLE": SMALL-SCALE PRODUCERS AND AGRIFOOD SMALL AND MEDIUM-SIZED ENTERPRISES

One of the biggest challenges in transforming agrifood systems, such as enhancing agricultural productivity and agrifood systems, is access to finance, particularly for the "missing middle" – i.e. small-scale producers and agrifood SMEs (Jenane *et al.*, 2022). Agricultural infrastructure, including machinery and technology, is expensive and often requires several years to pay off, making credit access crucial. Small-scale producers typically face limited

credit access due to lack of collateral and high transaction costs, among other challenges. This issue is particularly acute for African farmers. Even when credit is available, prohibitively high interest rates often make financing impossible. Credit policies and favourable import policies can play a key role in mechanization by affecting the costs of machinery, spare parts, and fuel (Daum, 2022; Diao, Takeshima and Zhang, 2020).

For many of those operating in the agrifood system, access to working capital is problematic, especially for producers. Under normal business practices, buyers and traders often buy crops on demand based on when and where they can sell them. This keeps their inventory low, enabling them to better manage their cashflow. The downside is that producers and cooperatives must then bear the costs not just of producing the crop, but also of storing it and even processing it (depending on perishability) until it is sold. Holding this inventory is a massive burden on the balance sheets of producers and cooperatives.

Small-scale producers and agrifood SMEs often seek loans between USD 25 000 and 2 million, which are both too small to attract commercial financiers and too large to qualify for concessional official direct assistance (ODA) grants or microloans (Perera *et al.*, 2024). In sub-Saharan African and Southeast Asia alone, the financing gap is estimated at USD 106 billion (ISF Advisors, 2022). Financing the missing middle is challenging due to high costs and risks, ranging from high transaction costs for small ticket sizes to high default risk for smaller loans. Two of the major drivers of hunger, climate and macroeconomic shocks, are also exacerbating the vulnerabilities of agrifood value chains, compounding the risks inherent to financing agrifood SMEs in the missing middle.

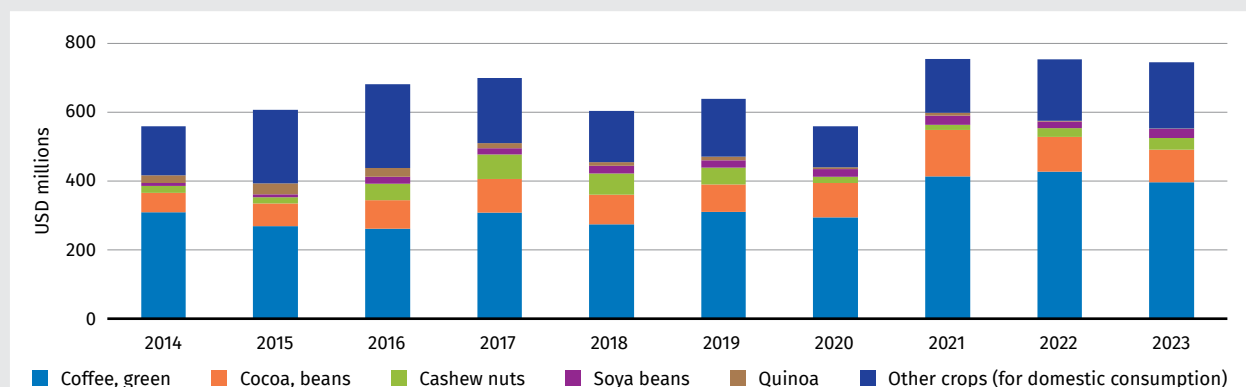
In addition to this, agrifood SMEs and producers also find it particularly difficult to borrow money from local banks and non-banks. These lenders have very little interest in agriculture, viewing it as a particularly risky sector. As a result, they develop very little expertise and thus being unable to distinguish between real and perceived risks (Perera *et al.*, 2024).

Banks can also require that agricultural borrowers post collateral that is higher than other borrowers, since agricultural assets such as land are illiquid. In addition, banks tend to substantially discount the value of assets in rural areas because of their lack of familiarity and thus comfort with these sorts of assets. As a rule of thumb, banks require collateral of over 100 percent of the loan value; for agrifood SMEs, the requirement can reach double that value. This conservative nature is in part due to International Financial Reporting Standards, which require banks to anticipate losses, as well as Basel III banking standards, which recommend that banks maintain higher capital (Corporate Finance Institute, no date).

Agrifood SMEs supplying domestic markets are even more constrained because they service domestic food markets and operate in local currencies. They therefore find it difficult to borrow from international blended funds and social lenders, which transact in hard currencies and shy away from lending to SMEs that cannot also provide purchasing orders in hard currencies (which would require negotiations with overseas buyers).

Accordingly, most financing for agrifood SMEs is targeted at those working in global value chains for commodities that they can sell in hard currencies rather than food crops destined for domestic consumption, which are sold in local currencies (CSAF, 2024; Perera *et al.*, 2024). Figure 8 shows that, over the last decade, most of the lending from the Council on Smallholder Agricultural Finance (CSAF) has targeted export-oriented crops (coffee, cocoa, cashew, soy and quinoa) rather than those focused on crops for domestic consumption.

FIGURE 8 Volume of lending by the Council on Smallholder Agricultural Finance (CSAF) by value chain, 2014–2023

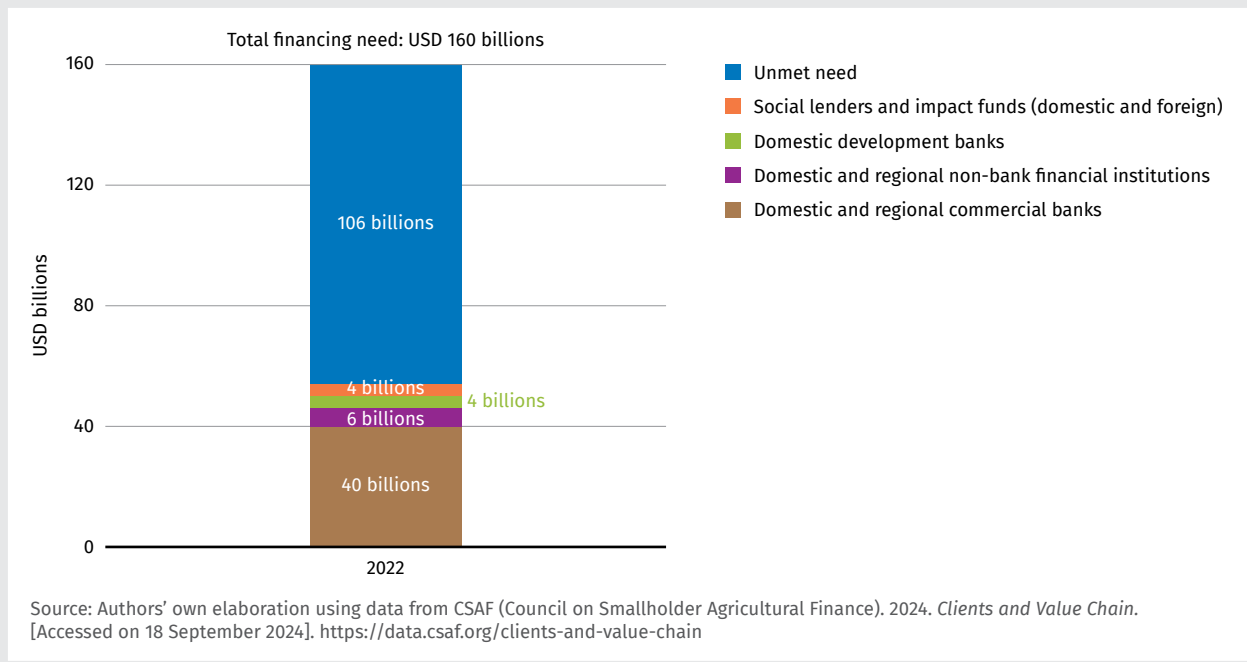


Source: Authors' own elaboration using data from CSAF (Council on Smallholder Agricultural Finance). 2024. *Clients and Value Chain*. [Accessed on 18 September 2024]. <https://data.csaf.org/clients-and-value-chain>

Domestic and regional lenders are also missing from the equation: they only meet a third (USD 54 billion) of the total financing needs of agrifood SMEs in sub-Saharan Africa and Southeast Asia (USD 160 billion) (Figure 9). Commercial banks are also restricted by prudential regulations to take on more and longer-term risks, and they consider the agrifood sector particularly risky.

This is especially true in developing countries where financial markets remain shallow and domestic banks focus on providing short- to medium-term loans to mature companies offering substantial collateral and stable cash flows. Non-bank institutions are slightly more flexible, but underrepresented (ISF Advisors, 2022; Perera et al., 2024).

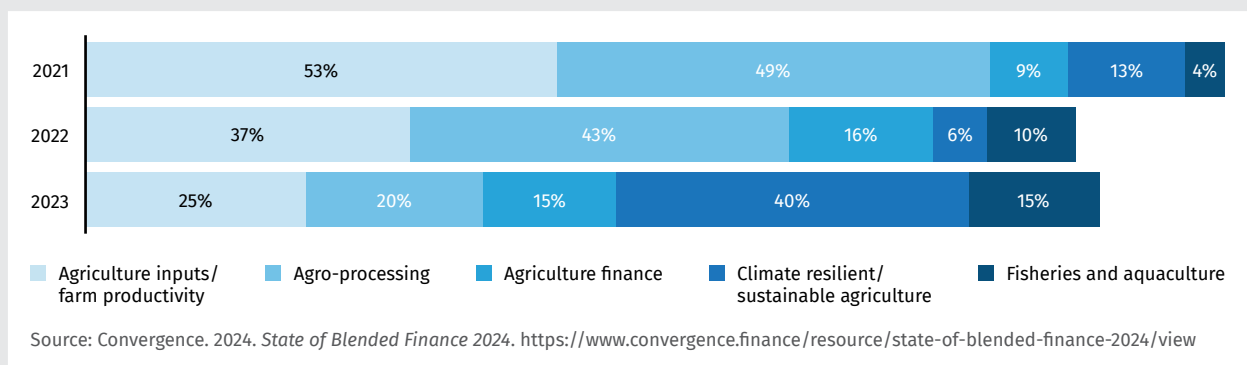
FIGURE 9 Supply of financing provided by domestic and regional lenders to agrifood small and medium-sized enterprises in developing countries compared to need, 2022



Blended finance for agriculture is a prominent component of the blended field but it is operating at a subpar transaction scale, and it underperforms other sectors in volume of private capital moved as compared to the unmet needs (Convergence, 2024).

Blended finance transactions target all aspects of the agricultural sector, but the amounts available are tiny, and there is a shirking share going into processing, with 49 percent in 2021 down to 20 percent in 2023 dedicated to processing (Figure 10).

FIGURE 10 Breakdown of agriculture deals by sub-sector, 2021–2023



3.4 POOR QUALITY AND INADEQUATE INFRASTRUCTURE FOR IRRIGATION, ROADS, STORAGE AND ELECTRICITY

Infrastructure for irrigation, roads and electrification

Poor rural infrastructure, particularly roads, irrigation and electrification are another significant hurdle to agricultural development (Adam *et al.*, 2012; AICD, 2010; Alila and Atieno, 2006). Currently, nearly one billion people, or one-third of the global rural population, live more than 2 kilometres away from an all-season road. These are the most isolated and often poorest communities. Poor road conditions and inadequate maintenance, as well as seasonal further accessibility problems due to a lack of proper bridges and river crossings, increase travel times and vehicle operating costs, in addition to reducing transport service reliability.

The lack of rural infrastructure isolates farmers from markets (Alila and Atieno, 2006). For example, trade costs in Ethiopia and Nigeria have been estimated to be as much as four or five times higher than in the United States of America due to poor road infrastructure, low competition in the transportation sector, topography, and insecurity (World Bank, 2024).

Infrastructure to prevent and reduce food loss and waste

In developing countries, a large amount of food is lost throughout the value chain at various stages between the farm and the wholesale market due to factors such as limited market access, inadequate mechanization, and outdated technology used during production and post-harvest activities. Unfavourable climatic conditions, pest and diseases infestations, and lack of

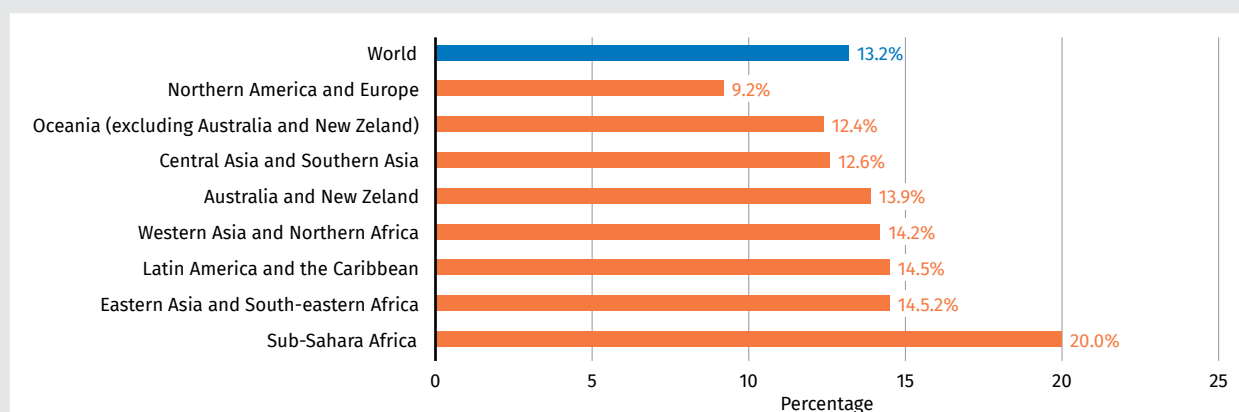
infrastructure, including roads, proper storage facilities, and refrigeration, further contribute to these losses (Delgado, Schuster and Torero, 2021).

Interventions to reduce losses across the value chain would therefore help meet the growing food demand, especially for nutritious foods such as fruits and vegetables, which are highly perishable, and also support the environmental sustainability and economic stability of agrifood systems by conserving resources and reducing financial losses.

Food waste refers to the reduction in the quantity or quality of food caused by the decisions and actions of retailers, food service providers and consumers (Delgado and Torero, 2021). Blakeney (2019) emphasizes that the causes of food waste are complex and interconnected, and vary between industrialized and developing countries. In developed countries, food waste is largely driven by factors such as consumer overconsumption, behaviour, lifestyle choices, legislation and business practices (Delgado and Torero, 2021). In contrast, addressing food waste in developing countries primarily involves improving infrastructure and facilities to prevent wastages during transportation and storage.

Based on the Food Loss Index, sub-Saharan Africa experienced the highest losses in 2019, at 20.0 percent, followed by Eastern and Southern Asia, and Latin America and the Caribbean, both at 14.5 percent (Figure 11).

FIGURE 11 Food loss from post-harvest to distribution in 2021



Source: FAO. 2024. Indicator 12.3.1 - Global Food Loss and Waste. In: *SDG Indicators Data Portal*. [Cited 2 October 2024]. <https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/1231-global-food-losses/en>

In developing countries, fruits and vegetables account for the highest volume of post-harvest losses.

In sub-Saharan Africa, it is estimated that between 16 percent and 52 percent of fruits and vegetables are lost post-harvest (Makule, Dimoso and Tassou, 2022). The primary reason is their susceptibility to physiological deterioration combined with bad post-production infrastructure. Where fruits and vegetables are stored in warm environments with relatively low humidity, ripening continues resulting in physiological deterioration – i.e. wilting, shrivelling, drying and the spreading of microbial organisms. This can lead to the loss of saleable weight or even the whole produce, as well as a decrease in the nutritional value and quality of the produce, all contributing to decreased returns and smaller income for farmers (Sibanda and Workneh, 2020).

Compounding the impact of limited rural infrastructure and weak domestic supply chains, in recent years, supply chain disruptions have emerged as a significant challenge to global food security (FAO, 2023b). The COVID-19 pandemic highlighted the vulnerability of global food supply chains, as lockdowns, border closures and labour shortages disrupted the production, transportation and distribution of food products

worldwide. These disruptions led to shortages, price volatility and reduced access to food for many populations, particularly in import-dependent countries (FAO, 2023b). The war in Ukraine further compounded these issues, disrupting critical grain exports and agricultural input supplies, which rippled through global markets. Supply chain challenges have also been intensified by extreme weather events, which damaged infrastructure, disrupted transportation routes, and affected production in key agricultural regions (FAO, 2023b). These disruptions not only impacted the availability and affordability of food, but also contributed to food loss and waste, further straining food security (FAO, 2023b). As global agrifood systems become increasingly interconnected, the resilience of supply chains has become a crucial factor in ensuring food security, highlighting the need for diversified sourcing, improved logistics, and more robust risk management strategies in the agrifood sector (FAO, 2023b).

As the stress on global food chains increases with population growth and climate change increasingly affecting production, minimizing post-harvest losses will be critical to transitioning to sustainable agrifood systems and meeting global demand (Faibil *et al.*, 2021).

3.5 WEAK TRADE, REGIONAL INTEGRATION AND HIGHLY CONCENTRATED MARKETS DOMINATED BY A FEW LEAD FIRMS

In a well-functioning market, firms compete for market share by offering better products and services to consumers at lower prices. However, in markets that do not function well, firms do not need to compete for market shares and can accrue a substantial market power, which allows them to set prices and control markets. These large firms can charge prices unrelated to the actual costs of supply, including through collusion with other firms to increase prices and profit margins (Buthelezi *et al.*, 2023). Developing countries tend to have more concentrated markets and higher barriers to entry – conditions that make it difficult for new firms to enter a given market. As a result, cartels in developing countries are likely to be stronger and have significant price mark-ups (Cheng, 2020; International Finance Corporation, 2021; Roberts, 2020).

In many agrifood markets, the extreme levels of global concentration affect the entire agrifood system, from the inputs used for production to the final sale to end consumers (Buthelezi *et al.*, 2023). Local producers are squeezed upstream and downstream since the firms that sell the inputs control prices while large buyers control the market for their outputs (Christiaensen

and Martin, 2018). The processing sector is also heavily concentrated in many developing countries, and specifically in Africa, SMEs struggle to enter and compete with large firms (Buthelezi *et al.*, 2023). At the retail level, consumers in African cities pay higher food prices than in other developing countries (Allen, 2017; Nakamura *et al.*, 2016), limiting accessibility of food and driving food insecurity (Baulch, Jolex and Mkandawire, 2021; Bell *et al.*, 2020; Cedrez, Chamberlin and Hijmans, 2020; Ochieng, Both and Baulch, 2019; Sitko and Chisanga, 2017).

