

Agrifood Systems in Northern Central America

Agrologistics for Modern Family Farms



THE WORLD BANK
IBRD • IDA

© 2022 The World Bank

1818 H Street NW, Washington DC 20433

Telephone: 202-473-1000; Internet: www.worldbank.org

Some rights reserved

This work is a product of the staff of The World Bank. The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of the Executive Directors of The World Bank or the governments they represent. The World Bank does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Rights and Permissions

The material in this work is subject to copyright. Because The World Bank encourages dissemination of its knowledge, this work may be reproduced, in whole or in part, for noncommercial purposes as long as full attribution to this work is given.

Attribution—Please cite the work as follows: “World Bank. 2022. *Agrifood Systems in Northern Central America: Agrologistics for Modern Family Farms*. Garcia, A., Perego, V.M.E., Prasann, A., Millán, F., Horton, J., Bueso, F.J., Channa, H., Mora, E., Traverso, M.V., Horst, A.C., Benjamin, M.P. © World Bank.”

All queries on rights and licenses, including subsidiary rights, should be addressed to World Bank Publications, The World Bank Group, 1818 H Street NW, Washington, DC 20433, USA; fax: 202-522-2625; e-mail: pubrights@worldbank.org.

Cover has been designed using resources from freepik.com and photos from stock.adobe.com [Amarinj, Anna Sitnik, nattan726, JuanLuis]. Icons designs from flaticon.com

Agri-food Systems in Northern Central America: Agrologistics for Modern Family Farms

Augusto Garcia, Viviana M.E. Perego, Ashesh Prasann,
Florecia Millán, John Horton, Francisco J. Bueso, Hira Channa,
Elena Mora, Maria Victoria Traverso, Alexandra C. Horst, McDonald P. Benjamin

Acknowledgements

This report was prepared by a World Bank team including Augusto García (Task Team Leader, Senior Agriculture Specialist, World Bank), Viviana Maria Eugenia Perego (Task Team Leader, Agriculture Economist, World Bank), Ashesh Prasann (Task Team Leader, Agriculture Economist, World Bank), Francisco Javier Bueso (Senior Agriculture Specialist, World Bank), Alexandra Christina Horst (Senior Agriculture Economist, World Bank), Hira Channa (Agriculture Economist, World Bank), Florencia Millán Placci (Consultant, World Bank), John Horton (Consultant, World Bank), McDonald Benjamin (Consultant, World Bank), Maria Victoria Traverso (Consultant, World Bank), and Elena Mora (Consultant, World Bank).

The team is grateful for the guidance and support of Diego Arias (Practice Manager, World Bank), Preeti Ahuja (Practice Manager, World Bank), and Eric Lancelot (Program Leader, World Bank). Aiga Stokenberga (Transport Economist, World Bank), Farbod Youssefi (Senior Agribusiness Specialist, World Bank), Mia Rodriguez (Investment Officer, International Finance Corporation), and Svetlana Edmeades (Senior Agriculture Economist, World Bank) kindly served as Peer Reviewers for this report. The team acknowledges advice and brainstorming from Michael Morris (Lead Agriculture Economist, World Bank), Christopher Brett (Lead Agribusiness Specialist, World Bank), Parmesh Shah (Lead Rural Development Specialist, World Bank), Edward Bresnayan (Senior Economist, World Bank), Pablo Valdivia (Senior Agribusiness Specialist, World Bank), Joanne Gaskell (Senior Agriculture Economist, World Bank), Barbara Farinelli (Senior Agriculture Economist, World Bank), Lisardo Bolaños (Consultant, World Bank).

Valuable insights and advice were gathered from Álvaro Moreno and Mario Tenorio (Organismo Promotor de Exportaciones e Inversiones de El Salvador – PROESA), Andrea Romero and Elieser Castellanos (Guatemala Logistics Chamber), Andrés Bickford and Mosés Mérida (Asociación de Exportadores de Guatemala – AGEXPORT), Barony Vazquez and Patricio Astolfi (Mahler, Nestlé Guatemala), Beatriz Moreno (Asociación Nacional del Café – ANACAFE), Carlos Yzaguirre (NAVY SA), Diego Baraona (Café Berlin), Douglas Urquia (Coffee Planet), Eduardo Solares (Polartika), Francisco Mendoza (International Fund for Agriculture Development), Gerardo Alberto de León and Katell Segalen (Federación de Cooperativas Agrícolas de Productores de Café de Guatemala – FEDECOCAGUA), Gerardo Torres (Sustainability and Especial Projects), Jenny Ramirez (Secretaría de Infraestructura y Servicios Públicos – INSEP), Jimmy Thoms Ramírez López (Cafés Especiales de El Paraíso – CAFEPSA), Jonathan Mendez (Central de Mayoreo – CENMA), José Gómez (Instituto Hondureño de Mercadeo Agrícola – IHMA), Jose Miguel Duro (Ministry of Agriculture Livestock and Food Guatemala), Karla Tay (United States Department of Agriculture), Mey L. Hung (Walmart Guatemala), Nelson Omar Funez (Consejo Nacional del Café, CONACAFE), Regina Ochaer and Roberto Mendoza (Comisión Ejecutiva Portuaria Autónoma – CEPA), Roberto Sandri and Marlene Soriano (Cooperativa Agrícola Cafetalera San Antonio Limitada – COAGRICSAL), Romel Hawit (TRANYCOP), Salvador Paiz (Fundación para el Desarrollo de Guatemala – FUNDESA), Samara Celada and Tulio García (Cuatro Pinos), Samuel Salazar Genovez (Fundación Salvadoreña para el Desarrollo Económico y Social – FUSADES), Santiago Herrera Valle, Marvin Oseguera, and Anabel Gallardo (Consejo Hondureño de la Empresa Privada – COHEP), Tomás Membreño (Technoserve), Vanessa Rodríguez (Honduras Chamber of Commerce of Cortés).

The team expresses its gratitude for logistical and administrative support from Mario Méndez (Team Assistant, World Bank) and Sofia Neiva (Team Assistant, World Bank). Graphic design services were provided by Jaime Sosa.

Acronyms and Abbreviations

3PL	Third-Party Logistics
ADECAFEH	Association of Coffee Exporters of Honduras (<i>Asociación de Exportadores de Café de Honduras</i>)
ANACAFE	National Coffee Association of Guatemala (<i>Asociación Nacional de Café</i>)
ASTI	Agricultural & Scientific Technology Indicators
B2B	Business-to-Business
B2C	Business-to-Consumer
BAGSA	Agricultural Commodity Exchange of Nicaragua (<i>Bolsa Agropecuaria de Nicaragua</i>)
BECOLSUB	Benefitting from Coffee and the Utilization of By-Products (<i>Beneficio del Café y Aprovechamiento de los Subproductos</i>)
CA	Central America
CAC	Central American Agricultural Council
CATIE	Tropical Agricultural Research and Higher Education Center (<i>Centro Agrónomo Tropical de Investigación y Enseñanza</i>)
CENICAFÉ	National Center for Coffee Research of Colombia (<i>Centro Nacional de Investigaciones de Café</i>)
CENMA	Central Wholesale Market of Guatemala (<i>Central de Mayoreo</i>)
CENTA	Enrique Álvarez Córdova National Center for Agricultural and Forestry Technology (<i>Centro Nacional de Tecnología Agropecuaria y Forestal Enrique Álvarez Córdova</i>)
CF	Contract Farming
CIAT	International Center for Tropical Agriculture (<i>Centro Internacional de Agricultura Tropical</i>)
CIMMYT	International Wheat and Maize Improvement Center (<i>Centro Internacional de Mejoramiento de Maíz y Trigo</i>)
COMITRAN	Sectoral Council of Ministers of Transport of Central America (<i>Consejo Sectorial de Ministros de Transporte de Centroamérica</i>)
COMRURAL	Honduras Rural Development Project
COMTRADE	UN International Trade Statistics Database
COVID-19	Coronavirus
CPSD	Country Private Sector Diagnostics
CSA	Climate Smart Agriculture
CSC	Salvadoran Coffee Council (<i>Consejo Salvadoreño de Café</i>)
DESLIM	Mechanical Demucilation (<i>Desmucilagador Mecánico</i>)
DIACO	Directorate for Attention and Assistance to the Consumer (<i>Dirección de Atención y Asistencia al Consumidor</i>)
DICORER	Rural Extension Directorate (<i>Dirección de Coordinación Regional y Extensión Rural</i>)
DICTA	Directorate of Agricultural Science and Technology (<i>Dirección de Ciencia y Tecnología Agropecuaria</i>)
D.O.	Denomination of Origin
DR-CAFTA	Dominican Republic-Central America Free Trade Agreement
EBA	Enabling the Business of Agriculture
EBRD	European Bank for Reconstruction and Development