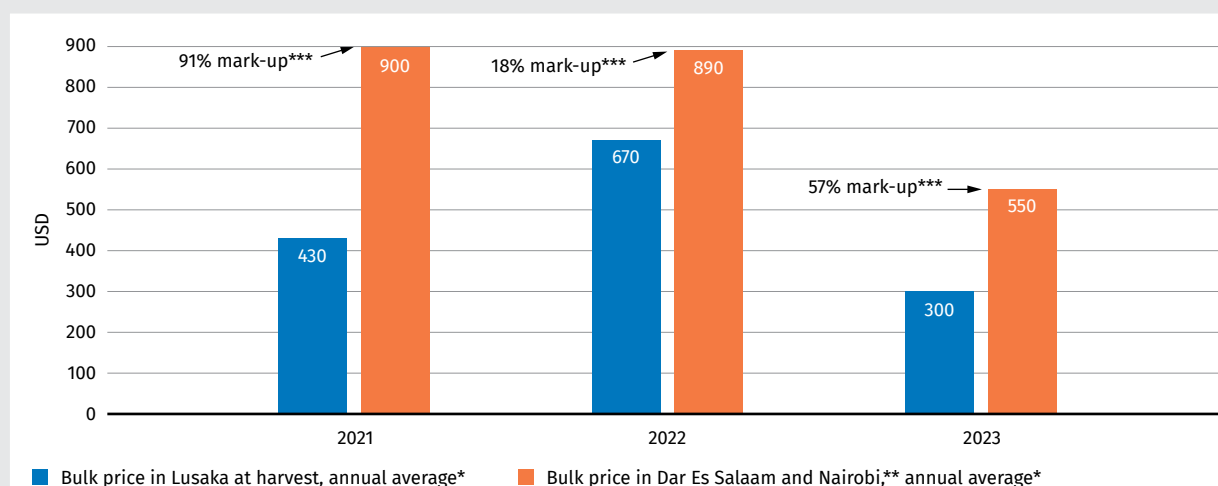
In Africa, markets for inputs such as fertilizer, seeds and pesticides are highly concentrated, thus facilitating anti-competitive behaviour by large firms across borders (Burke *et al.*, 2019; Vilakazi, 2017; World Bank, 2016). In fertilizers, three out of the five main companies operating in 24 countries across the continent have been involved in cartels detected in South Africa and Zambia, which increase prices for farmers (World Bank, 2016). Cartels in fertilizer and poultry have increased prices by 50 percent and more (Connor, 2020; Hernandez and Torero, 2013; Tups and Dannenberg, 2023). As a result, farmers are squeezed by cartels both

as buyers of inputs (for which they pay higher prices) and sellers of agricultural products (for which they are paid lower prices), due to high levels of concentration at input and processing levels (Connor, 2020; Lianos, Ivanov and Davis, 2022). Investigations of food and agricultural markets by African competition authorities' have uncovered extensive cartel conduct (Avdasheva *et al.*, 2023). For example, South Africa, which has the most vigorous competition enforcement in Africa, identified cartels in the markets for fertilizer, silo storage and trading, poultry, maize milling, wheat milling, bread and dairy (Muzata, Roberts and Vilakazi, 2017; Roberts, 2020). Given the reach of the companies involved, the impact of these cartels is felt across southern Africa, including in Botswana, Eswatini, Namibia and Lesotho. Cartel conduct in poultry, fish-farming and fertilizer has been reported in Zambia, and Kenya

has identified widespread coordination concerns in agricultural markets (Avdasheva *et al.*, 2023).

High levels of concentration mean that big corporations have the market power to set prices, even when explicit anti-competitive conduct is not detected (Avdasheva *et al.*, 2023). Data collected by the African Market Observatory show that large vertically integrated input suppliers and traders in Africa earn excessive margins, thus reducing prices for farmers, and increasing prices to customers, including small food businesses (Nsomba *et al.*, 2022a, 2022b; Roberts, 2023). In the soybean trade, for example, traders earn a mark-up of up to 91 percent in addition to producer prices, and after taking transport costs into account. They suppress farmer prices in Malawi and Zambia while increasing prices to buyers in Kenya (Figure 12).

FIGURE 12 Price at point of harvest in Zambia, compared with prices at point of sale in Kenya and the United Republic of Tanzania



Notes: * The annual average is based on the harvest season prices (April to June each year). ** Prices at the point of sale include the transport cost, based on responses in interviews, averaged at USD 90 per tonne. *** The mark-ups are calculated over the supplying country prices, net of the transport costs to Dar es Salaam and Nairobi.

Source: Buthelezi, T., Hammadi, M., Roberts, S. & Smaller, C. 2023. Empowering African food producers and agricultural enterprises through stronger competition law and policy. Geneva, Switzerland, Shamba Centre for Food & Climate. https://static1.squarespace.com/static/62b1cc763de5423a3166f5e3/t/658402d9e9da6906b638fc42/1703150306422/Shamba-Centre_report_Competition+Law+and+Policy_231220_v1.5.pdf based on African Market Observatory Price Tracker.

Consumers and small producers in developing countries bear the negative impacts of high global concentration in the trading and input markets (OECD, 2018; Paelo, Robb and Vilakazi, 2018; Tups and Dannenberg, 2023; Vilakazi and Roberts, 2019). Theoretically, farmers can benefit from the efficiencies generated by integrated traders and input suppliers. However, because of this concentration, farmers have limited alternatives and retain a very weak bargaining position (Sitko and Chisanga, 2017). In cases where the same companies

operate in many countries across Africa, such as in fertilizer and grain trading, collusion is more likely (World Bank, 2016).

Addressing such collusion can bring tremendous gains. According to the World Bank and the African Competition Forum, disciplining cartels and improving competition regulations could help reduce the prices of food staples by 10 percent, alleviate poverty levels for 500 000 farmers in Kenya, South Africa and Zambia,

and save consumers more than USD 700 million each year (World Bank, 2016). Yet, many African countries have not yet reached this goal. In general, competition enforcement resources are highly constrained, and their jurisdictional reach is limited (Avdasheva *et al.*, 2023). This hinders their ability to act decisively against

dominant firms engaging in anti-competitive practice, especially in cases where the behaviour is cross-border. Moreover, because some countries have not set up an effective competition authority, such behaviour may continue despite being identified and sanctioned in another country (Avdasheva *et al.*, 2023).

4 AN INCOME-GENERATING APPROACH TO END HUNGER AND MALNUTRITION: THE SOLUTIONS

To avoid short-term fixes and achieve resilient, sustainable and lasting results, transformation of agrifood systems will require a balanced approach that is properly sequenced and well financed. The most effective interventions are a mix of: (i) improvements in economic productivity through agricultural R&D, extension services and farm mechanisation; (ii) value addition through agrifood processing, distribution and retail, combined with skills training; (iii) access to finance for producers and agrifood SMEs; (iv) increased investment in market infrastructure for irrigation, roads, storage and electricity; and (v) trade and competition

policy, together with stronger regional integration, which are essential to ensure that the benefits of increased investment result in income-generating opportunities for small-scale producers and agrifood SMEs. Social protection programmes are essential to provide direct assistance for the most vulnerable for whom economic growth alone may not overcome the physical and structural barriers that prevent access to new opportunities. They are essential for generating economic growth, for example, by encouraging savings, creating community assets, and addressing market imperfections

4.1 IMPROVEMENTS IN PRODUCTIVITY THROUGH AGRICULTURAL RESEARCH AND DEVELOPMENT, EXTENSION SERVICES AND FARM MECHANISATION

The most effective interventions to improve agricultural productivity and incomes are: agricultural R&D combined with extension services; and increased farm mechanization and technological adoption, such as information and communications technologies (ICTs). Economic diversification is also conducive to overall growth in productivity.

Investments in agricultural research and development, and extension services

Public investment in agricultural R&D has a significant impact on productivity, but R&D needs time to be tested, adopted and scaled up (Laborde *et al.*, 2019). Agricultural R&D works best when complemented with other interventions, particularly extension services, roads and irrigation (Laborde *et al.*, 2019). Investment in extension services, particularly for women, must accompany R&D programmes (Acevedo *et al.*, 2020). For example, it has been found that the most important

determinants of adoption of climate-resilient crops are the availability and effectiveness of extension services (Acevedo *et al.*, 2020). SMEs such as cooperatives, processors, traders and marketing platforms frequently combine their provision of inputs and purchase of producer output with training or extension services, increasing impact (Liverpool-Tasie *et al.*, 2020).

Extension services that provide accurate information and training on new farming techniques, food safety requirements and market demands help farmers adapt to changing conditions and increase productivity (Yeboah and Flynn, 2021). Skills training programmes are particularly effective when they combine multiple elements, such as technical and financial mentorship and support for start-ups (Box 1). These programmes have been successful in enhancing engagement in agribusiness, especially among youth (Yeboah and Flynn, 2021).

BOX 1 Resilience of agropastoral populations in Eastern Sudan

UNIDO contributes to the project “Resilience of Agropastoral Populations in Eastern Sudan”, which aims at maximizing the effectiveness of skills training programmes by combining them with multiple elements. Specifically, the project seeks market-oriented solutions to create sustainable job opportunities, improve access to sustainable and modern energy sources, and foster inclusive economic growth in the Kassala State of Sudan through value chain development and access to finance. The project combines interventions in the area of agricultural production and processing, with interventions in the area of agricultural technology and agro-based micro- to small-sized enterprise development, including facilitating access to finance through financial institutions operating in the local market.



►► BOX 1 (CONT.)

The project components are as follows:

- Processing component: supporting micro and small agro-food entrepreneurs to add value to the selected raw materials, aggregate into more structured bodies, and integrate into the formal sector and access financial sources.
- Production and marketing component: building technical and management capacities of smallholder farmers and supporting them to better access support services, finance, markets as well as trade opportunities. This also includes the development of cold storage facilities.
- Renewable Energies Component: establishing sustainable financial schemes to foster access to renewable energy technologies for agricultural production and agro-processing applications.

Across all components, the project emphasizes blended financing solutions for agricultural producers and processors as a key tool.

The project set up a horticulture cold storage and sesame processing facilities, and successfully engaged 5 158 individuals, surpassing the original three-year target of 2 000, among whom 51 percent were women and 47 percent youth under the age of 35. Additionally, 853 firms actively participated in the project, resulting in the development of 709 investment-ready proposals. Furthermore, 126 new start-ups were launched, of which 68 percent were initiated by women and 44 percent by youth under 35 years old. A total of 189 capacity-building sessions were conducted, of which 48 percent were attended by a majority of women. Overall, the project contributed to create and sustain 7 009 jobs in the agro-production and agro-processing areas, of whom 44 percent for women and 37 percent for youth under 35 years old.

Source: Author's (UNIDO) own elaboration.

Mechanization and technological adoption on the farm

Mechanization and the adoption of yield-increasing technologies are essential for enhancing agricultural productivity and income. Returns to agricultural technology development (e.g. crop breeding, soil fertility management, weed control, soil and water management and agronomic practices) are high and far reaching not only in the smallholder sector, but also the entire rural economy (Yeboah and Flynn, 2021). Technological advancements are particularly important given the rising threat of climate change, which are predicted to decrease crop yields and livestock production by as much as 50 percent in certain regions in Africa (Yeboah and Flynn, 2021). However, their adoption is conditional on smallholders' perceptions of agricultural technologies as appropriate and beneficial to their context (as well as other physical barriers). Interventions to support better agricultural technology therefore need to consider the intrinsic and extrinsic set of factors that shape agriculture technology adoption (Yeboah and Flynn, 2021).

Substituting human labour with animal power or mechanical power can greatly enhance agricultural labour productivity (Daum, 2022). The use of tractors, irrigation systems and other mechanized tools significantly reduces labour inputs and increases output per unit of labour (Laborde *et al.*, 2019). Tillage using

manual tools requires around 500 labour hours per hectare compared to 60 hours using animal traction and 1–2 hours using tractors (Daum, 2022). Mechanization and technological adoption can therefore overcome some of the constraints facing smallholder farmers, for whom available labour often restricts how much households can cultivate and how much produce they can handle. In this way, mechanization can help households to overcome labour bottlenecks and shortages and expand the area under cultivation where extra land is available and affordable (Daum, 2022). In such situations, demand can be created for hired labour (Kubik, 2022).

In Asia, despite small farm sizes, mechanization rates are high due to the availability of smaller machinery and robust service markets. Similar mechanization service markets are emerging across various African countries, largely driven by the rise of small- and medium-size enterprises (SMEs) that can afford to purchase machinery but need to provide services to other farmers to ensure suitable utilization rates and a return on investment. Mechanization has proven beneficial; for instance, mechanized land preparation in Zambia increased yields by 25 percent, while tractor use across 11 African countries raised maize yields by approximately 0.5 tonnes per hectare. These findings underscore the importance of addressing labour

shortages and promoting mechanization to enhance agricultural productivity in sub-Saharan Africa (Daum, 2022; Daum and Birner, 2020).

Furthermore, through rising agricultural labour productivity, these technologies decrease the time required for on-farm activities, freeing more time for other income-generating off-farm activities. This is likely to have a larger positive effect on women who often make up the majority of the agricultural labour force (Laborde *et al.*, 2019). Additionally, increased mechanization can also increase cropping frequencies and yields. For example, mechanization in China led to a 15 percent increase in maize yields and higher agrochemical use, while in Côte d'Ivoire, tractors led to the adoption of better agronomic practices and higher input use, increasing yields by 40 percent (Daum, 2022). These technological advancements enable farmers to safeguard or raise yields, thereby increasing their income and contributing to the overall structural transformation of agrifood systems. Furthermore, mechanization of irrigation systems can have significant impacts on climate resilience by increasing water use efficiency, thereby increasing and stabilizing yields where rains are unpredictable or droughts common (see Section 5.4) (Daum, 2022).

Precision agriculture, which uses ICTs and other technologies to gather and analyse data to optimize and automate agricultural processes, also offers significant opportunities for improving agricultural productivity and sustainability. By utilizing technologies such as GPS, sensors, drones and data analytics, farmers can gather detailed information about their fields, crops and livestock. These data enable them to optimize resource use such as water, fertilizers and pesticides, leading to increased efficiency and reduced environmental impact. Precision agriculture allows for variable rate technology, which tailors inputs to specific locations within a field, potentially reducing costs and minimizing waste. Additionally, these technologies can help farmers adapt to climate change by providing real-time information on weather conditions and soil moisture. The benefits of precision agriculture extend beyond resource optimization. It can improve crop yields, enhance product quality, and increase overall farm profitability. For small-scale farmers in low- and middle-income countries, precision agriculture techniques, when adapted to their needs, can provide crucial information for decision-making. Examples include simple soil sensors in the United Republic of Tanzania that guide irrigation timing, and mobile apps in Myanmar that help farmers map their fields and determine input needs (Bizikova *et al.*, 2020). While there are challenges to widespread adoption, such as cost barriers and the

need for training, precision agriculture has the potential to significantly transform farming practices, making them more efficient, productive and environmentally sustainable (Bizikova *et al.*, 2020; Eber Rose and Murphy, 2021).

Finally, the use of mechanization with ICTs has been linked to improved working conditions for rural farmers (Yeboah and Flynn, 2021). By preventing workers from being directly exposed to occupational health hazards (e.g. exposure to chemicals and harsh natural environments), the adoption of advanced technologies and robotic systems across several countries in sub-Saharan Africa is leading to improvement in working conditions by making agriculture more safe, efficient and environmentally sustainable (Yeboah and Flynn, 2021).

Regional experiences in farm mechanisation: Latin America and the Caribbean, Asia and Africa

Latin American and Caribbean countries are characterized by the coexistence of large-scale, highly mechanized farms and smallholder farms in remote and hilly areas, which are often not as well mechanized. Nonetheless, Latin America and the Caribbean has a higher level of farm mechanization than Africa and Asia, although most countries lag in terms of mechanization compared to high- and upper-middle-income countries (Daum, 2022). As an example of the progress in Latin America and the Caribbean towards agricultural mechanization, between the 1960s and 2010, there was an increase from five to 65 tractors per 1 000 farm workers; an average increase of 4 percent per year (Daum, 2022). Although mechanization in Latin America and the Caribbean was largely driven by private actors, governments have played a key role in creating an enabling environment for it (Laborde *et al.*, 2019). Examples include public programmes to facilitate access to credit at low interest rates and tax exemptions in various countries such as Argentina, Costa Rica, Ecuador and Peru (Laborde *et al.*, 2019). Moreover, several countries have exempted agricultural machinery from imported duties (Laborde *et al.*, 2019). In Brazil and Mexico – and to some degree Argentina – strong agricultural machinery manufacturing sectors that sell to both regional and global markets have emerged, including large machinery such as tractors and harvesters. In Argentina, agricultural mechanization service markets play a major role in enabling smallholders to access mechanization (Daum, 2022).

Asia has also experienced significant levels of farm mechanization. In the 1960s, Asia was the least mechanized of all world regions; however, their

farming systems were already intensive, and the use of animal traction was common for land preparation and irrigation. This helped facilitate rapid mechanization. The development of service markets for mechanization and smaller-sized machinery has enabled even smallholder farmers to benefit from technological advancements. For example, in Bangladesh, while ownership of tractors is limited to only 4 percent of farm households, 89 percent of farmers access tractors through rental services. The vast majority of those renting tractors – 80 percent – are smallholder farmers with less than 1 ha of land (Diao, Takeshima and Zhang, 2020). This pattern illustrates the importance of equipment sharing and rental services in supporting small-scale agriculture in the country. This pattern has resulted in higher agricultural productivity, increased incomes and significant contributions to overall economic growth and poverty reduction in the region (Laborde *et al.*, 2019).

Historically in Africa, agricultural mechanization has been limited with limited market incentives and with most farmers relying on manual labour. However, there are signs of progress in selected pockets, where mechanization and improved infrastructure, driven by increased cropping intensities, have begun to enhance productivity (Diao, Takeshima and Zhang, 2020). For example, tractor usage in Northern Africa and South Africa is high, with estimates indicating that 57 percent of farms in Egypt and 70 percent in South Africa utilize tractors (Daum, 2022). Some sub-Saharan African countries have also seen progress towards mechanization. Indeed, in Ghana, about one-third of farm households use tractors for land preparation, but adoption rates vary significantly by region, ranging from as low as 2 percent in the forest zones to as high as 88 percent in the savannah zones (Diao, Takeshima and Zhang, 2020). In 2020, it was estimated that 7 percent of farmers in Nigeria used tractors, and up to 14 percent of the farmland in the United Republic of Tanzania was cultivated with tractors (Daum, 2022).

For the most part, the primary obstacles to agricultural mechanization in Africa are no longer on the demand side, but rather stem from supply-side limitations. These include insufficient technical expertise, restrictive trade and customs policies, inadequate infrastructure and highly concentrated markets. However, many governments are not addressing these supply-side issues effectively. Instead of creating an environment conducive to market-driven mechanization, they often focus on direct promotion methods. These typically involve large-scale initiatives to import and distribute heavily subsidized machinery to farmers, establishing public mechanization rental services, and planning

national tractor assembly facilities – efforts high on the agenda in countries such as Benin, Burkina Faso, Ghana, Kenya, Mali, Mozambique, Nigeria and Zimbabwe (Daum, 2022). This approach may not be the most effective way to overcome the real barriers to mechanization in African agriculture.