ECLAC	Economic Commission for Latin America and the Caribbean (<i>Comisión Económica para América Latina y el Caribe</i>)
ENC	National Central School for Agriculture (<i>Escuela Nacional Central de Agricultura</i>)
ENCOVI	National Living Standards Survey (<i>Encuesta Nacional de Condiciones de Vida</i>)
EPHPM	Permanent Survey of Multiple Purpose Households (<i>Encuesta Permanente de Hogares de Propósitos Múltiples</i>)
EU	European Union
F2F	Farm-to-Fork
FAO	Food and Agriculture Organisation of the United Nations
FAOSTAT	Food and Agriculture Statistics (<i>FAO</i>)
FDI	Foreign Direct Investment
FEDECOCAGUA	Guatemalan Federation of Agricultural Cooperatives of Coffee Producers (<i>Federación de Cooperativas Agrícolas de Productores de Café de Guatemala</i>)
FEWS NET	Famine Early Warning Systems Network
FFI	Feed the Future Initiative (<i>USAID</i>)
FFV	Fresh Fruits and Vegetables
FHIA	Honduran Agricultural Research Foundation (<i>Fundación Hondureña de Investigación Agrícola</i>)
FLW	Food loss and waste
FTA	Free Trade Agreement
FUNICA	Foundation for Agricultural and Forestry Technological Development of Nicaragua (<i>Fundación para el Desarrollo Tecnológico Agropecuario y Forestal de Nicaragua</i>)
FYDUCA	Single Central American Invoice and Declaration (<i>Factura y Declaración Única Centroamericana</i>)
GCI	Global Competitiveness Index
GDP	Gross domestic product
GHG	Greenhouse gas
GIEWS	Global Information and Early Warning System on Food and Agriculture (<i>FAO</i>)
GoH	Government of Honduras
GRID	Green, Resilient, Inclusive Development
GSSE	General Services Support Estimate
GSSEA	General Services Support Estimate for Agricultural Knowledge & Innovation Systems
GSSEB	General Services Support Estimate for Inspection & Control for Phyto-Zoo-Sanitary Protection & Food Safety
GSSEC	General Services Support Estimate for Development & Maintenance of Infrastructure
GSSD	General Services Support Estimate for Marketing & Promotion
GSSEE	General Services Support Estimate for Cost of Stockholding
GSSEF	General Services Support Estimate for Miscellaneous
ha	Hectares
HORECA	Hotels, Restaurants and Catering
ICT	Information and Communications Technology
ICTA	Institute of Agricultural Science and Technology (<i>Instituto de Ciencia y Tecnología Agrícolas</i>)

IDB	Inter-American Development Bank
IEA	International Energy Agency
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IHCAFE	Honduran Institute for Coffee (<i>Instituto Hondureño de Café</i>)
IHMA	Honduran Agricultural Marketing Institute (<i>Instituto Hondureño de Mercadeo Agrícola</i>)
IICA	Inter-American Institute for Cooperation on Agriculture
INVEST-H	Honduras Strategic Investment Office (<i>Inversión Estratégica de Honduras</i>)
IRENA	International Renewable Energy Agency
JOIN	Jobs Indicators Database (<i>WDI</i>)
kg	Kilograms
km	Kilometers
KNOMAD	Global Knowledge Partnership on Migration and Development
LAC	Latin America and the Caribbean
LPI	Logistics Performance Index
LULUC	Land Use and Land-Use Changes
MAG	Ministry of Agriculture and Livestock of El Salvador (<i>Ministerio de Agricultura y Ganadería</i>)
masl	Meters Above Sea Level
MINECO	Ministry of Economy of Guatemala (<i>Ministerio de Economía</i>)
MIT	Massachusetts Institute of Technology
MPI	Migration Policy Institute
MT	Metric Tons
NCA	Northern Central America (<i>i.e., El Salvador, Guatemala and Honduras</i>)
OECD	Organisation for Economic Cooperation and Development
OLADE	Latin American Energy Organization (<i>Organización Latinoamericana de Energía</i>)
PAFCIA	Policy on Family Farming, Indigenous and Afro-descendant Agriculture (<i>Política de Agricultura Familiar Campesina, Indígena y Afrodescendiente</i>)
PFI	Private Financial Institution
PHM	Post-Harvest Management
PMRML	Regional Mobility and Logistics Framework Policy (<i>Política Marco Regional de Movilidad y Logística</i>)
PNLOG	National Cargo Logistics Plan (<i>Plan Nacional en Logística de Cargas</i>)
PSE	Producer Support Estimate
PV	Photovoltaics
R&D	Research and Development
RFID	Radio Frequency Identification
RUTA	Regional Unit for Technical Assistance of SICA (<i>Unidad Regional de Asistencia Técnica</i>)
SDC	Swiss Agency for Development and Cooperation
SENASA	National Health and Food Safety Service of Honduras (<i>Servicio Nacional de Sanidad e Inocuidad Alimentaria</i>)
SIECA	Secretariat for Central American Economic Integration (<i>Secretaría de la Integración Económica Centroamericana</i>)

SICA	Central American Integration System (<i>Sistema de la Integración Centroamericana</i>)
SIRRS	System for Mutual Recognition of Sanitary Records (<i>Sistema Informática de Reconocimiento Mutuo de Registros Sanitarios</i>)
SPS	Sanitary and Phytosanitary
SNC	National Quality System (<i>Sistema Nacional de Calidad</i>)
tCO₂eq	Tons of Carbon Dioxide Equivalent
TSP	Technical Service Provider
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNSD	United Nations Statistics Division
US\$	United States dollars
USA	United States of America
USAID	United States Agency for International Development
USDA-GAIN	United States Department of Agriculture - Global Agricultural Information Network
VC	Value Chain
VUCE	Single Window for Foreign Trade (<i>Ventanilla Única de Comercio Exterior</i>)
WBG	World Bank Group
WDI	World Development Indicators
WFP	World Food Programme
WHO	World Health Organization

Table of Contents

Executive Summary	10
Chapter 1. Introduction: Agrologistics for Modern Family Farms in Northern Central America	21
1.1 Scope and Purpose of this Report.....	21
1.2 Making Agri-food Systems Efficient, Green, Resilient, and Inclusive	21
1.3 Key Challenges in Northern Central America	23
1.4 Agriculture in the NCA Countries and the Importance of Agrologistics	24
1.5 The Focus and Structure of this Report	24
Chapter 2. Agrologistics in Northern Central America: The Broader Context and the Current Status	26
2.1 The Sector Context: Agri-food Systems in Northern Central America	26
2.2 Megatrends in Central America's Agri-Food Systems	28
2.3 Challenges in Agrologistics in Northern Central America	36
2.4 A Key Consequence of the Challenges: Food Loss and Waste	41
2.5 Emerging Trends and Innovations in Agrologistics	43
2.6 Summary of Findings	45
Chapter 3. Public and Private Roles for an Enabling Environment	46
3.1 National and Regional Policy Frameworks for Agrologistics	46
3.2 The Current Status of Public Supports for Agrologistics in the NCA Countries	50
3.3 Advances and Limitations in Private Sector Engagements in Agrologistics	52
3.4 Summary of Findings	56
Chapter 4. Agrologistics for Key Value Chains: A Deep Dive	57
4.1 A Focus on Key Agri-food Value Chains in Northern Central America	57
4.2 Agrologistics in the Coffee Value Chain	58
4.3 Agrologistics for Fresh Fruits and Vegetables	69
4.4 Agrologistics and Basic Grains Value Chains	80
4.5 Summary of Findings for the Three Value Chain Deep Dives	90
Chapter 5. Options for Efficient, Green, Resilient and Inclusive Agrologistics in Northern Central America	92
5.1 Policy Priorities for Making Agrologistics Efficient, Green, Resilient and Inclusive	92
5.2 Investment Priorities for GRID Agrologistics in Northern Central America	97
5.3 Technology and Process Agrologistic Innovations for GRID	100
5.4 Conclusions	107
References	108

Executive Summary

Scope of the Report

1. This report explores the agrologistics challenges and opportunities faced by agri-food systems in three countries in Northern Central America (NCA), namely El Salvador, Guatemala and Honduras, with a specific focus on the impacts on family farming systems. As an overarching principle guiding the analysis, the report adopts the World Bank's framework of Green, Resilient, and Inclusive Development (GRID),¹ which recognizes that the challenges of poverty, inequality, climate change, and systemic shocks such as COVID-19 are strongly interrelated, and thus need to be addressed simultaneously and systematically. As such, the study seeks to highlight ways in which enhancing agrologistics systems can drive food system efficiency, environmental sustainability, resilience and inclusion in Northern Central America (NCA), thus contributing to wellbeing and overall economic performance. In this study, the term agrologistics is used to refer to the infrastructure, machinery, related services, and information systems that allow agri-food products to move from the original point of production to the final point of consumption. The analysis follows the five key components of agrologistics value chain, namely: (a) on-farm post-harvest management; (b) storage and handling, including cold storage; (c) processing and packaging; (d) transport from the farm to collection and processing centers, and onwards to distribution networks; and (e) distribution by wholesalers, retailers and exporters, which in the case of exports involves customs and other border crossing processes. The overall framework for the analysis and structure of the report is presented in Figure E.1.

Figure E.1: A Framework for Analysis of Agrologistics in Northern Central America

Agrologistics for Green, Resilient, and Inclusive Development (GRID) and Modern Family Farms in Northern Central America (NCA) – El Salvador, Guatemala and Honduras



Source: Authors

¹ World Bank Group (2021).

Agrologistics in Northern Central America: Broader Context and Current Status

2. With GDP per capita ranging from US\$2,390 in Honduras to US\$4,600 in Guatemala in 2020, the three countries are among the poorest in the Latin America and Caribbean (LAC) region. Northern Central America also has among the highest levels of food insecurity in LAC, with an average of 21% of its population facing food scarcity. The three NCA countries are also among the most vulnerable in the world to climate change and extreme weather events. For example, the twin tropical storms Iota and Eta that struck the sub-region in November 2020 generated an estimated US\$7 billion in economic losses.

3. The Northern Central American countries are characterized by traditional agri-food systems that are the major source of support for rural livelihoods. Agri-food systems have a large economic and social footprint in NCA relative to the LAC region. In terms of size of the primary agriculture sector and its contribution to employment, Guatemala and Honduras significantly exceed the corresponding regional averages. On average, agriculture in the three NCA countries accounts for 9% of GDP, 25% of employment, and 43% of exports (not including the industrial transformation of agricultural products via agro-processing). While the sector is relatively small in El Salvador, at 5 percent of GDP, its employment share is the same as the regional average. Primary agriculture is a key source of rural livelihoods, in which more than 4 out of 5 rural jobs are informal.

4. Family farming plays a key role in the sub-region's rural development, food security, and climate resilience. According to recent estimates from the Central America Integration System (SICA), family farms represent 80 – 90 percent of corn and bean producers, and supply 70 – 80 percent of the food consumed in the sub-region. While a growing fraction of family farms operates commercially oriented enterprises with the capacity to add value through aggregation, basic processing and access to local markets, their systems are predominantly characterized by limited productivity and competitiveness, low access to knowledge and markets, and high vulnerability to economic and climate shocks. Strengthening agrologistics, both on-farm post harvest and beyond the farmgate, can boost farmers' incomes by greatly reducing food loss and waste and by providing more inclusive linkages for family farmers to broader markets, as well as to more sophisticated purchasers that can result in improved technologies for farm-level production and risk management.

5. Northern Central America is home to established export-oriented value chains like coffee and fresh fruits and vegetables. Food exports comprise large shares of merchandise exports for NCA countries, ranging as high as 71% for Honduras, which is among the top 10 exporters of coffee in the world. The production of high-value export crops is also a key source of livelihoods and both small and large farms are becoming more integrated into global markets. For instance, in the case of Honduras, coffee production is practiced by 100,000 producers, 90 percent of whom are smallholders, and the entire coffee chain creates around 1 million jobs between picking, processing, and transportation.

6. Agrologistics in Northern Central America are being transformed by a number of megatrends that are reshaping the context in which agri-food systems operate:

- » **Climate change** is expected to have the largest long-term impact on agri-food systems and the welfare of smallholder farmers in NCA. Estimates of the annual expected cost of agricultural production losses across Central America due to extreme events average around 7.2% of regional agricultural value added, or US\$1.67 billion per year.

- » **Migration** trends for the three NCA countries are characterized by extremely high rates of emigration relative to immigration by global standards, with on average over 22 emigrants for every immigrant across the three countries. Poverty, food insecurity, violence, natural disasters and climate change are the key drivers of high rates of emigration, which in turn can affect agri-food systems by reducing the availability of workers at peak harvest times, whether on-farm or at processing centers. At the same time, the tenfold increase in remittances to the NCA countries since 2000, totalling US\$30.1 billion by 2021, represent a significant area of untapped potential for productive uses in agri-food value chains.
- » **Urbanization** is a powerful driver of change in agriculture and food systems in Northern Central America, where the urban population has increased by almost 70% since 2000. Close to 60% of the sub-region's population now lives in urban areas, and this share is expected to increase to 72% within the next generation, requiring that food systems produce and deliver significantly larger quantities of food for an additional 13.4 million new urban dwellers by 2050.
- » **Dietary shifts** are increasing demand for healthy, safe, and high-quality food products (in terms of carbon footprint, energy use, impact on biodiversity, and fair-trade approaches). For instance, in North America, sales volumes of fair-trade coffee increased by 16% in 2021 compared to 2020 and are expected to continue to grow at a compound annual growth rate of 8.7% through to 2025.
- » **The supermarket revolution** is seeing the expansion of supermarket chains as major providers of food, with backward linkages to local producers who have to fulfil increasingly demanding and capital-intensive standards. During the past two decades, the sub-region has undergone one of the world's most substantial shifts from primary reliance on traditional agricultural supply and domestic food distribution to supply chains driven by supermarkets. For example, in Guatemala, 30% of total food sales are now made by supermarkets. More broadly, during the last decade, Walmart has become the largest supermarket chain in Central America, growing from 40 stores in 2010 to 838 retail outlets today.
- » **Growing domestic markets** are creating new opportunities for agriculture to grow to fulfil domestic demand, as the market size of the food sector in Northern Central America totals over US\$40 billion, greatly exceeding the sub-region's agricultural GDP of US\$12.1 billion.
- » **International markets** are also growing in importance, with increasing regional and global interconnectedness, driven in large measure by free trade agreements. This creates opportunities and challenges for Central American producers in terms of potentially larger markets, higher import competition, and growing requirements in terms of quality, sustainability, and food safety standards for exports.

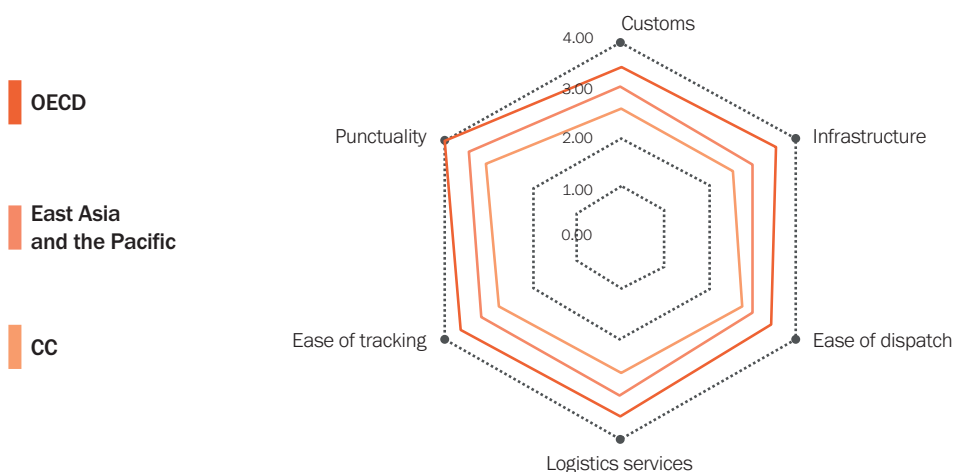
7. In addition to these megatrends, agri-food systems have been shocked by major recent disruptors. These include the COVID-19 pandemic, tropical storms Eta and Iota in November 2020, and the recent conflict between Russia and Ukraine that began in February 2022. These events have added to pre-existing systemic constraints and to the shocks to agri-food systems from natural disasters, and have resulted in supply and distribution chain disruptions, domestic and international mobility restrictions, the contraction of supply and

demand, a reduction in traditional marketing outlets, price volatility, and reduced liquidity and working capital for agricultural medium small and micro enterprises.