Nevertheless, the agricultural machinery market in Africa is experiencing changes. Private sector channels are expanding, offering both new and second-hand equipment. This includes efforts from major global manufacturers such as AGCO, John Deere and Mahindra, as well as smaller companies from developing countries (Daum and Birner, 2020). Across the continent, local industries are beginning to produce basic types of machinery. Additionally, private mechanization service markets are emerging in various countries. These supply-side developments are collectively contributing to a reduction in machinery costs, which have historically been higher in Africa compared to other regions (Daum, 2022; Daum and Birner, 2020).

Improving productivity through economic diversification

Many Asian countries transformed by focusing on non-agricultural productivity to draw labour out of agriculture (Laborde *et al.*, 2019). As the economies diversified, offering more lucrative and productive employment opportunities outside of agriculture, the proportion of the workforce engaged in farming decreased (Yeboah and Flynn, 2021). This shift resulted in rapid urbanization and industrialization, accompanied by rising rural wages. Concurrently, significant investments were made in agricultural mechanization and processing, further transforming the rural economy (Laborde *et al.*, 2019). For instance, countries such as Viet Nam and China have seen dramatic increases in rural wages and mechanization rates, driven by structural transformation and rising food demand (Daum, 2022). This dual process of economic diversification and agricultural modernization played a crucial role in driving overall economic development and improving rural livelihoods. However, there are some regional disparities. While China, India and Thailand were among the first countries to widely introduce tractors in the 1970s and 1980s, it occurred later in other countries such as Bangladesh (1990s and 2000s) and Myanmar (2010s). Consequently, there are various levels of progress towards mechanization and the use of tractors (Daum, 2022).

4.2 VALUE ADDITION AND INCOME-GENERATION THROUGH AGRIFOOD PROCESSING AND IMPROVED SKILLS

The most effective interventions to add value to primary production and increase incomes are: (i) investment in agrifood processing, particularly by agrifood SMEs in domestic and cross-border markets; (ii) better handling practices, improved packaging, more careful timing of the harvest, and cold storage for perishables, such as fruit and vegetables; (iii) diversification towards manufacturing; (iv) vocational training and university enrolment in STEM to meet the demands of the food processing sector for skilled labour; (v) strategic investment in rural roads and bridges, focusing on connecting agricultural production areas to markets and ensuring regular maintenance; and (vi) food safety measures such as basic food preservation methods (e.g. drying and fermentation) and advanced industrial processes (e.g. pasteurization and food fortification), accompanied by nutrition education.

Value addition through agrifood processing

Value addition through agrifood processing is a critical component of improving incomes in agrifood systems, and for re-engaging youth into the agrifood sector (Nakitto *et al.*, 2024). Agrifood processing can create employment opportunities by adding value to agricultural products through processing, packaging and marketing (Yeboah and Flynn, 2021). By investing in agro-industrial infrastructure, countries can stimulate economic growth and provide better employment opportunities for their populations. Additionally, agro-industrialization can attract foreign direct investment, further boosting economic development and technological innovation in the agricultural sector. Ethiopia's Integrated Agro-Industrial Parks Development is an example of efforts to spur industrialization of the agribusiness sector through agrifood processing and by forming connections between value chain enterprises (Box 2).

BOX 2 Ethiopia's Integrated Agro-Industrial Parks development

In Ethiopia, UNIDO is supporting the development of four Integrated Agro-Industrial Parks (IAIPs). An agro-industrial park is an agribusiness development corridor integrating value chain actors with high-quality infrastructure, utilities, logistics, and specialized facilities and services to create economies of scale for sustainable market-driven agribusiness development and rural transformation. The primary objective of agro-parks is to create investment opportunities in agribusiness. The IAIPs in Ethiopia also aim to promote the value addition of agricultural production through processing, manufacturing and storage of food, feed, and biofuel products; drive technological change; and spur industrialization of the agribusiness sector by offering premises and supporting services that connect value chain enterprises.

The IAIPs combine infrastructure needs, such as roads, power, water, sewage and telecommunications, with features to support agrifood processing, for example, open production zones, controlled environment growing areas, precision farming, research facilities, rural hubs, agri-infrastructure, collection centres, primary processing hubs and agri-marketing infrastructure. They also provide specialized infrastructure such as cold storage, quarantine facilities, quality control labs, certification centres and central processing units. The IAIPs are supported by a network of rural transformation centres in a 100-km radius, which function as hubs for agricultural processing, sorting, grading and other pre-processing activities, credit and finance services, input supply, and market information provision, thus further assisting producers and linking them to markets.

There are currently three operational IAIPs, with 114 investors committed to the initiative. To date, 25 factories are under establishment, and out of which nine agro-processing investments are fully operational. These efforts have generated over USD 48.1 million in export revenue and created 2 297 factory-level jobs. Smallholder farmers have been increasingly linked to the IAIPs as suppliers, with 131 605 farmers engaged in 2022, 103 800 in 2023, and 39 992 in Q2 of 2024.

The Ethiopian Government is encouraging investment through various incentives, such as low land prices, incometax exemptions, duty-free imports for capital goods, and financial support from domestic institutions.

Source: Author's (UNIDO) own elaboration.

These interventions not only increase income for farmers, but also generate employment in non-farm occupations as demand for goods and services rises (Yeboah and Flynn, 2021). Special attention to the role of women and youth in the agricultural sector is essential for improved employment outcomes and broader structural transformation (Yeboah and Flynn, 2021). With the proliferation of agro-processing practices, tertiary education and the service sector will play crucial roles, creating decent job opportunities and greater income. The international acceptance of these public and private services is inevitable to maintain the competitiveness of the agrifood sector.

A study conducted in Ethiopia, Ghana and Tunisia in 2022 showed that while employment in agrifood processing accounted for only 5 percent of total employment in the food economy, the ability of the food processing sector to generate employment opportunities as a percentage of its growth was high, which therefore presents significant opportunities for employment and income generation (Kubik *et al.*, 2022).

By transforming raw agricultural products into higher-value goods, farmers and local businesses can capture more of the final market price. For instance, processing tomatoes into paste or turning milk into cheese significantly increases the income of producers (Begimkulov and Darr, 2023). This approach not only boosts the financial returns for farmers, but also creates diverse employment opportunities in rural areas, ranging from low-skilled labour to high-skilled technical and managerial positions.

Brazil, the country that has experienced the most rapid mechanization progress in Latin America, accelerated its transformation through price interventions that removed anti-agricultural biases, leading to increased investment in agrifood processing. The region's focus on enhancing agricultural productivity resulted in higher incomes for farmers and the creation of numerous jobs in the food processing sector, contributing to broader economic development and poverty reduction (Daum, 2022).

New opportunities have emerged to increase participation of agrifood SMEs in food processing across Africa (Nakitto *et al.*, 2024). Many of these opportunities are in domestic and regional markets as processors respond to growing demand (Nakitto *et al.*, 2024). In Senegal, for example, demand for ready-to-eat millet has increased processing of millet (Badiane *et al.*, 2022).

Investments in modernised supply chain to reduce post-harvest losses

It is increased efficiencies in agrifood supply chains that will significantly impact farmers' and agrifood

SMEs incomes as they benefit from greater value addition and reduced food loss and waste. By improving infrastructure and logistics, such as cold chain facilities and transportation networks, countries can ensure that food reaches consumers in a timely manner, reducing spoilage and increasing the market value of agricultural products.

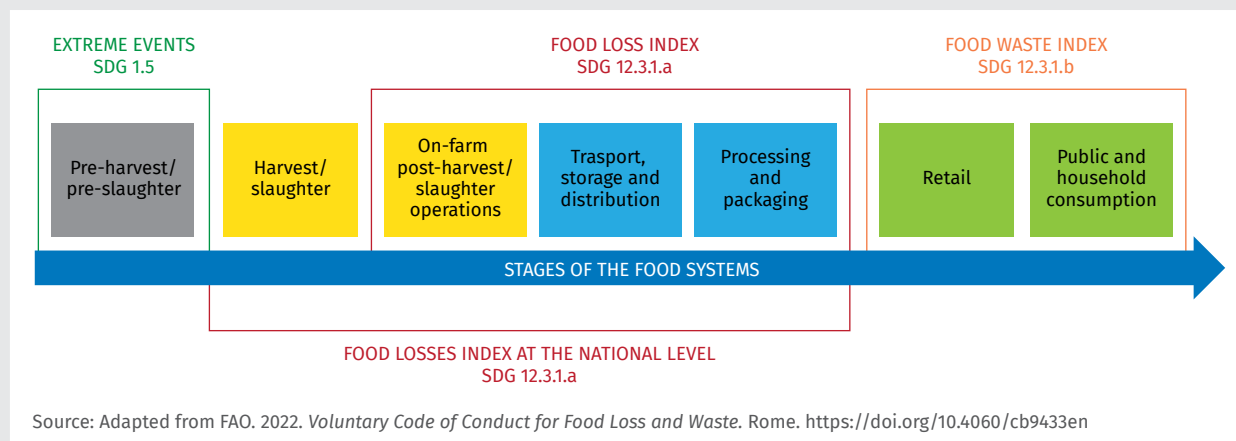
Efficiency in the food supply chain is crucial for reducing food loss and waste. However, there is insufficient accurate information to quantify the problem, limited evidence on its sources or causes, and no data on the cost-effectiveness of the technologies implemented (Delgado, Schuster and Torero, 2023). Moreover, traditionally food loss and waste have been measured together rather than separately, making it even more difficult to ascertain the extent of the problem.

In 2019, FAO launched the Food Loss Index, and in 2021, the United Nations Environment Programme (UNEP) introduced the Food Waste Index, both based on the respective definitions of food loss and food waste (Figure 13). The definitions of food loss and food waste align with the distinction outlined in SDG target 12.3, which refers to "food losses along production and supply chains" and "food waste at the retail and consumer levels" (Figure 13). The Food Waste Index estimates that approximately 13.2 percent of global food production is lost annually in 2021, while UNEP estimates that about 19 percent of food is wasted in 2024.

Food loss and waste can occur at various stages of the value chain from harvest to consumption. These stages include post-harvest handling, processing, storage, distribution, commercialization, and consumption, with losses manifesting as either reductions in quantity (weight or volume) or quality (Hodges, Buzby and Bennett, 2011). Intervention efforts have predominantly targeted specific stages of the value chain, aiming to quantitatively reduce food losses. Much of the research has focused on technical solutions to minimize losses during storage on farms, as well as at wholesale and retail levels.

Investments in modern supply chain technologies, such as sensors for real-time monitoring, can enhance supply chain efficiency and transparency, building consumer trust and opening new market opportunities for producers and agrifood SMEs. This not only improves income generation, but also contributes to the resilience and environmental sustainability of agrifood systems. The Food Loss App (FLAPP) developed by FAO is one such example of an innovative digital tool to reduce food loss along the value chain (Box 3).

FIGURE 13 Scope of the Food Loss and Food Waste Index along the supply chain



BOX 3 The Food Loss App

The Food Loss App (FLAPP) developed by FAO is a significant advancement in the fight against food loss. This innovative tool is designed to enhance data collection and identify food loss hotspots by leveraging real-time, crowd-sourced information directly from farmers.

FLAPP provides detailed insights into the causes of food loss at various stages and across different commodities. By offering a comprehensive view of where losses occur, the app helps to pinpoint areas that are particularly vulnerable to post-harvest losses.

Users of FLAPP can visualize food losses through intuitive interfaces and access tailored advice. This empowers producers, cooperatives and researchers to make informed decisions that aim to reduce food loss and improve supply chain efficiency. Through its practical application, FLAPP plays a crucial role in enhancing the sustainability of agrifood systems.

Source: FAO. 2023c. *Achieving SDG 2 without breaching the 1.5 °C threshold: A global roadmap, Part 1. In brief*. Rome. <https://doi.org/10.4060/cc9113en>

While most research on post-harvest loss interventions currently focus on staple crops, more attention is being given to interventions that target nutritious foods, which are often more perishable than staples (Stathers *et al.*, 2020).

There is general consensus that in sub-Saharan Africa, most losses of fresh produce occur in processing, packaging and distribution (Anand and Barua, 2022; Sheahan and Barrett, 2017). One of the identified key solutions to alleviate the high volumes of post-harvest loss of fruits and vegetables is cold storage (Nicastro and Carillo, 2021). Other technology interventions that were effective at reducing losses of fruits and vegetables further along the value chain included better handling practices, improved packaging and more careful timing of the harvest (Stathers *et al.*, 2020).

Cold storage refers to the “storage of highly perishable produce in a controlled environment with respect to temperature and relative humidity [which] leads to quality and quantity preservation” (Makule, Dimoso and Tassou, 2022). Studies investigating the effect of cold storage technologies on collards in the United Republic of Tanzania (Kathambi *et al.*, 2022) or mangoes in Kenya (Amwoka *et al.*, 2021) found that cold storage extended the produce’s shelf life by up to 16 and 18 days, respectively. Similarly, post-harvest quality, as measured by loss of weight, colour, texture and nutrients, was enhanced (Amwoka *et al.*, 2021; Kathambi *et al.*, 2022).

Under UNIDO’s “Fostering Inclusive Economic Growth In Kassala State through Agro-Value Chains Development and Access To Financial Services”, a cold storage facility for vegetables and fruits was built in the area of the Kassala horticultural market, the Sudan. The facility

helped smallholder farmers reduce the post-harvest losses from an average of 37 percent to 2.4 percent for bananas, pumpkins, potatoes, mangos, tomatoes,

oranges, grapefruits and watermelon. The cold storage facility increased the shelf-life of bananas by four-fold and by 1.5 to three-fold for the other crops (Table 1).

TABLE 1 Effect of cold storage on the perishability of vegetables and fruits in the Sudan

Crop	Storage duration	Percentage of post-harvest losses without using cold storage	Percentage of post-harvest losses after using cold storage	Shelf-life of produce when using cold storage	Percentage of shelf-life increase when using cold storage
	(days)	(%)	(%)	(days)	(%)
Banana	7	50	2	30	429
Pumpkin	180	20	3	360	200
Potatoes	90	50	1	240	267
Mango	30	40	3	90	300
Tomatoes	15	50	3	30	200
Orange	90	30	1	240	267
Grapefruit	90	30	1	240	267
Watermelon	30	25	5	45	150
Total		295	19		
Average		37	2.4		

Source: Authors' (UNIDO) own elaboration.

However, to date, smallholder farmers, despite contributing 80 percent of fruit and vegetables in sub-Saharan Africa have been unable to access cold storage (Sibanda and Workneh, 2020). Traditionally, cooling technologies have been viewed as inappropriate for rural smallholder farmers in sub-Saharan Africa given their high start-up and running costs, and infrastructure requirements, such as constant energy supply (Sibanda and Workneh, 2020). This disadvantages smallholder farmers who are unable to capitalize on the increasing national and international demand for fresh produce (Kitinoja *et al.*, 2021). As the requirements of high-value export markets become more complex as consumers, often located in the Global North, increasingly demand higher standards of food safety and quality, this exclusion has only worsened (van Berkum, 2021).

However, things are changing. Increasingly decentralized cold storage units are being made available to smallholder farmers, bypassing the traditional entry barriers (Kitinoja *et al.*, 2021). In the aim of enabling

smallholder farmers to more effectively cultivate fruits and vegetables, cold storage is a significant economic opportunity due to the higher rates of return of fruits and vegetables than staples (Ali *et al.*, 2021). Furthermore, the development of low-cost cold chain facilities could enable smallholder farmers to transition from subsistence to commercial farming, facilitating their integration into global value chains and access to the economic gains accompanying this (Sibanda and Workneh, 2020).

Scaling and diversification of value chains

Some agrifood SMEs have successfully scaled their operations by engaging in downstream activities, such as processing, cleaning, packing and distributing their products. This can involve opening distribution channels or improving logistics infrastructure and cold storage facilities. For example, animal producers have diversified their businesses to cultivate fodder or process caught marine products (Begimkulov and Darr, 2023). These approaches not only increase the value added to agricultural products and increase

the share of captured revenue, but also help mitigate price-related risks by stabilizing revenues during the off season and decreasing dependency on external service suppliers (e.g. input providers or transport companies) who can increase prices during high season (Begimkulov and Darr, 2023).

Furthermore, through a greater range of products and offerings, agrifood processors can diversify their income streams, mitigating the risks associated with market price fluctuations and low harvest seasons. For example, sheep farmers producing cheese and other dairy products can cover operational costs and increase their income, demonstrating the potential of value-added products to enhance financial resilience (Begimkulov and Darr, 2023). These diversification strategies reduce dependence on a single source of income and provides financial stability during the off-season or in the event of poor yields.

In some countries, employment in the off-farm areas of the agrifood system has become significant. In Malawi and the United Republic of Tanzania, food and beverages account for more than 40 percent of total manufacturing employment (Kubik, 2022). However, this has primarily been concentrated in wholesale and retail rather than agro-processing. For example, in West Africa, marketing activities such as transport, logistics, retail and wholesale account for 68 percent of off-farm agrifood system employment, while food processing only accounts for 22 percent (Kubik, 2022). This pattern is often due to the significant role of imported high-value agricultural products and grains in local consumption, which, although potentially boosting employment in wholesale and retail sectors, leads to the loss of potential gains in agro-processing to international suppliers (Kubik, 2022).

In Ethiopia and Ghana, new opportunities in non-farm sectors and employment opportunities for unskilled labourers in rural areas have led to an increase in rural wages, driving some mechanization and value addition efforts.

Several Asian nations have developed a robust local manufacturing industry that create machinery tailored to local needs offered at affordable prices. For example, India has become the world's largest producer of tractors, and China is taking a pioneering role in the use of agricultural drones. This follows the broad trend that mechanization in Asia has largely been driven by private markets. Where governments have played a role it has largely been through creating an enabling business environment (Daum, 2022; Diao, Takeshima and Zhang, 2020).

One of the major bottlenecks in the scaling of agrifood enterprises is the limited availability of, and access to, finance and resources. Scaling up often requires additional investments in technologies, capacities and resources, the immediate financing of which is not always straightforward. It also often requires an additional, new or existing resource, such as land, fertilizers and irrigation systems, and sometimes, even with sufficient financial resources, agrifood enterprises might not have access to the resources necessary for scaling (Begimkulov and Darr, 2023). Many agricultural innovations are first adopted by large farms with better tenure security, access to credits, extension services, markets and the ability to take risks. Large farms have a further advantage in adopting mechanization because mechanization technologies are indivisible and associated with economies of scale, putting farmers who operate on small and fragmented plots at a disadvantage (Daum, 2022). Historical and contemporary evidence from various low- and lower-middle-income countries consistently shows that larger farms tend to adopt mechanization earlier than smaller farms.