8. Within this broader context, Northern Central American countries face a range of common challenges in strengthening their agri-food systems to ensure green, resilient and inclusive development.

The Latin America and Caribbean (LAC) region lags behind most of the world in terms of logistics efficiency. According to the 2018 World Bank's Logistics Performance Index (LPI), the logistics performance of the Central America and Caribbean region consistently scored below all regions globally, except for Sub-Saharan Africa (Figure E.2). This study confirms that severe logistics bottlenecks hamper the performance of Central American agri-food value chains, including inadequate quality and quantity of post-harvest and storage capacity for agricultural products both on-farm and beyond the farmgate; under-investment in rural infrastructure, notably in upgraded road networks and digital infrastructure; and inefficient customs clearance operations, a lack of inter-agency coordination, and burdensome certification requirements at border crossings. For example, Guatemala had only 12 refrigerated warehouses in 2018, resulting in a refrigerated warehouse capacity of 0.125 million m³ with 0.014 m³ per urban resident, compared to over 2 million m³ in Chile, equivalent to 0.133 m³ per urban resident, i.e. almost 10 times more per urban resident. Similarly, average transit speeds on roads in El Salvador is 17km per hour for the entire road network, due to topography, road quality and road congestion, with comparable findings for Honduras and Guatemala, versus international standards of 80km per hour.

Figure E.2: Logistics Efficiency in Central America and the Caribbean Lags Other Regions



Source: World Bank - Logistics Performance Index (2018)

9. The automation and digitization of agri-food value chains constitutes one of the major trends and innovations that can revolutionize agrologistics and contribute to inclusive and sustainable growth and productivity improvements in the sector. Other innovations that are already well-tested in NCA include

innovative social platforms that aggregate and organize farmers, notably public-private alliances but also lead firm linkages with small and medium-scale enterprises (SMEs). In addition, Farm-to-Fork initiatives, including business-to-consumer and business-to-business e-commerce platforms, as well as opportunities for nearshoring are examples of emerging tools and mechanisms that warrant further development to promote green, resilient and inclusive agri-food systems in Northern Central America.

Public and Private Roles in Creating an Enabling Environment for Agrologistics

10. At the regional level, the 2019-2030 Strategy & Regional Mobility/Logistics Framework of the Central American Integration System (SICA) seeks to promote efficient, GRID-consistent agrologistics. It enumerates priority lines of action around the promotion of business development and of risk management and adaptation to climate variability and climate change. It also recommends the articulation of regional schemes for agriculture research and development (R&D) and innovation, as well as collaboration on regional agricultural health and food safety programs, including surveillance, early detection, eradication of diseases and pests. In addition, SICA's Regional Mobility and Logistics Framework Policy (PMRML) proposes a shared vision of mobility, addressing modal (maritime, airports, railroad, road, coordinated border management and urban logistics) as well as cross-cutting elements (production, trade, and mobility of people).

11. Despite a favorable regional framework and strategic guidance, budget resources for policy implementation are the responsibility of each country's government, and they tend to be scarce. The absolute values of public investments in agri-food systems range from 1.1% of agricultural GDP in El Salvador to 0.8% in Honduras and just 0.2% in Guatemala. By 2019 all three NCA countries had developed a National Cargo Logistics Plan (PNLOG), providing strategic guidance for the development of the logistics sector in accordance with the PMRML, although it is estimated that only around 10% of the respective investments have been implemented to date. There is significant heterogeneity in the composition of public support to agriculture and agrologistics, with a different balance across countries between private support and expenditure on public goods and services. El Salvador, with the smallest agricultural sector, provides a higher degree of protection in the form of subsidies to its producers than do its neighbors, whereas Honduras invests more than four to five times either Guatemala or El Salvador in the public goods and services, such as infrastructure, knowledge and innovation, that bear directly on agricultural and agrologistic development (Table E.1).

Table E.1: Public Investment in Agrologistics Sub-Categories (in US\$ millions)

Country (Year)	GSSEA R&D	GSSEB Inspection	GSSEC Infrastructure	GSSED Marketing	GSSEE Storage	GSSEF Other	TOTAL
Costa Rica (2019)	28.32	10.94	20.57	1.34	0	0	61.21
Dominican Republic (2019)	43.51	4.11	29.39	21.37	0	4.16	102.55
El Salvador (2017)	14.42	3.89	7.10	1.53	0	0	26.94
Guatemala (2018)	13.89	5.68	9.84	2.14	0	5.55	37.10
Honduras (2017)	24.25	6.51	33.37	0.15	2.57	0	66.85
Nicaragua (2017)	9.38	4.52	6.92	0	0	0	20.82
Panama (2015)	11.19	4.35	41.58	3.56	0	0	60.68

Source: IDB Agrimonitor (2021)

A Deep Dive Analysis of Key Agri-food Value Chains in Northern Central America

12. Overall, low levels of public support and expenditure, coupled with policy and regulatory uncertainty and low performance in terms of complementary services such as ICT connectivity, stifle the establishment of an enabling environment for entrepreneurship, innovation, and technology adoption in agrologistics across the three NCA countries. In certain cases, Foreign Direct Investment (FDI) plays a complementary role in ensuring the modernization of agriculture and agrologistics systems, such as through sophisticated supermarket supply chains or contract farming arrangements. Private-sector-led policies and initiatives are also driving change on cross-cutting GRID themes, such as through self-regulation and compliance with environment and social standards.

13. Deep dive assessments of agrologistics systems associated with selected value chains (VCs) in the three Northern Central American countries of El Salvador, Guatemala, and Honduras highlight specific structural bottlenecks, missing links, and development opportunities along the entire agrologistics chain. The analysis focuses on agrologistics systems from the production to retail stages in the coffee, fresh fruits and vegetables, and basic grains value chains for the three countries. These three value chains were selected based on their socio-economic footprint, relevance to family farms, and high potential to modernize and promote green, resilient and inclusive development of agri-food systems in Northern Central America.

14. The coffee industry has several promising inherent characteristics from the point of view of green, resilient and inclusive development (GRID). Coffee cultivation performs a vital function in watershed management, environmental and biodiversity protection and avoidance of land degradation. It also provides opportunities for inclusive development through employment opportunities for women, with around 20-30% of coffee farms female-owned, and income opportunities for rural communities living in remoter, more mountainous areas to engage in value chains linked to global markets. Honduras and Guatemala, whose coffee is almost exclusively produced by smallholder farmers (over 95% of both countries' producers are smallholders), rank 4th and 14th, respectively, in global coffee export markets, and all three countries have production zones with Denominations of Origin that contribute to premium prices for coffee produced in those areas. Where smallholder producers are organized into cooperatives, and where they obtain organic, fair-trade, rainforest protection or Cup of Excellence certifications and recognitions, they also can command significantly better prices for their products: for example, farmgate prices can increase by an additional US\$6.50-37.50 per 100 pounds with such certifications.

15. At the same time, coffee value chains in NCA face a range of challenges at each stage of the agrologistics value chain that impede more green, resilient and inclusive development. These challenges include limited access to technical and financial resources, resulting in limited on-farm adoption of innovations in post-harvest drying of coffee and underinvestment in adequate storage facilities for humidity controls post-harvest; excessive water use and toxic effluents in processing coffee; and costly, inefficient and risky transport logistics, due to the poor quality of rural roads from producers to collection/processing centers, as well as high costs in terms of container freight tariffs in transporting from distributors to port. Improvements in agrologistics, including

solar drying, water management, rural roads, and quality certifications, can significantly increase incomes for the smallholder coffee producers who account for most of production in NCA, and contribute to greener, more resilient and more inclusive development.

16. There is also significant potential for strengthening fresh fruits and vegetables value chains to boost green, resilient and inclusive development in Northern Central America.

Green development requires the adoption of innovative solutions at the production and on-farm post-harvest stages, with enhanced knowledge and capacity to strengthen production quality, grading and on-farm handling, as well as increased associativity and financing for essential on-farm controlled temperature storage to boost farmers' incomes and reduce food loss and waste. Food loss and waste in fresh fruits and vegetable chains in NCA can reach as much as 54% of total production in the case of Guatemalan tomatoes, with close to half in this case (22.7% of the 54%) occurring beyond the farmgate, i.e., during transport, handling, storage, processing and wholesale/retail sales. Reducing food loss and waste both on-farm and during the post-farmgate stages of the value chain, notably via improved cold chain management, would reduce carbon footprints and increase resilient development. Interviews suggest that cold rooms are a more important impediment than refrigerated transportation, as there are organized transport firms that can provide cold transportation, while for exporters the final inland transport is generally provided directly by the maritime company.

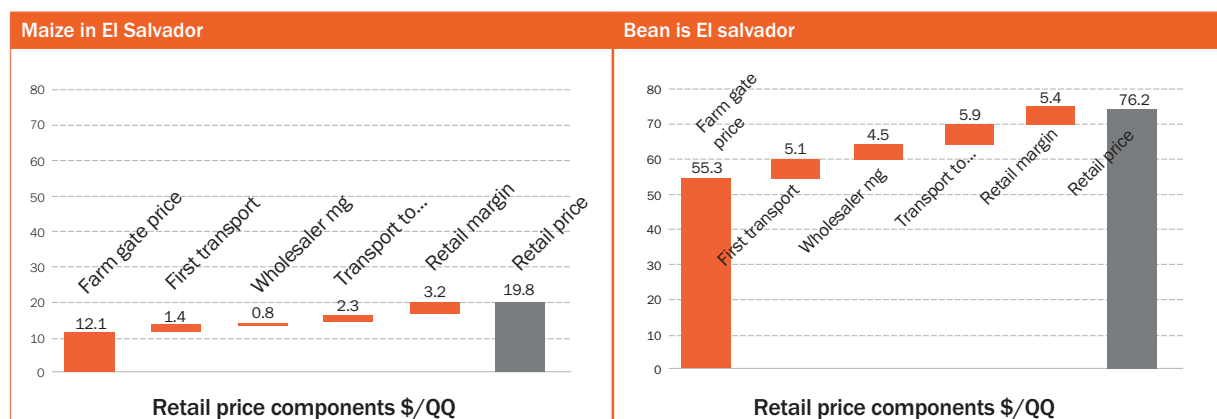
17. Better integrated fresh fruits and vegetables value chains can enhance inclusive development.

When small farmers are obliged to sell on-farm to intermediaries or to local markets, the prices they receive are lower than the prices they could obtain selling directly to retail chains or to exporters. For example, in the case of the tomatoes value chain from production areas in Guatemala to the central market in El Salvador, the farmgate price (US\$0.29 per kg) is only 20% of the final exporter price (US\$1.43 per kg), with post-farm agrologistics margins accounting for the remaining 80%. More integration along value chains of producers with standard-setting retailers can also result in increased capacity building for producers to ensure improved product standards, reduced food losses and waste, and strengthen linkages with high premium markets that can increase family farmers' incomes. At the same time, improved services via collection centers and wholesale markets that provide more efficient and comprehensive aggregation services, including cold rooms, washing, drying, and sorting, would also enhance food system efficiency and GRID, especially for family farms that lack direct business-to-business linkages.

18. Basic grains are of critical importance for cultural and food security reasons in Northern Central America, but the three NCA countries face major challenges in achieving green, resilient and inclusive agrologistics for these value chains.

Over 1.6 million farmers, the vast majority of whom are subsistence farmers, are engaged in producing basic grains, but face a range of challenges at all five key stages of the agrologistics value chains from farms to final clients. Transportation costs feature heavily in the agrologistics challenges for the value chain, driving up the final retail price. In particular, for maize, transport costs represent 19% of the final retail price on domestic markets, while for beans transportation represents 14% of the retail price. Logistics bottlenecks associated with poor rural roads, congestion, flooding, overloaded vehicles, and inefficient loading or unloading at the farm, wholesale or retail levels contribute to higher times to reach markets and drive up transport costs.

Figure E.3: Agrologistics Account for 25-40% of Retail Prices for Maize and Beans in El Salvador



Source: Authors, based on IICA (Accessed 2022, May 22), and IICA, CENTA & MAG (Accessed 2022, May 22)

19. Basic grains value chains in Northern Central America are characterized by significant food losses and waste at both the production and off-farm stages, driven in large measure by inadequate storage capacity. Calculations for Guatemala suggest that maize losses amount to 34% of total production, with annual post-farmgate losses (9% of total production) due to agrologistics challenges valued at US\$32.1 million. These losses have important implications for food security and for farmers' incomes and consumer prices. They also contribute to substantial imports of grains (with all three countries importing grain volumes equal to or exceeding domestic production), and result in significant carbon footprints. Improving agrologistics via priority investments and policy reforms at different stages of the basic grains value chains can contribute significantly to boosting green, resilient and inclusive development in Northern Central America.

20. In each of the value chains considered, improving agrologistics will have substantial effects on value-chain efficiency, profit margins for family farmers, and food accessibility for consumers. Some back-of-the-envelope calculations using estimates from the deep dives in this chapter provide telling examples of the monetary value of these effects. Previous World Bank studies in Latin America estimated that an improvement of logistics due to efficiency gains in ports, road transport, customs clearance and border crossings, better inventory practices, and more capacity and better use of storage and warehousing could reduce logistics costs by 20 to 50 percent. As a way of example, the application of the lower-bound estimate of a 20% reduction in the agrologistics costs allows to extrapolate significant economic impacts for key value chains in the NCA region:

- » US\$67 million for Honduran coffee producers involved in export value chain in 2021;
- » US\$11.30 million for Guatemalan tomato producers along the export value chain in 2020;
- » US\$18.1 million for El Salvador domestic maize producers in 2021.

Policy and Investment Options to Strengthen Agrologistics in NCA

21. Options for overcoming the above limitations, and for promoting environmental sustainability, resilience, and inclusion, include a mix of well-crafted policies and robust investments. Policy priorities for ensuring efficient GRID outcomes in agri-food value chains revolve around a redirection of public support towards the provision of public goods and services for agri-food systems, whereas private support should emphasize producing positive environmental and social externalities. In terms of public policies, the following options promise to pay significant GRID dividends:

- » **Systematic collection of sectoral data:** updating agricultural censuses and representative national household, agriculture, enterprise surveys, with an eye to including agrologistics bottlenecks, in order to provide a stronger base and rationale for more integrated decision-making among sectors that impact GRID in agriculture.
- » **Short-run redirection of existing direct subsidies to private agricultural enterprises to encourage private provision of agrologistics goods:** proactive incentives (subsidies, dedicated credit lines and other programs, including payments for mitigation or ecosystem services) for adoption of sustainable, energy-efficient, and natural-resource-conserving equipment and technologies by family farmers such as on-farm or collective investments in cold chains and upgraded storage.
- » **Strengthened agricultural extension services:** GRID objectives should become explicit key pillars of the public institutions in charge of the services of generation and transfer of agricultural technology, and the R&D functions of these institutions should be better coordinated and streamlined with those of other actors involved in agriculture innovation in each country, as well as with leading international research centers.
- » **Expanded access to and quality of laboratories and third-party quality verification mechanisms:** Providing better articulation, timeliness, and quality of these services across several fragmented national bodies, and streamlining regional controls and inspection of agricultural products that cross borders between Central American countries to increase the efficiency of logistic flows.
- » **Redoubled intersectoral policy dialogue, including at the regional level:** leveraging opportunities for customs harmonization at the regional level and simplification of national trade procedures, in particular ensuring that rules and processes are not excluding small and medium producers for high-value export opportunities.
- » **Revamped coordination efforts with the transport sector and operationalizing national Logistics Plans:** engaging in inter-sectoral dialogue to promote connectivity and penetration, as well as the prioritization of port and road infrastructure that can improve the efficiency, resilience, and inclusiveness of agriculture production systems while contributing to job generation.