Distribution and logistics: Avoiding bottlenecks and improving market access

Rural infrastructure creates significant bottlenecks that hinder distribution and logistics in these regions. Enhancing transportation, communication and electricity infrastructure is crucial for distribution and logistics. Poor infrastructure leads to high transaction costs for farmers in accessing markets for inputs and outputs, which reduces their incentives and ability to intensify production, engage with markets, and invest in technologies such as mechanization.

Improved transportation infrastructure allows farmers to better connect with growing domestic urban and international markets. There is broad consensus that rural transport infrastructure plays a pivotal role in driving economic growth and development. Improved rural transport infrastructure enhances market access of farmers and businesses, and enables them to source inputs more efficiently. It boosts agricultural production by facilitating the movement of goods from farms to markets, and enabling easier access to agricultural inputs and technologies. Furthermore, it fosters the creation and growth of firms by reducing operational costs and expanding business opportunities (Daum, 2022; Kaiser and Barstow, 2022).

To address the bottlenecks and promote supply chains and market access, strategic investment in rural roads and bridges is needed, focusing on connecting agricultural production areas to markets and ensuring regular maintenance. Investments in rural roads have

been deemed to be more cost-effective and impactful than central road networks, since they are the “first mile” and “last mile” that enable the flow of goods both to and from remote communities to urban centres (Kaiser and Barstow, 2022).

The focus on rural transportation should not just be limited to roads, but rather should also consider local terrain and bottlenecks. Programme design often considers measurements such as the Rural Access Index (RAI), which measures peoples’ proximity to an all-season road, ignoring obstacles such as rivers. Organizations such as Helvetas and Bridges to Prosperity (B2P) have successfully implemented community-based bridge construction projects that significantly benefit local communities. In Rwanda, B2P’s bridges increased labour market income by 25 percent, while in Nicaragua, they led to a 60 percent rise in women entering the workforce, an 11 percent increase in overall welfare, and mitigated earnings losses during floods (Brooks and Donovan, 2020; Kaiser and Barstow, 2022; Thomas *et al.*, 2021).

Generally, governments are perceived to be responsible for infrastructure interventions. However, there is a vast financing gap between projected needs and actual funding. Given the well-established evidence base on the benefits of enhanced rural infrastructure, especially transport services, alternative funding streams need to be considered. Traditionally, the creation of a consistent revenue stream has been suggested through tolls or fuel taxes, but in rural and poor areas, this seems unfeasible and is rarely seen in practice. Additionally, infrastructure interventions need to be gender-sensitive because men and women have different needs and do not reap the benefits of infrastructure equally and because specific gendered challenges limit women’s ability to utilize infrastructure and services (Kaiser and Barstow, 2022). Finally, integrated planning that links rural transport with agricultural development policies and market access strategies is essential (Kaiser and Barstow, 2022).

Decent jobs and better income through skills development and training

In Africa, there is a severe shortage of people with the technical skills required in the agrifood processing sector. This can partly be attributed to low enrolment in STEM subjects (Nakitto *et al.*, 2024). According to the African Development Bank, only 19 percent of Africa’s higher education graduates had studied in one of these fields, compared to 27 percent in developed economies (AfDB, 2022). The skills gap for agrifood processing technologies, combined with inadequate access to

finance have undermined Africa’s innovation capacity in agrifood processing enterprise (Badiane *et al.*, 2022). In Ethiopia, Kenya, Nigeria and South Africa skills gaps were reported 52 percent of the time by automated firms, and 40 percent of the time by mechanized firms, and it was reported that the most sought-after skills related to machine operations and computer use (Baumüller, Kubik and Getahun, 2023).

Programmes that offer training in multiple skills to rural youth show promise in increasing employment levels and wages among the programme graduates, creating new possibilities for income (Maïga *et al.*, 2020). Entrepreneurship and self-employment support programmes provide financial and technical support to micro, small and medium-sized enterprises, helping to overcome barriers to starting and sustaining businesses (Yeboah and Flynn, 2021). Proper targeting of these programmes ensures that individuals with entrepreneurial ambitions are encouraged to start their ventures. Programmes that combine skills training with financial support and continuous mentorship show positive results in enhancing youth engagement in agribusiness.

Public-private partnerships can play a critical role in ensuring the effectiveness of employment interventions. Skills training interventions are 20–30 percent more impactful when carried out by private sector entities compared to public sector training providers (Yeboah and Flynn, 2021). Private sector involvement ensures alignment of training programmes with market needs, improving the relevance and quality of the training provided.

The effectiveness of employment interventions varies by target group, and a balanced approach that addresses both supply- and demand-side constraints is necessary. Further, investment in larger firms, which are generally better positioned to create sustainable jobs, should be balanced with support for SMEs to increase their production and productivity over time (Kubik, 2022; Quak and Flynn, 2019). The emergence of agrifood processing SMEs have the potential to increase overall employment compared to large firms (Ellis, Fang and McMillan, 2022).

Finally, efforts are needed to enhance vocational training and university enrolment in STEM to meet the demands of the food processing sector for skilled labour (Nakitto *et al.*, 2024). This will require better linkages between industry and academia, such as the training programme created by the International Labour Organization (ILO) to improve skills in the food processing sector in Ethiopia (ILO, 2022).

Processing for nutritious and safe food

Growing food demand in developing countries, a consequence of rising per capita incomes, urbanization and new export opportunities, is leading to a shift of production from cereals to high-value fresh, processed and convenient foods. These changes in production patterns will require a higher level of food management and transformation beyond the farm, requiring major investments in processing, logistics and market infrastructure.

Food processing plays a crucial role in ensuring food safety, extending shelf life, and enhancing the nutritional value of food products. Various processing methods are employed to transform raw agricultural commodities into safe, palatable and nutritious foods for consumers. These techniques range from basic preservation methods such as drying and fermentation to more advanced industrial processes such as pasteurization and modified atmosphere packaging. While processing can help make foods safer and more accessible, it is important to balance these benefits with potential nutrient losses or the addition of less healthy ingredients.

A transition towards nutritious, and safe foods will require the development of preservation and storage technologies which can enhance food safety as well as reduce food losses. For instance, preservation and storage technologies such as dryers and cold storage can considerably reduce food losses and

enhance food safety by reducing contamination with fungi such as aflatoxins (Stathers *et al.*, 2020). Technologies for preservation, storage, processing and transportation are particularly key to prolong the shelf life of foods with high nutritional value, such as fruits and vegetables, contributing to increased food security and better nutritional outcomes (Duncan *et al.*, 2022).

Robust policy and regulatory frameworks are essential for successful agrifood processing interventions. Implementing and enforcing stringent food safety standards ensures the production of safe food products, protecting public health and building consumer confidence. Supportive policies that encourage investment in agro-industrial activities, such as tax incentives and subsidies for SMEs, stimulate growth and innovation in the food processing sector. Strengthening agricultural value chains and facilitating market access ensure that smallholder farmers and local processors can diversify into more nutritious, often more perishable products. See, for example, UNIDO's Cambodia Programme for Sustainable and Inclusive Growth in the Fisheries Sector: Capture component (CaPFish Capture), which focuses on post-harvest activities in fisheries, especially on the importance of adhering to international food safety standards to enable smallholder farmers to access international markets (Box 4).

BOX 4 The Cambodia Programme for Sustainable and Inclusive Growth in the Fisheries Sector: Capture component

In Cambodia, post-harvest fisheries activities are still dominated by small and micro-scale productions that are generally informal and uncompetitive. The programme aims at the inclusive development of the post-harvest fisheries' value chain by focusing on capacity building, skills development and food safety system implementation, matching investment support, and building business development services and mechanisms. The programme is expected to result in improved recognition of Cambodia's food safety systems, improved market access to global markets, such as European Union markets, increased investments in the fisheries sector, and overall improved productivity and competitiveness.

The programme seeks to develop a more competitive, global market compliant and profitable post-harvest fisheries industries in Cambodia through three levels of intervention using a participatory and sustainable approach:

- Food safety control system: Establishing an efficient and standardized food safety control system in post-harvest fisheries to ensure that Cambodia products meet global market requirements, including the European Union markets.
- The private sector: Supporting private sector businesses through value chain financing schemes along fisheries value chains to upgrade operations and market compliance while enhancing business competitiveness.
- Research and development (R&D) and innovation: Bolstering R&D to improve product quality and innovation and foster entrepreneurship together with universities and research institutes.



►► BOX 4 (CONT.)

By 2025, the programme aims to harmonize Cambodia's food safety systems with global requirements, increase private sector competitiveness, expand fishery exports, and foster greater access to finance through an inclusive value chain financing mechanism. By 2024, the key achievements of the project included: certification of 17 enterprises with Cambodia Quality Seal (CQS); creation and retention of 11 113 jobs, with 5 109 for women; production of 9 518 tonnes of fishery products; 28 enterprises linked to new markets; 211 business plans developed; and the inspection of 314 establishments for hygiene and food safety compliance. The programme so far provided the micro, small and medium-sized enterprises (MSMEs) with around EUR 1 million worth of technical assistance and equipment support, which in turn leveraged additional EUR 1.8 million of own investment from the MSMEs. The project recently launched the Investment Support Facility, an innovative blended finance scheme comprising grants, guaranteed loans and enterprises' own investment, underpinned by business development technical support. It targets more than 100 enterprises in fish value chain and can be easily scaled up and replicated in other agrifood value chains. Pilot stage includes EUR 0.5 million of grant funds, which would leverage additional EUR 0.75 million of enterprises own investment and contribute to financial inclusion of fisheries enterprises and better access to financial services.

Source: Author's (UNIDO) own elaboration.

Concerning the nutritious value of foods, food fortification programmes have been instrumental in addressing micronutrient deficiencies by adding essential vitamins and minerals to staple foods. Fortification can occur on the production side where farmers grow biofortified or nutrient-dense crop varieties that have been modified by conventional breeding or biotechnology to address a nutrient deficiency (Ofori, *et al.*, 2022). There are also some successes with agronomic fortification where fertilizers are fortified with minerals. In Malawi, it has been shown that adding selenium fertilizers to staple cereal crops has alleviated micronutrient deficiencies (Joy *et al.*, 2019). Additionally, fortification can occur through nutrient enhancement during food processing. Food fortification is effective but more costly than biofortification for many low- and middle-income countries. Yet, fortification with iron, iodine and other vitamins has greatly reduced the prevalence of diseases associated with nutrient deficiencies such as anaemia (Ofori *et al.*, 2022).

In addition to ensure the availability of healthy and nutritious foods, nutrition education and awareness programmes play a crucial role in promoting healthier food choices and improving public health outcomes. In addition to the availability and affordability of nutritious foods, awareness among households in both urban and rural areas of the nutrition contents of different foods affects their consumption. Hence, to maximize the impact of supply-side interventions, such as social protection programmes, nutrition programmes and agricultural productivity programmes, they should be complemented by other initiatives that provide nutrition education and deliver advice on storing and utilizing diverse, nutritious food products. Engaging local communities in the design and implementation of food processing interventions ensures cultural relevance and acceptance, enhancing the effectiveness of these initiatives.

4.3 FINANCING THE "MISSING MIDDLE": SMALL-SCALE PRODUCERS AND AGRIFOOD SMALL AND MEDIUM-SIZED ENTERPRISES

Access to finance is essential to make all the interventions discussed above possible. One of the biggest challenges in transforming agrifood systems, including enhancing agricultural productivity and agrifood systems, is access to finance, particularly for the "missing middle" – i.e. small-scale producers and agrifood SMEs. Reducing costs and risks is critical to close the financing gap for small-scale producers and agrifood SMEs across value chains. A joint UNIDO, FAO, ILO and United Nations Population Fund (UNFPA) project

under the Agrifood Systems Transformation Accelerator (ASTA) programme, focuses on access to finance and market services for small-scale producers and agrifood SMEs in the pineapple value chain in Suriname (Box 5).

In the context of financing for domestic agrifood SMEs, strengthening supply chain relationships is key to unlocking more financing. Catalytic capital providers should be focusing not only on direct project-level interventions but also on aggregation plays that pull

larger investors into the space (Convergence, 2024). Several innovative solutions that emphasize the value of relationships and trust between farmers, SMEs and their buyers, traders and wholesalers are proposed below. They are: (i) factoring; (ii) supply chain finance

or reverse factoring; (iii) outcome financing; (iv) real estate investment trusts; (v) PSL; (vi) asset monetization; and (vii) guarantees. Critical to all seven solutions is the need for increased participation by domestic governments and investors.

BOX 5 Sustainable pineapple value chain development in Suriname

The United Nations Joint SDG Fund approved a project in Suriname, under the joint UNIDO and FAO ASTA programme. The project aims to develop a sustainable and inclusive pineapple value chain, transforming Suriname into a competitive exporter of organic and processed pineapple products. The focus is on economic diversification, boosting production, improving access to financial and market services, and promoting stakeholder collaboration.

The project focuses on three key initiatives:

- **Pineapple innovation hub:** A one-stop shop for farmer support, offering inputs, and finance and technical assistance. The Hub tracks farmers' production and finances, supporting accurate record-keeping and monitoring. A credit committee assesses loan risks and prepares monthly audited reports. Out-grower production plans are developed and monitored with farmers while coordinating the supply of inputs and financing. Post-harvest handling, including packhouse operations, are managed to maintain product quality. Additionally, the project negotiates deals with national and international buyers, and oversees the Hub's accounting, preparing annual audited financial reports for the Board.
- **Collateral support facility:** A loan guarantee fund to promote investment by de-risking loans for farmers and allowing private sector banks to lend to farmers and collectives that otherwise would not have had access to finance. To this end, the ASTA team designed a loan facility that aligns with local conditions and Basel Banking standards. It provides cash collateral for loans to pineapple farmers, covering input and service costs under an out-grower scheme managed by the Hub. Interested farmers are assessed by a credit committee on their risk profile and willingness to adopt improved practices. After harvest, participating farmers sell their pineapples via the Hub at going farmgate prices, which will pay the farmers in two parts, a payment directly to the bank to repay the loan, and a payment directly to the farmer for the remainder.
- **Pineapple Cooperative Development Company:** A growers' cooperative for marketing and aggregation, enhancing economies of scale. Through an out-grower scheme with individual farmers, most but not all of whom will also be members of village level cooperatives, the Company will be responsible for centralized production planning and marketing of the pineapples.

The initiative expects to create nearly 1 000 full-time equivalent jobs, improve livelihoods for at least 1 400 households, and increase incomes for at least 400 smallholders while preserving 200 hectares of forests. The suggested net earnings in the final year are estimated at over USD 14 000.

Source: Authors' (UNIDO) own elaboration.

Factoring 2.0

Factoring refers to when borrowers use an invoice or a purchasing order to raise a working capital loan from a third-party such as a commercial bank. The advantages of factoring for farmers and SMEs are that it eases cashflow constraints and helps optimize working capital. An important element, however, is that the ability to raise the loan depends on the creditworthiness of the borrowing farmer or SME as well as their buyers. This reinforces the earlier point regarding the challenges faced by farmers and SMEs servicing domestic markets, since they may not have advance purchasing orders from a buyer or wholesaler, and even

if they do, the creditworthiness of both entities may still be insufficient to obtain a working capital loan.

There is, however, welcome innovation in traditional factoring. What if SMEs could use their purchasing agreements as well as the strength of their relationships with buyers or wholesalers upstream to improve their creditworthiness and borrow without posing collateral? The Food Securities Fund, launched in 2021, builds on the trust between producers and buyers to provide credit guarantees (Box 6). While the focus here is on global value chains, the design could well be transferred to domestic value chains in the medium term.

BOX 6 Food Securities Fund

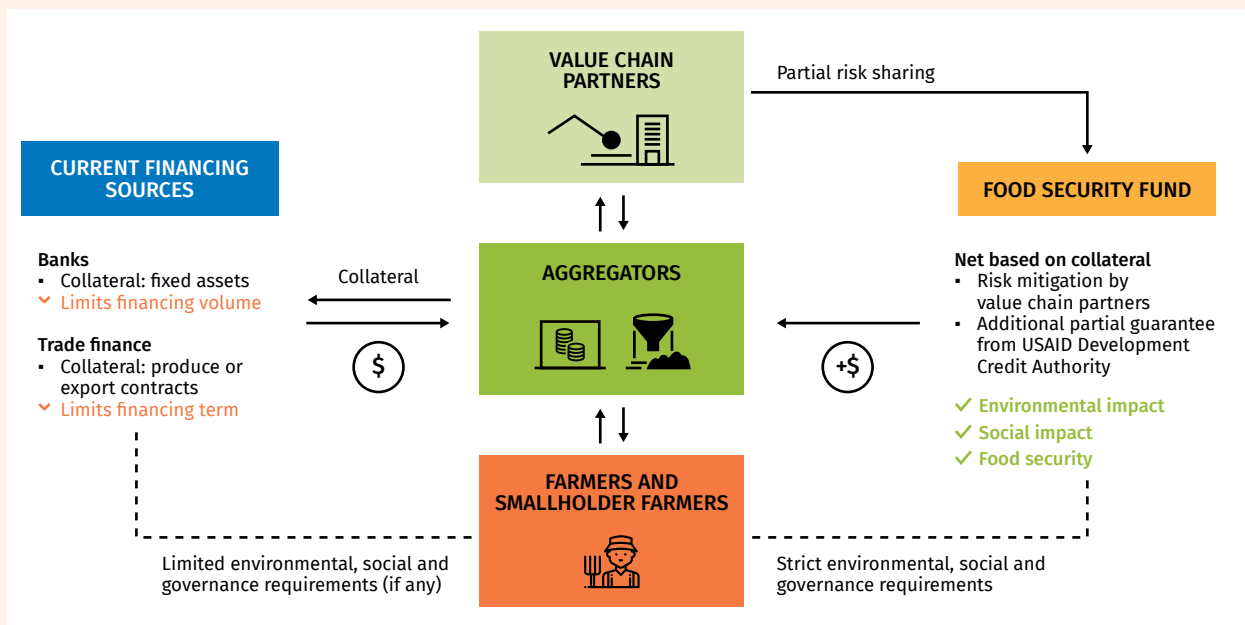
The Food Securities Fund provides financing to agrifood small and medium-sized enterprises (SMEs) without requiring collateral by combining credit guarantees and risk mitigation through supply chain relationships. It provides renewable, short-term loans (of a 12-month tenor in general) denominated in US dollars and incurring a 9–15 percent interest rate for developing and emerging country agrifood SMEs to finance their activities throughout the agricultural cycle.

The Food Securities Fund provides financing directly to agrifood SMEs, which it identifies in collaboration with international agricultural companies. Because of their pre-existing relationships with selected agrifood SMEs, international agricultural companies (e.g. traders, input providers, exporters, agents, consumer facing brands) agree to act as guarantors for the transactions, effectively sharing part of the risk with the Fund. In exchange for the financing provided by the Fund to agrifood SMEs in their network, international agricultural companies provide first loss guarantees of 10–40 percent of the loan principal.

This partial risk-sharing mechanism with supply chain partners is consolidated by a partial guarantee from the Development Credit Authority of the United States Agency for International Development (USAID). This additional guarantee allows the Fund to cover loans for a period of up to six years (including renewals) for specific borrowers.

Its borrowers must have a proven track record of a strong commitment to sound social and environmental practices, in addition to active engagement in transactions with farmers who implement good agricultural practices, such as climate-smart agriculture.

FIGURE 14 The Food Securities Fund model



Note: USAID = United States Agency for International Development.

Source: GEF (Global Environment Facility). 2019. *The Food Securities Fund: A fund to finance sustainable supply chains at scale in Emerging Markets.* https://www.thegef.org/sites/default/files/web-documents/10322_NGI_PIF.pdf

Value creation across supply chains is also the baseline proposition of IDH, which works to align the interests of buyers, sellers, regulators, voluntary standards and regulators to create a common understanding on pressing sustainability issues. For example, the Cocoa

& Forest Initiative facilitates dialogue between the foremost cocoa producing country governments and large cocoa buyers to halt deforestation. Similarly, the IDH Malawi tea 2020 programme brings buyers, civil society actors, Malawian tea producers and

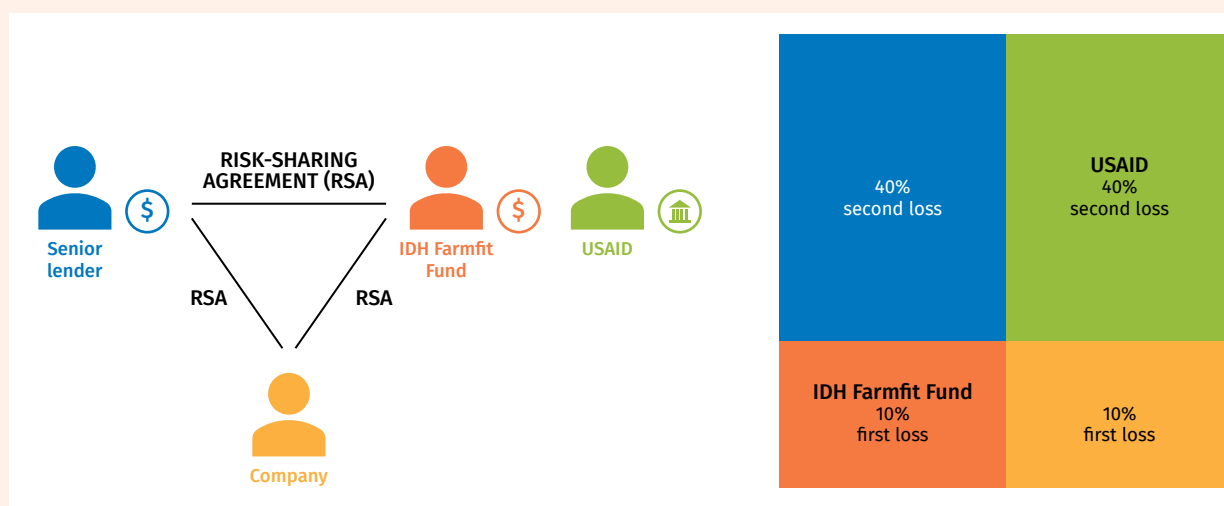
trade unions together to work towards living wages. The Sustainability Initiative Fruit and Vegetables is also noteworthy. Designed as a membership programme, it offers technical assistance to members on voluntary standards that certify the environmental and social

footprint of their produce. This helps SMEs transact with both local and foreign buyers seeking premium products. The intelligence from all these initiatives feeds into the IDH Farmfit Fund (Box 7).

BOX 7 IDH Farmfit Fund

The Farmfit Fund offers concessional financing to scale and diversify buyer-supplier contracts that are designed and informed by IDH Farmfit Intelligence and IDH Business Support. The Fund provides first loss financing to banks, covering 10 percent of loans, together with second-loss guarantee facility from United States Agency for International Development (USAID), covering 40 percent of the loans offered to small and medium-sized enterprises (SMEs) and smallholder farmers. Because lending is informed by IDH data, transactions are concluded with reduced costs and risks for both lenders and SME borrowers.

FIGURE 15 The Farmfit Fund structure



Note: USAID = United States Agency for International Development.

Source: IDH. 2024. IDH Farmfit Fund. In: *IDH - the Sustainable Trade Initiative*. [Cited 25 September 2024]. <https://www.idhsustainabletrade.com/farmfit-fund>

Supply chain financing or reverse factoring

Supply chain financing (also referred to as reverse factoring) refers to when buyers of a crop or food product pay farmers and SMEs ahead of the harvest or production. There are myriad ways in which these early payments can be organized, such as in tranches or with a larger payment upfront.

The drawback is that these early payments are rarely free. Farmers and cooperatives have to offer the buyer a discount in return, and discounts can be particularly sizeable for unprocessed and perishable crops. For SMEs working in commodities, dynamic discounting is a very common practice (Gelsomino *et al.*, 2016). If a producer gets paid early, for instance, within five days instead of the customary 30, 60 or even 90-day period, the discount can be as much as 5 percent.

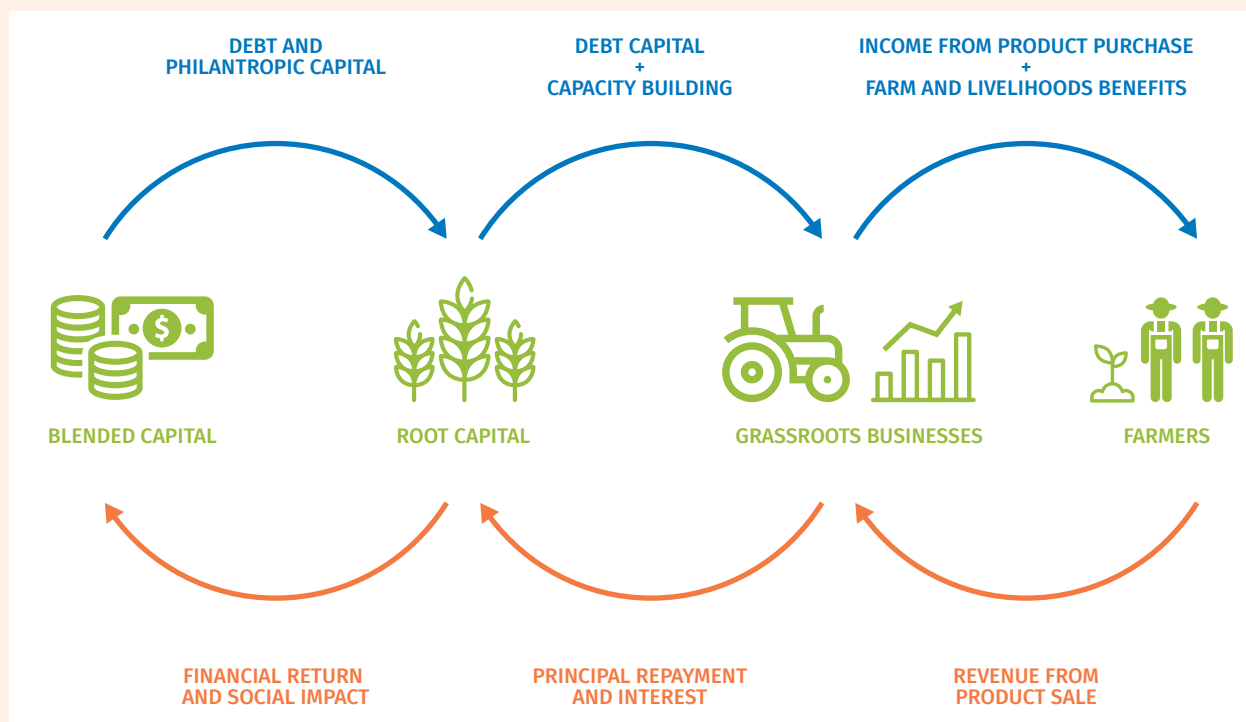
Outcome financing

Outcome financing consists of offering grants and low-cost loans to SMEs, farmers and producers to fund the delivery of pre-agreed, measurable outcomes as opposed to providing working capital to fund daily operations. The value proposition is that funding is conditional upon the achievement of given outcomes that align with development outcomes, such as the SDGs, and that, as such, donors are assured of impact, while beneficiaries are also provided with an incentive to change the way they work to achieve the targeted impact. This marks an important shift in development finance, with funding no longer allocated to deliverables, outputs and the execution of work, but rather redirected and tied to the achievement of measurable and verified SDG outcomes (Box 8).

BOX 8 Roots of Impact

Roots of Impact uses its Social Impact Incentives (SIINC) model to provide financial rewards to enterprises contingent upon performance against pre-agreed social impact targets. The programme consists of cash incentives for enterprises to scale their business operations in cost-effective and innovative ways that achieve additional impact (e.g. in terms of enhanced productivity, incomes and/or climate resilience).

Roots of Impact and Root Capital have partnered with the Swiss Agency for Development and Cooperation (SDC) and the Inter-American Development Bank to deploy the SIINC programme for agricultural small and medium-sized enterprises (SME) lending in Latin America. The programme was based on “a market-correcting payment to incentivize Root Capital to take on that additional cost and risk of financing early-stage agri-SMEs” (Naeve, 2022). The programme targeted agricultural SMEs in Latin America, which might be unprofitable but presented great potential for growth and impact. Figure 16 shows the lending model.

FIGURE 16 Roots of Impact and Root Capital’s Social Impact Incentives lending model

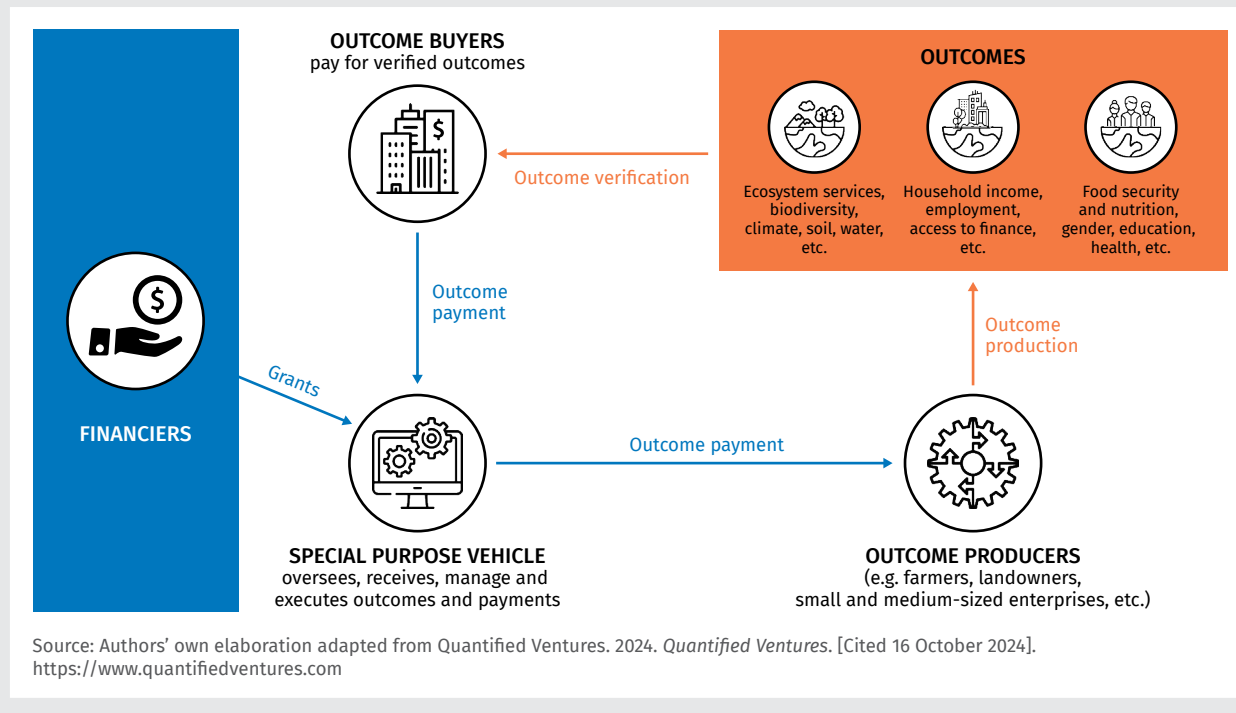
Source: Naeve, K. 2022. *How Impact-Linked Finance Incentivizes High-Impact Investment in Agricultural SMEs*. Root Capital. <https://rootcapital.org/wp-content/uploads/2022/01/How-Impact-Linked-Financing-Incentivizes-High-Impact-Investment-in-Agricultural-SMEs.pdf>

The pilot served the “missing middle” and thus realized development as well as financial additionality. Two years after the programme launch, it was reported that 77 percent of the 39 loans provided to high-impact businesses would not have been made by any other lender, while the remaining 23 percent could have only been made by a concessional or impact-oriented lender. This type of programme was effective in enabling early-stage agrifood SMEs to deliver on their impact potential, contributing to the development of a more sustainable agrifood system.

An innovative way to scale outcome financing consists of organizing outcome payments at the landscape level and in a single transaction. This enables outcome payments to be made to multiple farmers and entities, in which outcomes are sold to several outcome buyers. The aggregation of

outcomes brings scale and reduces transaction costs. Figure 17 shows the financial flows and contractual relationships involved in this scaled outcome financing model, which is currently being explored by the Shamba Centre and Quantified Ventures.

FIGURE 17 Innovative outcomes-based financing model



Bringing real estate investment trusts to the agrifood sector

Real estate investment trusts (REITs) pool financing from a variety of private investors (e.g. institutional investors, impact investors and individual investors) to invest in a group of commercial and residential real estate assets. The value proposition is that it aggregates funding as well as investment opportunities and thus provides funding at scale for longer-term and relatively risky projects such as owning and managing property.

A nascent spin-off from traditional REITs is Farmland REITs. These vehicles pool together farmland assets (e.g. farmland, water rights, processing, storage and distribution facilities), sell these assets to investors, and lease them back to farmers and SMEs for operation. The profits remain with the farmers and SMEs, and investors are paid a dividend.

Because Farmland REITs lease back the agriculture assets to farmers and SMEs, this allows farmers and SMEs to use their illiquid assets and unlock financing. Hence, farmers and SMEs can raise funding that would otherwise not be accessible to them because their assets such as land, storage facilities, warehouses and processing plants are illiquid (i.e. difficult to sell and turn into cash in the immediate term). The model would also diversify the pool of investors for the agrifood sector while making farmland and other agrifood real

estate assets marketable and more liquid (Lekovic, Cvijanovic and Jaksic, 2018).

Farmland REITs can also be useful to fund climate-resilient farming and to support investments for non-commodity crops. This model would thus be particularly relevant in a context where traditional financiers shy away from lending or investing in agrifood enterprises, especially those serving domestic markets.

Farmland REITs are emerging in Ghana and Nigeria (Africa Land, 2024), countries where financial markets are more regulated and diversified, and involve large numbers of investors, traders, borrowers and lenders.

Priority sector lending

PSL policies are used by several countries to increase lending to projects that are of high economic value but fail to attract commercial lending. Such policies are implemented by central banks, which mandate commercial banks to allocate a designated portion of their total lending portfolio to priority sectors (e.g. agriculture, food, SMEs, education and housing).

To ease compliance with priority lending targets, banks can issue PSL certificates. These certificates are tradable between banks, enabling those that exceed their PSL targets to sell surplus credits to those that fall short (Perera *et al.*, 2024; Reserve Bank of India,

2016). This trading mechanism enhances liquidity in the banking system while directing essential funding to priority sectors.

An example of PSL is seen in India, where banks are required to dedicate 40 percent of their lending portfolio to nine priority sectors, including 18 percent to the agricultural sector. This agricultural portion covers loans to individual farmers, corporate farmers, agricultural infrastructure, and small and marginal farmers, financial intermediaries (e.g. non-bank financial institutions and microfinance institutions) on-lending to farmers and agri-SMEs. Banks falling short of meeting these targets must contribute to the Rural Infrastructure Development Fund established with the National Bank for Agriculture and Rural Development or other funds designated by the Reserve Bank (Reserve Bank of India, 2020). This has facilitated access to finance for many who would otherwise be excluded from the formal financial system.

This mechanism encourages banks to gain expertise in critical sectors such as agriculture, in which they might initially lack familiarity or confidence. By requiring banks to meet specific lending quotas in these areas, PSL ensures that banks do not avoid crucial, yet often underserved, sectors. The result is that banks are encouraged to acquire the knowledge and the skills needed to better serve these sectors and avoid penalties. This can also contribute to more effective and informed lending practices over time. Thus, PSL not only enforces compliance, but also gradually drives the banking sector to enhance its capacity to serve priority sectors more effectively.

Asset monetization

Developing countries often face severe budget constraints to co-finance development projects with donors and development finance institutions. Their low sovereign credit ratings also make it expensive for them to borrow from foreign creditors. This can curtail development financing as donors and development finance institutions increasingly and rightly demand that domestic governments have “skin in the game”, by co-financing and even de-risking their own development.

What if developing countries could put forward underutilized public assets instead of cash to co-finance their own development? For example, many development countries have warehouses, processing plants, container terminals and buildings that remain in poor condition and are not used to their full capacity. And what if a public entity such as a sovereign wealth fund or its equivalent worked with line ministries and the ministry of finance to monetize (calculate the commercial financial value

of) underutilized assets? Once this financial value is established, the sovereign wealth fund could use these assets to take an equity stake in development projects. With the host government taking an equity position in a project that entails upgrading and optimizing the use of public assets, donors and development finance institutions would then be more likely to crowd in. This is the innovative idea behind asset monetization (Hamirani, 2024).

Guarantees

Guarantees are vital to improve the credit profile of agrifood investments and encourage domestic banks and non-banks to fund the agrifood sector. Guarantees are typically funded by donors, sometimes with the participation of domestic governments.

Short-term guarantees can be particularly valuable to encourage domestic banks and financial intermediaries to provide working capital loans to agrifood SMEs that may not have healthy financial statements and the ability to offer sufficient collateral. For example, the Ghana Incentive-based Risk-sharing System for Agricultural Lending (GIRSAL) offers credit risk guarantees to participating financial institutions, GIRSAL covers 70 percent of the agricultural loan principal, giving lenders more confidence to extend credit to agrifood SMEs across the entire value chain. Loan sizes typically range between USD 5 000 and USD 15 million, supporting a wide range of borrowers, from small farmer groups to large corporate entities engaged in agro-value chain and renewable projects.