22. Several of these policies call for regional solutions, as well as for a stronger engagement of the private sector. In light of the importance of regional trade, and of leveraging opportunities for regional coordination to strengthen integration into global markets, advancing a regional agenda in the context of the Central American Integration System (SICA) is highly warranted, including on issues such as regional mobility and logistics, integrated SPS systems, harmonized border procedures, and trade negotiations. In some cases, synergies may be leveraged with the private sector through public-private partnerships, especially for R&D, infrastructure operation, and the facilitation of private-sector financing to actors along the agrologistics value chain.

23. To articulate this agenda at the value-chain level, investment options include actions in each link of the agrologistics value chain, from post-harvest, storage, and processing, to transport and distribution. Targeted solutions and innovations can be tailored to the reality of specific agriculture value chains. A series of options for investments in coffee, fresh fruits and vegetables, and basic grains are presented in Table E.2 below, along with a proposed prioritization based to their expected impact on green, resilient and inclusive development.

24. While several of the investment priorities identified will ultimately rely on private adoption and investment, environmental and social externalities justify complementary actions by the public sector to promote green and inclusive development. These actions would include, for example, technical assistance, matching grants programs, and policy measures to promote financial inclusion in rural areas, to ensure adequate adoption of climate-smart, efficiency-enhancing agrologistics technologies on the part of family farmers. The use of public financing to provide private goods should follow three overarching principles: (i) be economically viable; (ii) be temporary; and (iii) be designed to crowd in private sector development in the market.

25. The public sector can also play a critical role in facilitating agrologistics development through regulatory or legislative reforms to strengthen the agribusiness and innovation enabling environment. Improving the predictability and agility of policy regimes and regulatory processes, notably for sanitary and phytosanitary controls, cross-border clearances and trade regimes, as well as for ensuring expanded access to financial services, will reduce costs and risks, and will favorably impact investment and innovation decisions by family farmers and private actors along agri-food value chains.

Table E.2: Investment Opportunities for Key Agrolistics Value Chains in Northern Central America

Stage of Value Chain	Coffee	Fresh Fruits and Vegetables	Basic Grains
Post-harvest	<ul style="list-style-type: none"> » Roya-resistant varieties » Solar dryers » Reduce transport and labor costs » Bundle input-supply » Know-how 	<ul style="list-style-type: none"> » Mainstream on-farm storage and handling technologies, including cold storage » Improved packaging to prevent damage during transport 	<ul style="list-style-type: none"> » Mainstream the use of on-farm storage and handling technologies
Storage	<ul style="list-style-type: none"> » Hermetic bag storage systems » Smart devices » Certified warehouse receipts as collateral 	<ul style="list-style-type: none"> » Expand cold storage for perishable products » Improve handling practices to reduce damage 	<ul style="list-style-type: none"> » Ensure grains warehouses comply with quality standards » Silo bags for producers' organizations » Solar dryers
Processing	<ul style="list-style-type: none"> » Coffee washing water recycling systems » Solar-powered pumps » Reduce impact of coffee-washing water effluent 	<ul style="list-style-type: none"> » Set up processing plants in production areas for value-addition activities (sorting, grading, washing, packaging) » Cold rooms 	<ul style="list-style-type: none"> » Increase capacity near main production areas for value-addition activities (ex: flour and concentrates)
Transport	<ul style="list-style-type: none"> » Upgrade rural road segments » Boost tracking and remote surveillance » Evaluate costs of trucking bagged coffee 	<ul style="list-style-type: none"> » Develop appropriate loading/unloading practices » Improve road maintenance and links with urban areas 	<ul style="list-style-type: none"> » Develop appropriate loading/unloading practices » Upgrade rural road segments and improve maintenance
Distribution	<ul style="list-style-type: none"> » Custom-purchasing opportunities » Traceability of specialty coffees » Own labels for price premia 	<ul style="list-style-type: none"> » Cold rooms » Traceability » Vehicle accessibility and cross-docking platforms 	<ul style="list-style-type: none"> » Reduce delays and losses » Improve transit on urban and rural roads » Improve loading and unloading at port of exit

Source: Authors. Note: A more intense shading marks options with higher priority and GRID potential at each stage of the value chain.

Introduction: Agrologistics for Modern Family Farms in Northern Central America

1.1 Scope and Purpose of this Report

1. This report explores the agrologistics challenges and opportunities faced by agri-food systems in three Northern Central American (NCA) countries, namely El Salvador, Guatemala and Honduras, with a specific focus on the impacts on family farming systems.² Agri-food systems account for a substantial share of Gross Domestic Product in each of the countries and the post-farmgate stages of agri-food value chains can account for anywhere between 25% and 80% of the value added to their agricultural products. In addition, the agrifood system represent between 50% and 57% of GHG emissions in NCA countries, with farm-gate and post-production stages being the main drivers of emissions. Given the agri-food system's large economic and environmental footprints in the region, the performance of the agrilogistics system has large potential impacts on economic growth and wellbeing. In fact, efficient, sustainable and inclusive agrologistics are critical to promote green, resilient and inclusive development in Northern Central America.

2. Overall, the study aims to identify agrologistics bottlenecks that affect the development of the main agri-food value chains in NCA, taking into account potential trade-offs and synergies between multiple objectives such as export promotion and trade integration, creation of green and decent jobs, food security, poverty reduction and inclusion of vulnerable populations, climate change adaptation and mitigation. The objective of this report is to inform public and private stakeholders in the sub-region; identify key challenges, opportunities and best practices in strengthening agrologistics systems, where these are understood to represent the entire value chain from the farmgate to the final consumer; and present concrete, operational recommendations for consideration by public and private sector actors engaged in agrologistics in El Salvador, Guatemala and Honduras. The overall framework for this report is presented in Figure 1.2 at the end of this Introduction.

1.2 Making Agri-food Systems Efficient, Green, Resilient, and Inclusive

3. As an overarching principle guiding the analysis, the report adopts the World Bank's framework of Green, Resilient, and Inclusive Development (GRID), with a cross-cutting focus on efficiency³. The GRID approach recognizes that the challenges of poverty, inequality, climate change, and systemic shocks such as COVID-19 are strongly interrelated, and thus need to be addressed simultaneously and systematically in Northern Central America's agri-food systems. The GRID framework is thus based on a three-pillar development paradigm, and rests on a cross-cutting foundation of efficiency:

- » **Green development:** Economic development can both affect and be severely impacted by factors such as natural disasters, the health effects of pollution, or the degradation of fertile soils, while natural resource depletion is in turn accelerated by stagnating growth. Green solutions are those that sustain natural capital, including climate, to ensure a virtuous circle of development and environmental benefits.
- » **Resilient development:** A wide range of risks and uncertainties (economic, social, climate, or health-related) produce repeated cycles of shocks, restructuring, recovery, and rebuilding. Resilient approaches enable both the public and private sector to prepare for, mitigate, and adapt to a variety of risks, thereby avoiding the diversion of scarce resources towards second-best shock responses.

² While Belize is also located geographically in the northern part of Central America, it is closely associated with, and generally analyzed as part of, the Caribbean, and is therefore not included in this study. Thus, for the purposes of this study, Northern Central America (NCA) refers to El Salvador, Guatemala and Honduras.

³ World Bank Group (2021).

- » **Inclusive development:** Rising inequality and the exclusion of social groups from services, markets and opportunities hampers development and foments discord, especially as shocks disproportionately impact the poor and vulnerable. Inclusive strategies that boost human capital, foster job creation, and tackle exclusion and inequality promote the sustainability of interventions and investments, ensuring that development leaves no one behind.
- » **Efficiency as the foundation:** In anticipation of declining fiscal space and a resource-constrained future, countries need to spend better and use scarce resources more efficiently. The efficient use of resources is also shaped by laws and regulations that allow countries to maximize returns to society while minimizing the financial, social, and environmental costs. Better spending can deliver the infrastructure and services that countries need, creating more competitive cities. The productive use of agricultural lands, fisheries, forests, and other natural resources are key to achieving prosperity and improving lives.

4. Specifically, this report examines how the improvement of agrologistics can advance agri-food system efficiency and GRID outcomes in Northern Central America. As such, the study seeks to highlight ways in which enhancing agrologistics systems can drive environmental sustainability, inclusion, and resilience in the region, in addition to improved efficiency and overall economic performance (Table 1.1 below). In this study, the term agrologistics is used to refer to the infrastructure, machinery, related services, and information systems that allow agri-food products to move from the original point of production to the final point of consumption. The five key components of agrologistics value chains (VCs) are: (a) on-farm post-harvest management (PHM); (b) storage and handling, including cold storage; (c) processing and packaging; (d) transport from the farm to collection and processing centers, and onwards to distribution networks; and (e) distribution by wholesalers, retailers and exporters, which in the case of exports involves customs and other border crossing processes. Various features of the agrologistics system cut across the five stages of agrologistics value chains, including: (i) cold chain infrastructure and the use of temperature control equipment from the farm to the final consumer; (ii) coordination of supply chains, including information management systems and traceability technologies like blockchain; (iii) sanitary and phytosanitary (SPS) checks and certifications (e.g. organic, fair trade, etc.).

Table 1.1: Improving the Efficiency of Agrologistics Contributes to Green, Resilient and Inclusive Development

Agrologistics Components	Efficiency	Green	Resilience	Inclusion
1. On-farm post-harvest management	<ul style="list-style-type: none"> » Higher volume of agricultural output » Larger marketable surplus 	Reduced food loss and waste	Greater resilience to heat and postharvest pathogens	Higher market participation for family farms
2. Storage and handling, including cold storage	<ul style="list-style-type: none"> » Lower transaction costs via aggregators in remote production zones » Larger marketed surplus 			
3. Processing and packaging	<ul style="list-style-type: none"> » Growth in food manufacturing and services » Higher value-added from agrifood system to economy 	Smaller water footprint	Lower contamination and greater food safety	High quality jobs in non-farm segments (including women, youth, Indigenous Peoples, Afro-descendants)
4. Transport infrastructure and services	<ul style="list-style-type: none"> » Lower transit times and costs » Stronger market linkages between remote geographies and urban markets 	Lower GHG emissions		
5. Distribution	<ul style="list-style-type: none"> » Lower transit times and export costs » Stronger market linkages between urban markets, and with export markets 	Price premia for sustainable, healthy, and high-quality products	Reduced seasonality and food price volatility	Improved access to national and global markets for remote family farms
			Strengthened food and nutrition security	Direct farm-to-fork linkages for smallholder farmers
				Lower export costs for family farms

1.3 Key Challenges in Northern Central America

5. With GDP per capita ranging from US\$2,390 in Honduras to US\$4,600 in Guatemala in 2020, the three countries are among the poorest in the Latin America and Caribbean (LAC) region. Women, youth, and indigenous people are among the most affected by economic instability, informality and lack of job opportunities. Northern Central America also has among the highest levels of food insecurity in LAC, with an average of 21% of its population facing food scarcity.⁴ In the traditionally hungry months between May-August last year (2021), 20% of the population of Guatemala (3.5 million people) were facing crisis levels of food insecurity, with 16 out of 22 Departments in the country classified as Phase 3 (out of 5 phases on the Integrated Food Security Phase Classification Scale). In El Salvador, 13% of the population (over 840,000 people) was facing crisis levels of food insecurity at that time, while the projection for May-August 2022 for Honduras is that 28% of the population of the country (more than 2.6 million people) will be facing Crisis (Phase 3) or Emergency (Phase 4) levels of food insecurity, with all of Honduras' Departments classified as facing Phase 3 food insecurity (Figure 1.1). According to FEWSNET forecasts for 2022,⁵ food security crisis outcomes will prevail in the Guatemalan and Honduran Dry Corridor, eastern Honduras, the Guatemalan Altiplano, and areas impacted by hurricanes Eta and Iota, due to smallholder farmer's crop losses, reduced coffee-related income, and an inability to recover livelihoods following multiple shocks in recent years. Furthermore, rising fuel and transportation costs are likely to contribute to higher food prices and result in reduced household purchasing power.

Figure 1.1: More than 2.6 Million Hondurans will face Crisis Levels of Food Insecurity in 2022



Source: IPC (2022, January 24).

⁴ IPC (2021, September 13), IPC (2021, June 14), and IPC (2022, January 24). The World Bank's High Frequency Phone Surveys in mid-2020 found that nearly 68 percent of households reported losing income and more than one-third reported food insecurity because of insufficient resources.

⁵ Famine Early Warning Systems Network (FEWS NET) (2021).

6. The three NCA countries are also among the most vulnerable in the world to climate change and extreme weather events (see Chapter 2). About 30% of the Central America's territory is in the Dry Corridor, one of the most vulnerable areas of the subregion to the adverse effects of climate change, especially droughts.⁶ The NCA countries are significantly exposed to extreme weather events; for example, the twin tropical storms Iota and Eta that struck the sub-region in November 2020 generated an estimated US\$7 billion in economic losses.

7. The countries of the sub-region also face governance challenges as well as widespread insecurity and violence, which have contributed to significant outmigration. Although important progress has been made in reducing homicide rates since 2018, all three countries were among the eight countries in the world with the highest homicide rates per 100,000 of population in 2018.⁷ These factors have contributed to making the NCA countries important emigration hotspots from the region (see Chapter 2). Indeed, in 2021, the Border Patrol of the United States encountered nearly 684,000 nationals of the three NCA countries at the US Southwest border,⁸ and a representative survey carried out in the same year indicated that 15 percent of individuals interviewed in those countries were making concrete plans to migrate abroad, up from 8 percent in 2018⁹ The high levels of insecurity, combined with a lack of opportunities, food insecurity, and climate shocks are consistently cited among the top reasons that are driving emigrants from Northern Central America to leave their countries.

1.4 Agriculture in the NCA Countries and the Importance of Agrologistics

8. Agriculture in the three NCA countries accounts for 9% of GDP, 25% of employment, and 43% of exports (not including the industrial transformation of agricultural products via agro-processing).¹⁰ Central America's agriculture sector has a significant role in food security and the generation of economic opportunities, especially for the most vulnerable population. According to the 2007 national agriculture census, El Salvador counted with a total of 395,588 agricultural producers, of whom 18% were commercially oriented farmers and 82% were smallholder producers. According to the 2003 national agriculture census, Guatemala had 822,188 agricultural producers, of whom 99.6% identified themselves as individual producers, while the remaining 0.4% were corporate producers.¹¹ In Honduras, agriculture is the main economic activity of more than 500,000 households, of whom around 95% are smallholders. Farming incomes constitute the primary source of income among poor rural households in NCA. Since agrologistics account for an important share of value added in agri-food systems, this report, therefore, focuses on agrologistics as a critical means to improve resilience, food security, and job opportunities in NCA, with a view to contributing to addressing the root causes of poverty and lack of opportunities, vulnerability to shocks, and emigration from the sub-region.

1.5 The Focus and Structure of this Report

9. In light of the above challenges, and of the importance of agri-food systems for their economies, this report focuses on strengthening agrologistics systems for family farms in the three Northern Central American countries – El Salvador, Guatemala, and Honduras. In particular, the report aims to identify challenges and opportunities for promoting agrologistics systems in the sub-region that are green, resilient and inclusive. The report is structured as follows: Chapter 2 provides an overview of the broader context for, and the state of, agrologistics in NCA. It takes stock of Central American agri-food systems and outlines key megatrends and disruptors with a bearing on these systems. It then assesses key agrologistics bottlenecks and gaps that are adversely affecting the performance of agri-food systems in terms of food loss and waste, and deficiencies in critical rural infrastructure, before identifying important trends and innovations that are beginning to be introduced in agri-food systems in the sub-region. Chapter 3 provides a deeper analysis of the

⁶ International Institute for Strategic Studies (IISS) (2021).

⁷ World Bank - World Development Indicators (2022c). Data were available for 2018 for 94 countries and territories.

⁸ Congressional Research Service (2022)..

⁹ Ruiz Soto et al. (2021). Rome, Washington, DC, and Cambridge, MA.