The credit guarantees provided by GIRSAL are cash-backed, carry a 0 percent risk rating from the Bank of Ghana, and are valid for a period of 12 months, with the option of an annual renewal for loans exceeding one year in duration. In return, financial institutions pay a guarantee fee between 0.75 percent and 1 percent of the guaranteed loan amount (AFI, 2022). GIRSAL also offers a technical capacity-building programme for borrowers to ensure their success in managing the financing. The Ministry of Finance is the principal shareholder of GIRSAL, with initial funding provided by the Bank of Ghana and the African Development Bank.

In 2022, 18 financial institutions received agricultural credit guarantees from GIRSAL, together with support for assessing, structuring and managing agricultural loan applications. In total, 137 agribusinesses across 72 districts in 15 regions of Ghana have benefited from these guarantees, which supported various value chain activities, including inputs, production, aggregation, processing, marketing, services, and export (GIRSAL, 2022).

As the agrifood sector begins to enter climate financing, guarantees for climate bonds are critically needed. Following its formal launch at the London Stock Exchange in February 2024, the Green Guarantee Company has emerged as the world's first global institution dedicated to providing guarantees for climate bonds, specifically focused on achieving significant climate adaptation and mitigation impact.

The Company provides borrowers with a full guarantee, anchored in hard currency and aligned with the international Climate Bond Standard. Borrowers in developing countries will thus be able to enhance their credit rating and gain access to global capital markets. Additionally, this support will enable the issuance of bonds and loans with maturities of up to 20 years, specifically targeting institutional investors purchasing green bonds listed on the London Stock Exchange and green loans in the private credit market. The Group has raised USD 100 million from its investors to provide up to USD 1 billion in guarantees, supported by an investment grade rating of BBB/Stable from Fitch Ratings (Tran, 2024).

The guarantees offered by the Green Guarantee Group will therefore contribute to improving the credit ratings of climate-smart agrifood projects in developing countries to above investment grade, therefore helping developing country stakeholders access long-term hard currency debt financing at lower cost. The Group also provides technical assistance to potential issuers in developing countries.

Increasing the participation of domestic investors

Financing for agrifood supply chains cannot be achieved without the participation of domestic investors. Until domestic governments and domestic investors “have skin in the game”, financing for ending hunger will not flow, and even when it might, the ventures and projects to which it will flow will only bring limited impact.

To remedy this situation, donors, governments, central banks, domestic investors, development finance institutions, international accounting standards and international banking guidelines all need to work together to establish baselines.

The prudential rules of the Basel III framework require banks to maintain a capital adequacy ratio representing 8.5 percent of their risk-weighted assets to guard against potential losses. Given that financial markets are nascent in most developing countries, the capital adequacy ratio imposed on developing country central banks tends to be higher. For example, in India, public banks are required to maintain a ratio of 12 percent,

and commercial banks, of 9 percent (Reserve Bank of India, 2011). In Nigeria, as of 2024, international and national commercial banks are required to maintain a capital adequacy buffer that is nine times higher than the previous threshold (Obianwu *et al.*, 2024). These rules, while important to guard against the collapse of the banking system, prevent banks from lending to the agrifood sector, generally seen as highly risky.

International Financial Reporting Standards (IFRS) 9 also require banks to anticipate the expected credit losses from loans and maintain buffers to guard against them (IFRS Foundation, 2024). This further deters banks from lending to sectors perceived as risky, such as agriculture and food.

Following on from the discussion on guarantees above, many developing countries' central banks also do not always allow banks to use guarantees to de-risk loans, and instead, stipulate that these be used to cover eventual credit losses. While this is somewhat of a technical treatment, these policies can also prevent banks from using guarantees to increase lending through third-party assumption of risks (Garbacz, Vilalta and Moller, 2021). There is, therefore, a strong case for donors and development finance institutions to work with developing countries' central banks to design dedicated lending rules for the agriculture sector because the resulting outcomes can transform the entire economy.

Welcome reforms are already ongoing across the World Bank Group, using “callable capital” and, in 2024, further reforms on the Capital Adequacy Framework to reduce loan-to-equity ratios from 20 percent to 19 percent. As reported by the World Bank, this can increase potential lending commitments by approximately USD 50 billion over ten years (World Bank, 2024). At the 2024 World Bank and International Monetary Fund (IMF) Spring Meetings, further instruments in the form of a shareholder capital instrument (bond that pays a coupon) and a portfolio guarantee platform were also announced. Of particular note were also announced incentives for donors and developing countries to increase investment in eight global challenges with a cross-border impact: climate change mitigation and adaptation, biodiversity, food and nutrition security, water security and access, energy access, fragility and conflict, pandemic prevention, and preparedness, and enabling digitalization (World Bank, 2024).

While these announcements are promising, there remains the challenge to improve governance in developing countries for the effective mobilization of

their small but growing pools of capital. Innovation in the debt restructuring of Sri Lanka, a middle-income country, offers glimpses into sophisticated outcomes bonds. Negotiations with creditors include macro-linked bonds, where payouts and principal will be adjusted

according to the country's economic performance and a governance-linked bond, which could enable the country to reduce payments if the reforms required by the IMF were implemented (Aripaka and Jayasinghe, 2024).

4.4 INVESTMENT TO BUILD AND MAINTAIN INFRASTRUCTURE FOR IRRIGATION, ROADS, STORAGE AND ELECTRICITY

The most effective interventions to improve infrastructure focus on electrification and irrigation infrastructure, combined with road infrastructure for even greater results; and support several storage interventions, such as the use of airtight bags and containers, to reduce post-harvest losses for cereals and pulses. But evidence-based research on the positive benefits of reducing post-harvest losses for small-scale producer's incomes is thin.

Infrastructure for irrigation, electricity and roads

Increased public investment in rural infrastructure is central to transforming agrifood systems to eradicate hunger and malnutrition. Focusing on electrification and irrigation to improve agricultural productivity is key, and delivers even greater results when combined with roads (Laborde *et al.*, 2019). Improvements in transportation, power, irrigation and storage networks can reduce transportation costs, increase market access, and strengthen supply chains, leading to more resilient and sustainable agrifood supply chains (Kubik, 2022).

Several low- and middle-income countries have initiated large-scale rural road construction programmes to improve connectivity in remote areas (Kaiser and Barstow, 2022). These initiatives recognize the critical role of rural road infrastructure in enhancing mobility and access for isolated communities (Kaiser and Barstow, 2022).

India's Pradhan Mantri Gram Sadak Yojana (PMGSY) is a prime example of such efforts. Launched in 2000, this programme aimed to provide all-weather road access to unconnected villages with populations of 500 or more. The PMGSY focused on connecting these villages either to other villages with improved roads, or directly to market centres, significantly enhancing rural connectivity across India (Aggarwal, 2018).

Similarly, Ethiopia implemented the Universal Rural Road Access Programme (URRAP) in 2010. Funded by the central government and technically supported by regional authorities, URRAP has constructed thousands of rural roads connecting isolated administrative units known as woredas (districts) and kebeles (wards).

This programme has dramatically increased mobility in areas that were previously accessible only on foot, now allowing motorized vehicle access (Nakamura, Bundervoet and Nuru, 2020).

These programmes demonstrate a growing recognition among developing countries of the importance of rural road infrastructure in improving connectivity and mobility for remote communities. By investing in rural roads, these countries aim to stimulate economic growth, improve access to services, and enhance the overall quality of life in rural areas (Kaiser and Barstow, 2022).

Storage infrastructure to reduce post-harvest losses

Stathers *et al.* (2020) reviewed studies on post-harvest loss reduction across 22 crops in South Asia and sub-Saharan Africa from the 1970s to 2019. It emerged from the review that 79 percent of the studies focused on improving storage technologies, with maize accounting for 23 percent. However, most of the studies were conducted in India, leaving 24 other countries underrepresented. This highlights significant knowledge gaps and the need for broader research to address various factors in reducing food losses.

During harvest, effective aeration is critical for maintaining uniform grain temperature and moisture in storage facilities (Kaminski and Christiaensen, 2014). Proper aeration prevents overheating, mould growth and insect activity, with optimal grain temperatures maintained below 15 °C to minimize these risks. Good aeration practices balance temperature differences between storage and outside air, preventing moisture migration and preserving grain quality.

Moisture content control is equally important for preventing mould growth and reducing losses, achievable through grain dryers or aerators, and ensuring that storage facilities prevent external moisture ingress. Regular inspections and thorough cleaning of storage areas, handling equipment and the grain are essential for detecting issues early, such as hot spots, mould or insect infestations, allowing for timely and cost-effective corrective actions.

Efficient drying techniques, applied within 24 hours of harvesting, are crucial for reducing bacterial and mould growth risks. Both traditional and mechanical drying

methods should be tailored to local conditions. Box 9 presents key innovations in drying, testing and storage technologies aimed at mitigating post-harvest losses.

BOX 9 Innovative approaches to reducing post-harvest losses

Temperature and moisture are the key factors affecting grain quality during storage (Coradi *et al.*, 2020). To address these factors, most interventions focus on three main areas: drying, testing, and storage technologies.

Drying innovations

Drying is a widely-used method to extend food shelf life by removing moisture, which reduces the risk of spoilage (USAID, 2022a). Technologies such as mechanical and solar dryers, albeit promising, must be more cost-effective for small-scale farmers than traditional sun drying (Ricker-Gilbert *et al.*, 2022). Innovations such as tarps and solar dryers can reduce aflatoxin levels and improve grain quality but face challenges from weather conditions (Leavens *et al.*, 2021). Other drying methods, such as convective dryers for small farms and drying beds for seed preservation, show potential to reduce post-harvest losses (Sultana *et al.*, 2021).

Testing innovations

Determining the optimal moisture content is essential for safe grain storage, yet challenging. Direct moisture testing methods offer high accuracy, but require specialized equipment, while indirect methods such as hygrometers and test cards are quicker and more accessible but less precise (Flor *et al.*, 2022). Efforts are underway to make moisture testing technologies more affordable for smallholders (Ricker-Gilbert *et al.*, 2022).

Storage technologies

Storage innovations, such as hermetic bags (Purdue Improved Crop Storage [PICS] bags), metallic silos and cold storage units, help preserve grain quality and reduce losses. Hermetic storage has been effective in pest control without chemicals, but access remains limited for many farmers. Cold storage solutions, such as solar-powered cold rooms, are gaining traction, especially in regions with limited electricity access (USAID, 2022b; Coldhubs, 2024).

The choice of appropriate storage facilities and the adoption of modern technologies are crucial for improving storage outcomes. It is important to select storage solutions that align with specific needs, capacities and storage duration. Options such as hermetic bags, silos and cold storage units each offer unique benefits and challenges. The exploration and implementation of modern storage technologies can significantly enhance the efficiency and effectiveness of maintaining the quality. Cold chain facilities have the potential to increase smallholder farmers' market access and incomes through better preservation of perishable produce and reducing post-harvest losses.

Reducing post-harvest losses is also critical for minimizing the environmental impact of agrifood systems. Around 30 percent of the world's agricultural land and 25 percent of global freshwater are used to produce food that is subsequently lost. Food loss and waste generate approximately 4.4 gigatonnes of GHG emissions annually. If food loss and waste were a country, it would be the third largest GHG emitter (WRI, 2015). Addressing food loss and waste therefore represents a significant opportunity to reduce the

contribution of food production to GHG emissions and the wastage of resources, among other far-reaching economic, social and environmental consequences (Nicastro and Carillo, 2021).

The evidence demonstrating the positive impacts of reducing post-harvest losses for smallholder farmers' incomes remains limited. Most research is driven by estimates of post-harvest losses or the technological efficiency of interventions, often conducted in controlled environments, rather than by understanding of the real-world significance and consequences of these losses (Sheahan and Barrett, 2017). (Delgado, Schuster and Torero, 2023) highlighted that, while food losses have been widely studied in relation to production, the link to other important issues, such as environmental pressure or income effects, has been largely overlooked. According to a systematic review of post-harvest loss literature, only 13 percent of studies mentioned the socioeconomic or environmental impacts consequences of interventions (Stathers *et al.*, 2020). Moreover, none of the studies included a gender analysis, despite the critical role that women play in agriculture, particularly in post-harvest activities (Stathers *et al.*, 2020).

By improving infrastructure and logistics, including packaging, storage facilities and transportation networks, countries can ensure that food reaches consumers more efficiently, reducing spoilage and increasing the market value of agricultural products. Investments in modern supply chain technologies, innovative solutions, improved working methods,

and best practices for managing food quality and minimizing food loss and waste are vital for achieving SDG 12.3.1, which targets a 50 percent reduction by 2030 (Delgado and Torero, 2021). This not only improves income generation, but also contributes to the resilience and sustainability of agrifood systems.

4.5 TRADE AND COMPETITION POLICY, AND REGIONAL INTEGRATION

Trade and competition policies, together with stronger regional integration, are essential to ensure that the benefits of increased investment result in income-generating opportunities for small-scale producers and agrifood SMEs. A successful World Trade Organization Doha Development Agenda could lead to several substantial gains for developing and other countries, such as increased global production of food and industrial goods, resulting in better access to cheaper food items and greater consumer welfare (Boüet & Laborde, 2015). Moreover, it might lead to better trade infrastructure and more efficient customs procedures in developing countries, which would ease trade flows and lower the costs of trade (Boüet & Laborde, 2015). It could also result in lower tariff protection, reduced production-distorting domestic support, and elimination of export subsidies (Boüet & Laborde, 2015) that create unfair competition for many low-income producers.

The trade policy instruments that many countries used in response to high international food price levels and volatility are often not appropriate responses, for several reasons. While export taxes or restrictions decrease domestic prices, they contribute to higher world prices and hurt local farmers. Further, trade policies should be used for treating trade issues, which food price volatility is not (Boüet & Laborde, 2015). There are more direct instruments (e.g. investments in food supply and R&D) with which to address supply-side problems, while safety nets and cash/in-kind transfers can help poor households cope with augmented food prices (Boüet & Laborde, 2015).

Low- and middle-income countries, particularly in Africa, urgently need to improve the effectiveness of their competition regimes to address high and increasing concentration in agrifood markets (Buthelezi *et al.*, 2023). The existence of competition laws and policies, and the establishment of independent competition authorities are the best institutional fixes for the abuse of market power and its resulting consequences (North *et al.*, 2009; Acemoglu & Robinson, 2012; Stiglitz, 2017). The proliferation of competition laws throughout the world is one of the most striking developments in recent

years (OECD and International Competition Network, 2021). However, competition regimes have not yet proved effective in tackling excessive concentration and its negative effects (Buthelezi *et al.*, 2023). First, the extent of market power is much greater than anticipated. Second, authorities require greater powers and capacity than has generally been allocated in legislation (Buthelezi *et al.*, 2023). Finally, competition regulators in low- and middle-income countries are simultaneously challenged by the difficulty of regulating powerful and well-connected entities and their limited experience and resources (Buthelezi *et al.*, 2023). Effective enforcement of competition laws on a global scale is a prerequisite for open economies, fair trading conditions, a level playing field, and, ultimately, inclusive economic development for enhanced food security and better lives (Ratshisusu *et al.*, 2021). Regional competition authorities are fundamental in addressing cross-border anti-competitive behaviours. Regional competition authorities exist in low- and middle-income countries, but their enforcement actions have been limited, particularly in Africa (Buthelezi *et al.*, 2023). With the exception of the Common Market for Eastern and Southern Africa (COMESA) Competition Commission, few regional competition regimes are currently operational. The extent of cross-border markets in Africa, and the regional footprint of the major agriculture and food businesses, requires effective regional competition bodies for markets to function properly (Buthelezi *et al.*, 2023).

4.6 ACCELERATING INCOME GENERATION THROUGH SOCIAL PROTECTION PROGRAMMES

Social protection programmes are critical to providing cash or goods to people affected by hunger and poverty. Economic growth alone is often insufficient because those living in poverty may face physical and structural barriers that prevent them from capitalizing on the opportunities created and afforded by economic growth. Examples of such barriers are persistent inequalities in the distribution of assets such as land, water, finance, capital, education and healthcare (Wouterse, 2020). Social protection works to overcome these barriers, assisting poor households to meet basic needs and escape extreme poverty. In general, social protection aims to provide beneficiaries with a greater purchasing power, which allows them to finance immediate consumption needs. However, beyond delivering social inclusiveness through the redistribution of the benefits of macroeconomic growth, they could lift people out of poverty and hunger through accelerated investments, innovations and efficiency gains. They could increase future income streams through investments and savings (Leight, Hirvonen and Zafar, 2024). Social protection programmes can also enable households to reach the basic level of capital and security needed to take part in from accelerated economy growth by seizing more opportunities and risks, thereby contributing to income generation (Wouterse and Taffesse, 2018).

The effectiveness of social protection programmes varies based on their design and context. Research shows that cash transfers have significant short-term impacts on poverty reduction, increasing household consumption and income. Social protection programmes have also had positive effects on the production side and to contribute to economic growth, for instance, by encouraging savings, creating community assets, and addressing market imperfections. For example, social grants in South Africa had positive impacts on farm labour supply, entrepreneurial skills and investment in farm inputs. Social safety nets can therefore grant the opportunities to vulnerable households to work their way out of poverty through an income generating approach (Wouterse and Taffesse, 2018).

However, while cash transfer programmes are easy to implement and scale across diverse contexts, there is a more mixed record in the sustainability of these effects when the payments stop (Leight, Hirvonen and Zafar, 2024). Programmes that combine cash transfers with complementary interventions, known as cash plus programmes, are more effective in breaking the cycle of chronic poverty and building resilience because they help households enhance their livelihood activities or diversify into new activities. An important example

of cash plus programmes is the Ethiopian Productive Safety Net Programme (PSNP). It is a multi-purpose social protection programme designed to: (i) protect vulnerable and chronically food insecure households through predictable assistance; (ii) prevent poverty traps by reducing the impact of potential crises; and (iii) promote agricultural production and productivity to generate income. To achieve these intertwined objectives, the PSNP comprised two major interventions: a direct cash transfer, and a transfer through the labour contribution to public works such as the development of water points, tree planting, and soil and water conservation activities. The aim of the transfer through labour contribution was to help build community assets that were not initially built due to market imperfections and the “tragedy of the common” to contribute to long-term growth. In 2016–2017, around 8 million people were beneficiaries of the PSNP. The programme was found to contribute to consumption smoothing and a reduction in food insecurity. The PSNP also ensured a minimization of productive disincentives, thereby contributing to long-term growth while protecting vulnerable households (Wouterse and Taffesse, 2018).

Cash plus programmes can yield an additional USD 4 to USD 5 per USD 100 transferred compared to cash-only programmes. These programmes also address one of the major concerns regarding social protection programmes; i.e. that the latter create dependency among beneficiaries, reducing their benefits if and when they end (Wouterse, 2020). In supporting economic productivity, cash plus programmes mitigate this risk, making the impacts of social protection more sustainable. However, since they come with higher costs, the financial viability of cash plus programming can be a concern (Leight, Hirvonen and Zafar, 2024).

Beyond evidence of the effects of social protection on the immediate recipient in terms of nutrition, health, housing, education and access to basic services, the impacts of social protection are less clear. Social protection has been linked to broader economic change and structural transformation through five main channels (Gassmann *et al.*, 2023). First, short-term economic gains are realized through spending and consumption. As the purchasing power of beneficiaries increases, the demand for goods and services increases, thus stimulating economic activity at both a local and national level, and contributing to fiscal sustainability through increased economic activity and potential tax revenues. Second, social protection programmes can also contribute to building human capital by improving access to education,

health and nutrition services. This investment in human capital can lead to long-term economic benefits, since healthier and better-educated individuals are more productive and can contribute more effectively to the economy. Third, social protection can enable capacities and an environment favourable to investments in productive activities through both an improvement of the household's capacity in managing risks, and a reduction of the economic constraints they face. Social protection is also conducive to investments in higher-risk economic activities that often offer higher returns (Wouterse and Taffesse, 2018). Fourth, social protection measures can enhance resilience to shocks by mitigating economic fallout. For instance, during the COVID-19 pandemic, cash transfers helped mitigate the impact on poverty by providing a safety net for affected households. Another example is in Zambia, where cash transfers helped rainfed agricultural producers manage climate risk (Wouterse and Taffesse, 2018). Anticipatory cash transfers before shocks, such as floods, can help preserve assets and livelihoods, further strengthening economic resilience. And, fifth, social protection can help facilitate job transitions and reforms for competitiveness, including by offsetting the costs of labour reallocation (Gassmann *et al.*, 2023).

However, the cost of implementing comprehensive and effective social protection systems is significant. Globally, 4.1 billion people, more than 50 percent of

the population, are not covered by any form of social protection. In Africa, only 17.4 percent of the population is covered by at least one social protection benefit (Social Protection Inter-agency Cooperation Board, 2024). Closing this global social protection financing gap, including healthcare, has been estimated to require an additional USD 1.19 trillion per year, or 3.8 percent of the GDP of developing countries. This gap varies across regions and income groups, with the highest costs in low-income countries (USD 78 billion per year) (Durán Valverde *et al.*, 2020). Furthermore, to maximize effectiveness, social protection programmes must be well-targeted to ensure that they reach the most vulnerable populations and that they result in income redistribution and opportunities for the poorest households. They must be integrated into broader policy frameworks and accompanied by investments in infrastructure, education and healthcare, as well as policies that promote fair labour practices and equitable income distribution.

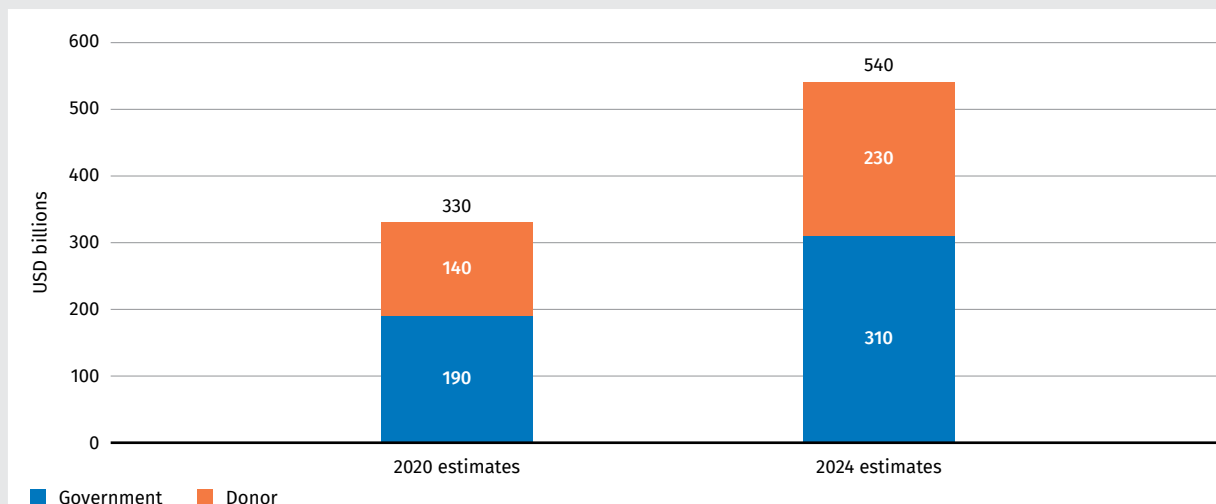
The long-term sustainability of social protection programmes depends on their ability to evolve and adapt to changing economic conditions, and to be supported by robust fiscal policies. Sustainable financing for these programmes is crucial, and innovative approaches such as leveraging the economic multipliers of cash transfers can help justify the expenditure as an investment rather than a mere cost.

5 ENDING HUNGER AND MALNUTRITION: WHAT WOULD IT COST?

Current projections show that in a business-as-usual scenario, 582 million people, or 6.8 percent of the global population, will be affected by hunger in 2030 (FAO *et al.*, 2024). This is an increase of approximately 130 million people compared to pre-pandemic projections (FAO *et al.*, 2024). Most of the progress in eradicating hunger is predicted to be in Asia, while absolute hunger will rise in Africa. Without additional efforts, more than half of the people affected by hunger in 2030 will be in Africa (FAO *et al.*, 2024). Addressing the high projected estimates of hunger in 2030 will therefore require addressing changing population demographics and consumption trends.

And yet, with every year of inaction, the cost and effort of ending hunger increases significantly. In 2020, it was estimated that ending hunger by 2030 would cost an additional USD 330 billion (Laborde, Smaller and Parent, 2020). In 2024, updated estimates suggested that it would cost USD 540 billion (von Braun *et al.*, 2024). The lack of sufficient investment during the last four years has therefore added an extra cost of USD 210 billion to end hunger by 2030 (Figure 18).

FIGURE 18 Cost to end hunger by 2030



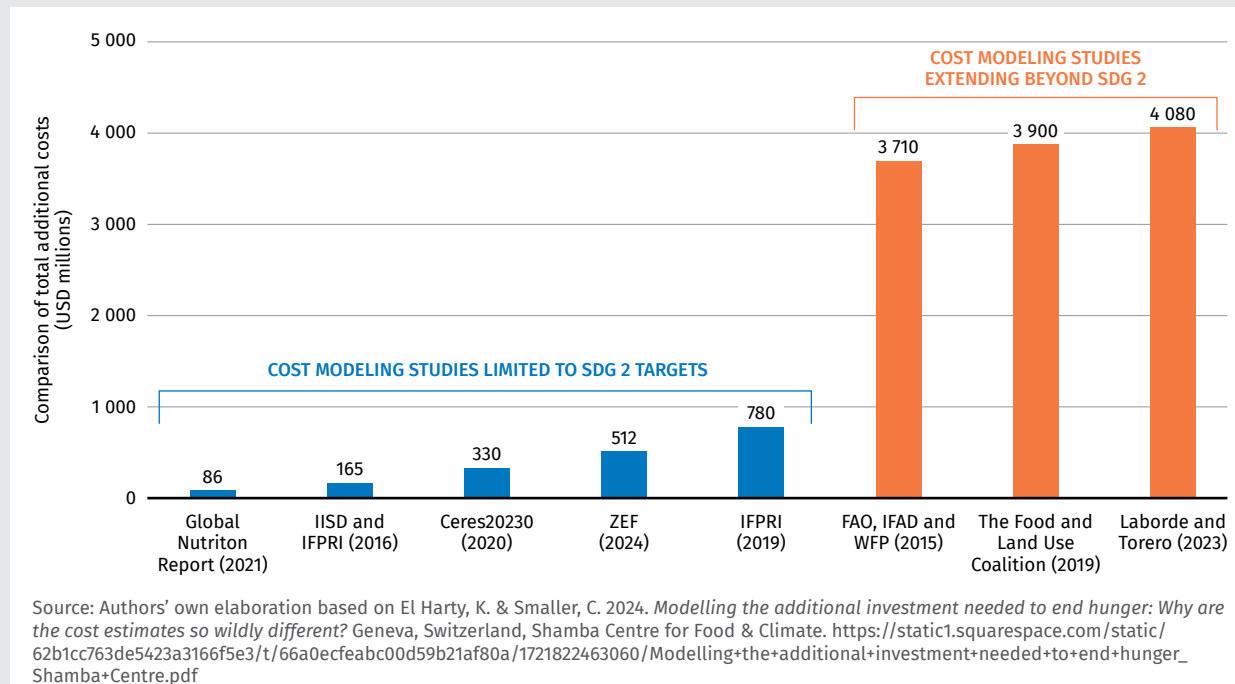
Note: Ceres2030 estimates were considering the elimination of hunger (SDG 2.1), the doubling of economic productivity for small-scale food producers (SDG 2.3) under a constant GHG budget for agriculture (SDG 2.2). The updated estimates only considered the elimination of hunger (SDG 2.1).

Source: Authors' own elaboration based on Laborde, D., Smaller, C. & Parent, M. 2020. *Ending hunger, increasing incomes, and protecting the climate: What would it cost donors?* Ceres2030. Cornell University, IFPRI and IISD. https://www.foodfortransformation.org/files/upload/z_archiv%20WOH/8%20Veranstaltungen/Event%20Was%20zu%20tun%20ist/Dokumente/ceres2030-what-would-it-cost.pdf; von Braun, J., Chichaibelu, B.B., Laborde, D. & Torero Cullen, M. 2024. *Cost of Ending Hunger – Consequences of Complacency, and Financial Needs for SDG2 Achievement*. ZEF-Discussion Papers on Development Policy 347. Bonn, Germany, University of Bonn, ZEF (Center for Development Research). https://www.zef.de/fileadmin/webfiles/downloads/zef_dp/ZEF_DP_347.pdf

5.1 ESTIMATES OF THE COST OF ENDING HUNGER

How much would it cost to end hunger and malnutrition by 2030? This is a key question that governments, donors and policymakers have been asking since they made the global commitment in 2015 to achieve SDG 2. According to a review of eight reports published

between 2015 and 2024, cost estimates range from USD 86 billion to USD 4 trillion (Figure 19) (El Harty and Smaller, 2024). This huge difference creates confusion among the intended audiences and serves as an obstacle to effective action.

FIGURE 19 Additional cost of ending hunger and malnutrition by 2030 according to various modelling exercises

The reality is that there is no right answer, because the answer largely depends on the question the researchers asked. Three reports estimate costs in the trillions because they address a wide range of SDGs beyond SDG 2, or focus on transforming agrifood systems. The other five reports, which focus on specific SDG 2 sub-targets, have cost estimates in the billions. However, even within the five reports focusing on SDG 2, the cost ranges between a total of USD 86 billion and USD 780 billion. This is due to difference in the researchers' choice of targets and the quantification of those targets, baselines and data sources used for 2030 projections, and modelling approaches (El Harty and Smaller, 2024).

Some of these differences are healthy, for instance, using different modelling approaches to answer a similar question as a way of increasing the confidence in the model results. Other differences are problematic, such as the use of different data sources for the baselines, which could lead to confusion and inaction. These variations underscore the importance of standardized baselines and clear communication of assumptions, and the need for policymakers to understand the different modelling approaches used in these reports to ensure effective resource allocation and make the goal of ending hunger more achievable (El Harty and Smaller, 2024).

5.2 THE COST OF INACTION

As the deadline for the 2030 Agenda for Sustainable Development draws closer, the cost of inaction rises exponentially. The cost of meeting the G7 commitment of lifting 500 million people out of hunger by 2030 is now estimated to cost an additional USD 27 billion annually, or USD 146 billion between 2025 and 2030 (von Braun *et al.*, 2024), more than double the estimated annual increase of USD 11–14 billion projected in 2020 by several reports (von Braun *et al.*, 2024; Laborde, Smaller and Parent, 2020).

There are several reasons to explain the cost increases since the estimates made in 2020 and before. First, the last years in progress due to unprecedented food security disruptions since 2020, including the COVID-19 pandemic, followed by the war in Ukraine, had adverse spill over effects on global food, fertilizer and energy markets. Second, there are therefore more people facing hunger today and projected to be facing hunger in 2030 than was estimated in 2020, increasing the overall costs. Third, the frequency of extreme weather events has

increased substantially since 2000, further worsening food insecurity, especially in vulnerable regions such as the Horn of Africa and South Asia. Fourth, with only six years remaining until the 2030 deadline, the range of technically feasible interventions is limited to those that have a more immediate effect, such as social protection programmes. Investments that take longer to yield results, such as R&D, are no longer feasible with a 2030-time horizon. Fifth, short-term interventions are often more expensive than long-term strategies. For example, implementing ten short-term measures to lift about

700 million people out of hunger and malnutrition by 2030 would require an increase of USD 93 billion annually, or USD 512 billion over a six-year period between 2025 and 2030 (von Braun *et al.*, 2024). This marks a sharp increase in the projected costs compared to the 2020 estimate of USD 30–33 billion annually, which included a broader range of short and long-term interventions, highlighting the significant cost of delayed action (von Braun *et al.*, 2024; Laborde, Smaller and Parent, 2020; ZEF and FAO, 2020).

5.3 THE HIDDEN COSTS OF THE AGRIFOOD SYSTEM

Agrifood systems have not yet succeeded in eradicating hunger. Efforts to do so become increasingly expensive, and agrifood systems are generating enormous hidden costs to human health, poverty and the environment (Hendriks *et al.*, 2023; The Food and Land Use Coalition, 2019; World Bank, The Food and Land Use Coalition and IFPRI), 2021). The estimated hidden costs of agrifood systems were at least USD 12.7 trillion in 2020, or 10 percent of GDP (FAO, 2023c). Another study estimated the cost of human suffering and planetary harm caused by agrifood systems at around USD 15 trillion per year, or 12 percent of GDP in 2020 (Ruggeri Laderchi *et al.*, 2024). In both studies, the vast majority of the hidden costs were associated with dietary patterns that led to obesity and non-communicable diseases, causing labour productivity losses. These were estimated at over USD 9 trillion 2020 PPP (purchasing power parity) (73 percent) according to FAO (2023c)

and USD 11 trillion according to Ruggeri Laderchi *et al.* (2024). The next biggest hidden costs were environmental, accounting for nearly USD 2.9 trillion (20 percent) according to FAO (2023c) and USD 3 trillion according to Ruggeri Laderchi *et al.* (2024). Further additional costs were due to poverty-related costs, since the incomes of the moderately poor working in agrifood systems need to increase to ensure that they are above the moderate poverty line, thus reducing food insecurity and undernourishment.

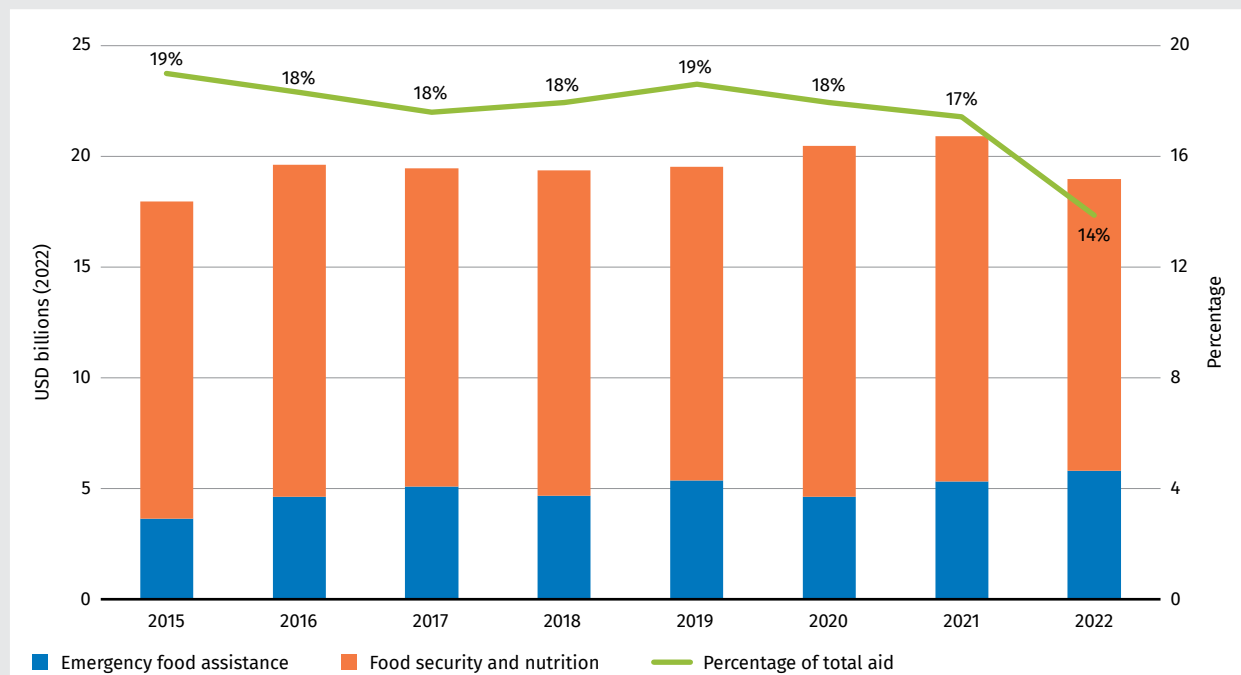
The escalating costs of addressing hunger and the hidden costs of current agrifood systems underscore the urgent need for immediate and decisive action. The stark increase in projected costs serves as a sobering reminder that time is of the essence in the collective effort to eradicate hunger and achieve food security.

5.4 FINANCING THE INVESTMENT GAP

In addition to these efforts, there has been an increasing focus on how to finance the investment gap to end hunger and malnutrition. The international community's progress on increasing the financial resources for food security and nutrition has been mixed. On the one hand, G7 aid related to food security and rural development has almost tripled since 2000 (von Braun *et al.*, 2024). In 2022, according to the G7, developed countries exceeded their goal of providing and mobilizing USD 100 billion in climate finance for developing countries per year in 2023 (G7, 2024). Targeted agricultural aid has, on aggregate, had a positive impact on hunger alleviation (Kornher, Kubik and Chichaibelu, 2021). Other actors have also made investments. The World Bank continued with its Food Systems 2030 initiative established in November 2020; IFAD launched its 13th replenishment cycle with a specific focus and ambition to scale up financing for

food systems transformation; and a new and innovative Joint SDG Fund Food Systems Window was incubated by the United Nations Food Systems Coordination Hub and the Joint SDG Fund Secretariat (von Braun *et al.*, 2024).

On the other hand, since 2015, G7 aid for long-term development finance for food security and nutrition has remained fairly stagnant (Eber-Rose and Smaller, 2024). Figure 20 shows the volume of G7 aid for food security and nutrition, and emergency food assistance. It reveals that between 2015 and 2021, G7 aid to food security and nutrition hovered between USD 14 and USD 16 billion, dropping to a seven-year low at USD 13.2 billion in 2022. Arguably, yet more importantly, the volume of aid allocated by the G7 to food security and nutrition (including emergency food assistance) as a proportion of its total aid budget has been declining, again dropping to a seven-year low in 2022, at 14 percent.

FIGURE 20 G7 official development assistance (ODA) for food security and nutrition as a percentage of all ODA, 2015–2022

Notes: Based on Ceres2030 definition (Bizikova *et al.*, 2023) of ODA for food security and nutrition, total spending of all G7 countries per year in grant equivalent, amounts adjusted to 2022. Percentage of total for food security and nutrition, including emergency food assistance, and is calculated relative to all G7 ODA disbursements.

Source: Authors' own elaboration using data from OECD Development Assistance Committee (DAC) Creditor Reporting System (CRS) database.

Prior, between 2015 and 2021, food security and nutrition (including emergency food assistance) comprised between 17 and 19 percent of the G7's total aid disbursements.

More granular research on the impact of aid has also yielded interesting results, indicating that the effect of aid on food security may vary across different components and types of aid (Gyimah-Brempong and Adesugba, 2015; Petrikova, 2015). In particular, Petrikova (2015) found that multilateral aid, grants, and social and economic aid had a positive effect on

food security, whereas the impact of bilateral aid, concessional loans and agricultural aid on food security was more conditional on good governance in the recipient country.

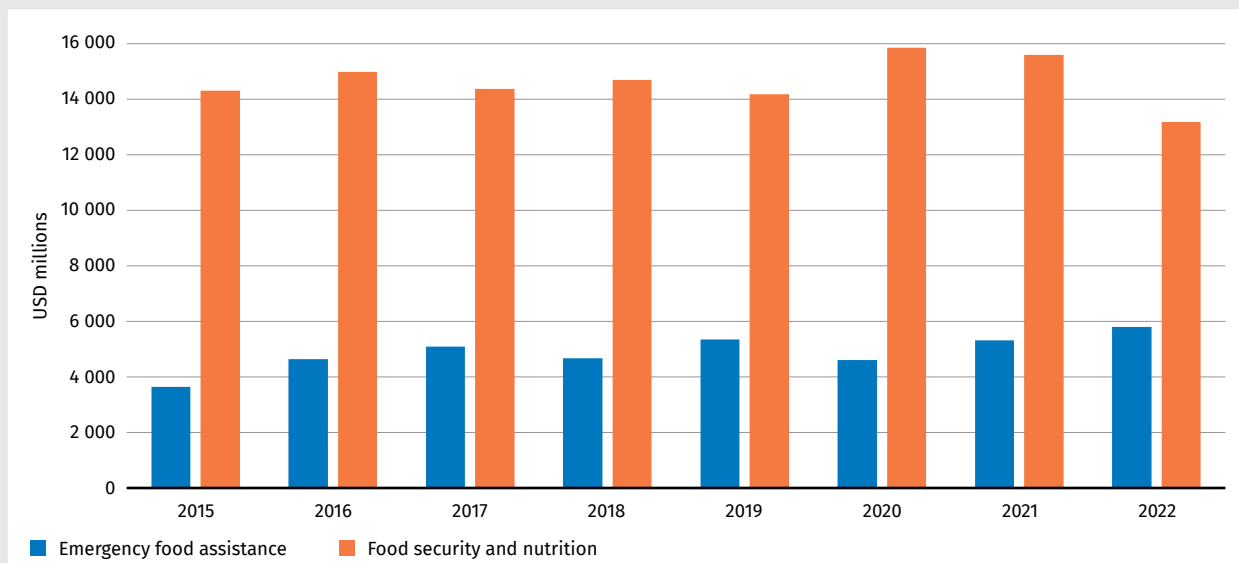
Indeed, financing the investment gap for hunger and malnutrition remains a significant challenge, particularly for low-income countries. While many countries are mobilizing domestic funding, it is often insufficient for the required transformation. The options presented above are innovative financing solutions that could contribute to fill the gap (see Section 5.3).

5.5 THE GROWING HUMANITARIAN FINANCE AND THE NEED TO BALANCE BETTER WITH LONG-TERM DEVELOPMENT FINANCE

Unlike long-term development finance, which has been stagnating, donor spending on emergency food assistance continues to increase (Figure 21). Moreover, while donor spending on emergency food assistance has increased, acute food insecurity has increased at a sharper rate. In the past seven years, donor spending

has doubled, and acute food security has tripled (Figure 22). Given the link between acute food insecurity in humanitarian crises and longer-term chronic food insecurity, more attention needs to be given to the balancing and complementarity of humanitarian and development spendings.

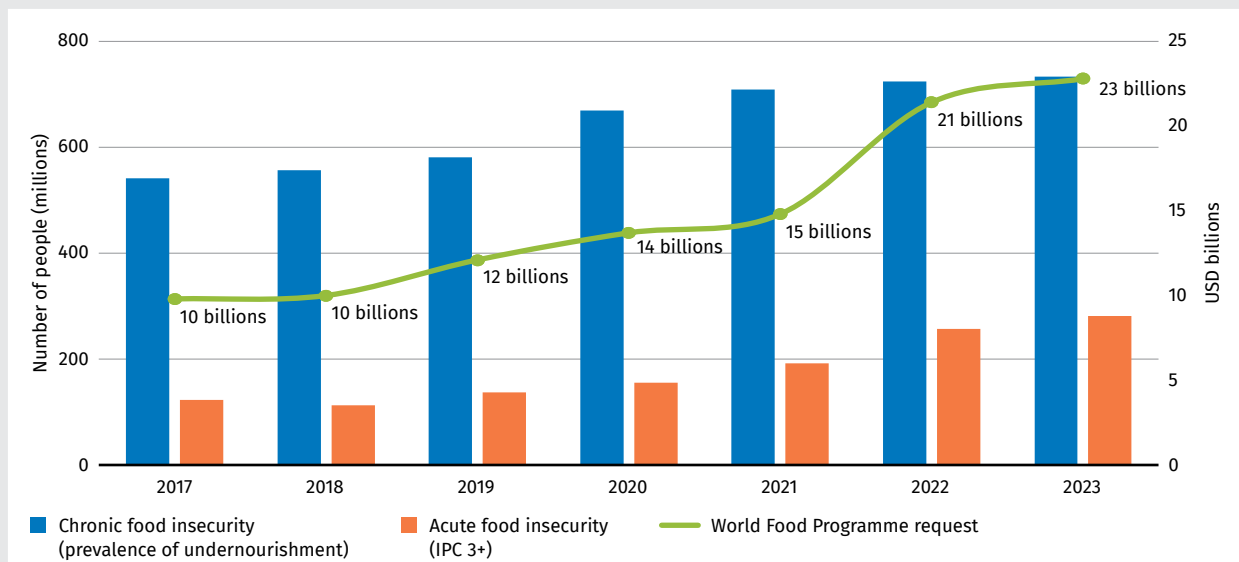
FIGURE 21 G7 official development assistance for food security and nutrition compared to emergency food assistance, 2015–2022



Note: According to Ceres2030 definition (Bizikova et al., 2023) of ODA for food security and nutrition, total spending of all G7 countries per year in grant equivalent, amounts adjusted to 2022.

Source: Authors' own elaboration using data from OECD Development Assistance Committee (DAC) Creditor Reporting System (CRS) database.

FIGURE 22 Evolution of World Food Programme requests for aid, compared with acute and chronic food insecurity, 2017–2023



Sources: Authors' own elaboration based on FAO, IFAD, UNICEF, WFP & WHO. 2024. *The State of Food Security and Nutrition in the World 2024 – Financing to end hunger, food insecurity and malnutrition in all its forms*. Rome. <https://doi.org/10.4060/cd1254en> for data on needs-based assessment information in annual reports, chronic food insecurity measured using prevalence of undernourishment and FSIN (Food Security Information Network) & GNAFC (Global Network Against Food Crises). 2024. *Global Report on Food Crises 2024*. Roma. <https://www.fsinplatform.org/sites/default/files/resources/files/GRFC2024-full.pdf> for acute food insecurity measured using IPC 3+ (crisis or worse).

In situations of food crisis, even where protracted, currently, financing mainly comprises humanitarian spending, with longer-term development finance less prominent. Naturally, humanitarian assistance will continue to play a vital role in providing immediate support to preserve lives, protect livelihoods and mitigate suffering. However, there is a growing consensus that a more coordinated approach is necessary to tackle the underlying structural challenges of hunger and malnutrition, especially given the protracted nature of many food crises, and convergence between acute and chronic food insecurity.

Long-term investments are increasingly recognized as essential for creating an enabling environment for sustainable development in food crisis contexts. Ultimately, this would decrease the demand for humanitarian assistance and enable humanitarian efforts to focus on addressing urgent needs without being overstretched in addressing protracted crises. In short, the appropriate integration and timing of humanitarian and development funding targeting the fundamental causes of food insecurity would reduce the need for future humanitarian intervention.

Such an approach is embodied in the concept of the humanitarian–development–peace nexus, which takes a comprehensive approach to tackling food insecurity and malnutrition. This approach aims to bridge the gap between immediate humanitarian needs and long-term development goals while also addressing issues of peace and stability.

Principles to better balance humanitarian and long-term food security development generally aim to reshape humanitarian funding along a horizontal and demand-driven continuum from anticipation, to mitigation, to response, rather than a top-down approach focused solely on supply. Funding interventions that support resilience building may save money on humanitarian responses while reducing vulnerability, land degradation, and even the occurrence of conflict, which are so often fuelled by lack of resources. In this manner, programmes that support sustainable livelihoods may contribute towards food security and peace efforts by addressing grievances related to limited economic opportunities and resource scarcity, and by avoiding illegal survival means and destructive coping mechanisms. Examples of these interventions include programmes that support sustainable livelihood strategies by increasing climate-resilient agricultural productivity, and improve equitable access to relevant natural resources, and the delivery of inclusive social services (Bunse and Delgado, 2024).

Despite a theoretical awareness of the need to address underlying vulnerabilities to food insecurity, there is currently a significant imbalance between the humanitarian and development funding streams, with humanitarian assistance continuing to dominate the funding landscape in protracted food crisis situations. For example, in the 19 countries affected by major food crises in the past seven years, nearly half of humanitarian spending was directed to food sectors (USD 10.6 billion compared to USD 9.7 billion for other sectors). Comparatively, just over 10 percent of total development spending was targeted towards food sectors, despite the food crises in these countries extending over several years (GNAFC, 2024).

From the donor perspective, in 2022, the G7 allocated USD 5.8 billion in ODA for emergency food assistance compared to USD 13.2 billion for all other food security and nutrition ODA (Figure 21). This represents nearly a third (31 percent) of the total ODA budget for all food security and nutrition concerns. Rather than relying on short-term humanitarian assistance, this disparity underscores the urgent need to increase development funding to address the root causes of food insecurity and malnutrition.

Despite the promises of the humanitarian–development–peace nexus, challenges remain in its implementation. Donor financing often remains siloed within humanitarian, development and peacebuilding funding streams (Eber Rose *et al.*, 2024). This earmarking of funds prevents much-needed collaboration between implementing actors and limits the ability to pool resources and adapt to changing conflict and peacebuilding dynamics. To overcome these challenges, there is an emphasis on developing transition strategies that can help move vulnerable populations from reliance on humanitarian assistance towards self-reliance and sustainable development (Bunse and Delgado, 2024; GNAFC, 2024).

Donors, such as Switzerland, are increasingly integrating their humanitarian and development funding streams, while Sweden is among the donor countries that are bringing agencies together from across the humanitarian, development and peace nexus. Multilateral development banks can play a crucial role in breaking down siloed approaches to funding (The Rockefeller Foundation, 2023). The International Monetary Fund (IMF), for example, has created a Resilience and Sustainability Facility, with USD 60 billion that can be drawn down by countries to invest in long-term resilience. The Facility aims to help low-income and vulnerable middle-income countries address longer-term

challenges in particular, providing policy support and affordable financing (IMF, 2023). The IMF also offers interest-free concessional support through the Poverty Reduction and Growth Trust, which aims to ensure that low-income countries maintain the stable and sustainable macroeconomic position needed for poverty reduction and growth (The Rockefeller Foundation, 2023).

Reacting to increasing levels of acute food insecurity and in efforts to keep pace with growing humanitarian needs (Figure 22), World Food Programme (WFP) has made increasing demands for funding. However, interestingly, since the late 2000s, WFP has shifted from an emphasis on food aid to food assistance in general, and cash assistance in particular. While cash transfers provide immediate relief, they can also be seen as a more effective tool than food aid, which can bridge humanitarian and development objectives .

To better integrate humanitarian and development approaches and financing in protracted food crisis countries, interventions need to consider the specific needs of the local context and the timeframe of the initiated program. Area-based approaches, for example, can provide aid that is explicitly multisector and multidisciplinary, and that holistically treats needs within a defined community or geography, and can

be designed and implemented through participatory engagement with affected communities and leaders. Working on a multi-year timeframe is also beneficial for enabling the transition from humanitarian assistance to more sustainable solutions because it allows for a gradual shift from immediate relief to long-term development strategies. Better understanding of the interconnected nature of acute and chronic food insecurity will allow for the development of more effective and holistic solutions to break the cycle of hunger in protracted crisis situations.

One potentially important area of investment is in emergency agricultural interventions. Despite a significant increase in humanitarian financing, spending on emergency agricultural interventions has remained largely unchanged. On average, around 4 percent of humanitarian financing to food sectors is spent on emergency agricultural interventions. Among the food sectors, this is the lowest amount of humanitarian financing received. And yet, agriculture is the main source of food and income for over two-thirds of people experiencing high acute food insecurity (GNAFC, 2024). While there is development funding for agricultural interventions in such contexts, this is a considerable area for investment and a rebalancing of humanitarian and development spending.

6 FROM RECOMMENDATIONS TO ACTION

With just over five years left to 2030, political momentum is strong. Most recently, Brazil, under its G20 presidency announced the G20 Alliance Against Hunger and Poverty (G20 Brasil, 2024). This initiative aims to bridge gaps in the fight against hunger and poverty by offering technical and financial support to implement policies and technologies that have proven successful on a large scale. Open to all countries, not just G20 members, the Alliance will serve as a practical mechanism in the fight against hunger by showcasing the potential of country-owned, large-scale initiatives, and will facilitate knowledge sharing and partnerships among participating nations. The Alliance will be open for membership, with its official launch expected in November at the G20 Leaders' Summit in Rio de Janeiro.

The G20 initiative comes after Italy, under its G7 presidency, launched the Apulia Food Systems Initiative, building on the Global Alliance for Food Security, launched by the German G7 presidency in 2023. The important political momentum has been backed with financial commitments. G7 aid related to food security and rural development, for example, has almost tripled since 2000 (von Braun *et al.*, 2024). In 2022, the G7 exceeded its joint commitment to provide USD 14 billion in ODA for food security and nutrition (G7, 2024). Developed countries in 2023 exceeded their goal of providing and mobilizing USD 100 billion in climate finance for developing countries per year (G7, 2024).

The momentum generated by the 2021 United Nations Food Systems Summit has also contributed to the high level of political momentum. This was evident from the outcomes of the summit, and the ongoing initiatives, such as the establishment of the United Nations Food Systems Coordination Hub, engagement with National Convenors, coalitions of action, development of tools and knowledge products, creation of regional platforms, financial investments, and increased collaboration and partnerships (United Nations Secretary-General, 2023). Several countries have developed food security and nutrition strategies for the first time, and many have integrated their food systems transformation vision into policies beyond the traditional sectors of agriculture, food security, and nutrition. Since 2021, 126 countries have adopted national food systems pathways, 155 have appointed national convenors, and 101 submitted voluntary country progress reports, demonstrating the global commitment to food systems transformation (United Nations Secretary-General, 2023).

This political momentum needs to be channelled into concrete, bankable actions. Six actions to prioritize, based on an income-generating approach to ending hunger, as follows:

1. **Investments to improve productivity and incomes on the farm, through agricultural R&D, extension services, farm mechanization and technology adoption** such as ICTs. Agricultural R&D has a significant impact on productivity, especially when complemented with extension services that provide accurate information and training on new farming techniques, food safety requirements and market demands that help farmers adapt to changing conditions. Specifically, precision agriculture and mechanization have the potential to significantly transform farming practices, making them more efficient, productive and environmentally sustainable.
2. **Investments to build and maintain infrastructure for irrigation, electricity, rural roads and storage** to reduce post-harvest losses. Electrification and irrigation are key to improve agricultural productivity, and deliver even greater results when combined with roads. The focus on rural transportation should not be limited to roads, but rather, should consider local terrain and bottlenecks. Improved transportation infrastructure allows farmers to better connect with growing domestic urban and international markets. Further attention should be given to storage interventions, such as the use of airtight bags and containers, to reduce post-harvest losses for cereals and pulses.
3. **Investments in agrifood processing, distribution and retail, particularly by agrifood SMEs** in domestic and regional markets. Agrifood processing can create employment opportunities by adding value to agricultural products through processing, packaging and marketing. It can also reduce post-harvest losses for more nutritious foods through better handling practices, improved packaging and cold chain facilities. This can simultaneously improve food safety through measures such as basic food preservation methods (e.g. drying and fermentation), or advanced industrial processes (e.g. pasteurization and food fortification). To complement these investments and meet the labour demands of the food processing sector, there is a need for more vocational training and increased university enrolment in STEM.

4. **Improve access to finance, especially for small-scale producers and agrifood SMEs.** Access to finance is essential to make all the other interventions possible and accessible for farmers in developing countries. One of the biggest challenges in the agrifood sector is access to finance, particularly for the “missing middle”: Productive social protection programmes are a critical fiscal instrument to increase the risk appetite of these actors, and to provide an insurance policy for lenders. Several innovative solutions that emphasize the value of relationships and trust between farmers, SMEs and their buyers, traders and wholesalers, are: (i) factoring; (ii) supply chain finance or reverse factoring; (iii) outcome financing; (iv) real estate investment trusts; (v) PSL; (vi) asset monetization; and (vii) guarantees. Critical to all seven solutions is the need for increased participation by domestic governments and investors.
5. **Better trade and competition policy, together with stronger regional integration,** are essential to ensure that the benefits of increased investment result in income-generating opportunities for small-scale producers and agrifood SMEs. Low- and middle-income countries, particularly in Africa,

urgently need to improve the effectiveness of their competition regimes to address high and increasing concentration in agrifood markets. The existence of competition laws and policies, and the establishment of independent competition authorities are the best institutional fixes for abuse of market power and its resulting consequences.

6. **Sustained investments in productive social protection programmes, such as the cash+ programme,** which provide income support combined with productive investments in productivity growth or infrastructure development. Social protection works to overcome the structural barriers that prevent the poorest and most vulnerable households from capitalizing on the opportunities created and afforded by economic growth. The long-term impacts of social protection programmes depend on their ability to evolve and adapt to changing economic conditions and to be supported by robust fiscal policies. Sustainable financing for these programmes is crucial, and innovative approaches such as leveraging the economic multipliers of cash transfers can help justify the expenditure as an investment rather than a mere cost.

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