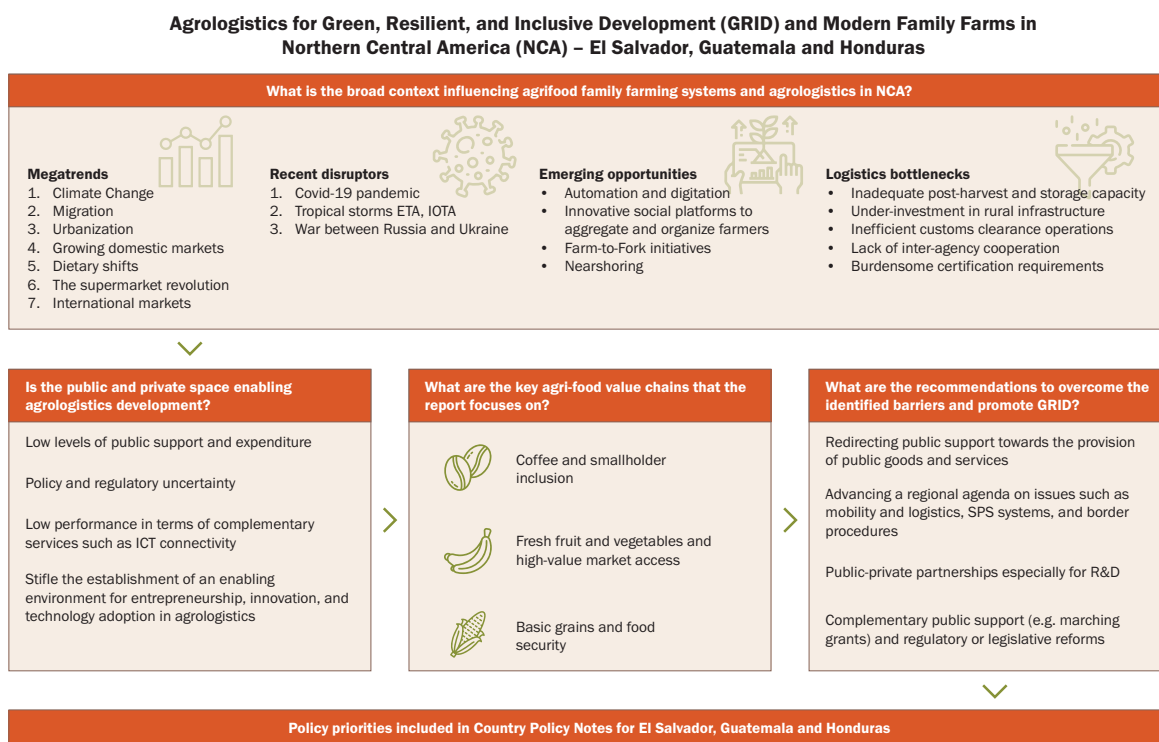
¹⁰ Ibid.

¹¹ Gobierno de Guatemala (2004).

policy environment for agrologistics, as well as of the scope for public investments and private engagements to strengthen agri-food systems in NCA.

Chapter 4 reports findings from three deep dives into the agrologistics of coffee, fresh fruits and vegetables, and basic grains value chains in El Salvador, Guatemala and Honduras, reviewing constraints and opportunities at each stage of the key stages of the value chains (on-farm post-harvest, storage and handling, processing, transport and distribution). The selection of these important products for the sub-region enables the analysis to explore the mapping of agrologistics in terms of food security, supply and competitiveness in domestic markets, and integration with global value chains. Chapter 5 concludes with a range of options and opportunities for consideration by public and private stakeholders for strengthening the sub-region's agrologistics, via policy actions, public investments and private capital. Figure 1.2 below presents the overall framework of analysis for this report.

Figure 1.2: A Framework for Analysis of Agrologistics in Northern Central America



Source: Authors

Agrologistics in Northern Central America: The Broader Context and the Current Status

1. This chapter provides an overview of key features of agri-food systems in three NCA countries, megatrends shaping agri-food systems in the sub-region, key challenges facing these systems as well as emerging trends and innovations that have a critical bearing on ensuring green, resilient and inclusive development of agri-food systems in Northern Central America. The chapter begins with a characterization of agri-food systems in the sub-region, before analyzing the key macro and sector-specific trends (“megatrends”) that are transforming the sector, such as climate change, rapid urbanization and the growing presence of supermarket chains. The chapter then discusses key challenges for agri-food systems in the sub-region, including inadequate cooling and storage, inefficiencies in logistics, and insufficient rural road infrastructure, resulting in high levels of food loss and waste. Finally, the last part of the chapter presents major trends and innovations that are featuring in agrologistics value chains in NCA and elsewhere that have the potential to help Salvadoran, Guatemalan and Honduran agri-food systems grow in a green, resilient and inclusive way.

2.1 The Sector Context: Agri-food Systems in Northern Central America

2. The three NCA countries are characterized by traditional agri-food systems that are the major source of support for rural livelihoods. Agri-food systems have a large economic and social footprint in NCA relative to the LAC region. In terms of size of the primary agriculture sector and its contribution to employment, Guatemala and Honduras significantly exceed the corresponding regional averages. While the sector is relatively small in El Salvador, at 5 percent of GDP, its employment share is the same as the regional average (Table 2.1).¹² Primary agriculture is a key source of rural livelihoods, in which more than 4 out of 5 rural jobs are informal.¹³ Expanding on an established food-system classification that accounts for the relevance of agriculture in the economy, the level of economic development, and the degree of rurality¹⁴ to include agriculture’s share of GDP, employment, and informal jobs in rural areas, El Salvador, Guatemala and Honduras can be considered to be largely traditional agri-food systems. These systems stand in contrast to agri-food systems in Costa Rica and Panama, which are considered transitional, given their smaller contributions to the economy and employment, and lower informality. Globally, traditional agri-food systems are characterized by mainly rural populations, low income levels, short and fragmented value chains, and largely informal spot markets. However, even though the NCA countries are classified as traditional, they are at the cusp of a rapid transition in parts of the agri-food system extending beyond primary agriculture. This is due in large part to megatrends and disruptors that are reshaping the systems, as discussed in Section 2.2 below.

3. Family farming plays a key role in the sub-region’s rural development, food security, and climate resilience. According to recent estimates from the Central America Integration System (SICA), family farms represent 80 – 90 percent of corn and bean producers, and supply 70 – 80 percent of the food consumed in the sub-region. This is reflected in the large share of unpaid family workers in Guatemala (18 percent), Honduras (15 percent), exceeding the LAC average (Table 2.2). While a growing fraction of family farms operates commercially oriented enterprises with capacity to add value through aggregation, basic processing, and access to local markets, their systems are predominantly characterized by limited productivity and competitiveness, low access to knowledge and markets, and high vulnerability to economic and climate shocks. Significantly, this underinvestment and underperformance correlates highly with rural poverty in the sub-region; in fact, it is estimated that 6 in 10 family farmers face food insecurity and 65 percent live in poverty.¹⁵

¹² World Bank - World Development Indicators (2022b).

¹³ World Bank - World Development Indicators (2022d). Note: calculated as a share of the population aged 15-64.

¹⁴ See Morris et al. (2020)

¹⁵ IFAD (2016)

Table 2.1: Agriculture Accounts for a Large Share of Income and Employment in NCA

Country	Agricultural GDP (in US\$ billions)	Share of GDP (%)	Share of employment (%)	Share of informal jobs in rural areas (%)
Northern Central America				
El Salvador	1.26	5.1	19	86
Guatemala	7.95	10.2	29	91
Honduras	2.87	12.1	32	99
Southern Central American Countries				
Costa Rica	2.89	4.7	12	30
Nicaragua	1.99	15.8	31	72
Panama	1.50	2.8	14	N/A
LAC	18.46	8	19	–

Sources: World Bank - World Development Indicators (2022b) and (2022d)

Table 2.2: Large Shares of Jobs for Unpaid Family Members Point to the Importance of Family Farms

Countries	Total employed in Agriculture, Forestry and Fisheries (million)	Share of own account workers (%)	Share of unpaid family members (%)
El Salvador	0.47	33	13
Guatemala	2.13	30	18
Honduras	1.20	32	15
Costa Rica	0.26	22	4
Panama	0.27	47	25
LAC		38	14

Source: International Labour Organization (2022)

4. Northern Central America is home to established export-oriented value chains like coffee and fresh fruits and vegetables. The sub-region's agri-food systems produce various export-oriented crops like coffee and bananas, with Honduras and Guatemala ranked among the top 10 exporters of coffee and bananas in 2020. Food exports comprise large shares of merchandise exports for NCA countries, ranging as high as 71% for Honduras.¹⁶ The production of high-value export crops is also a key source of livelihoods and both small and large farms are becoming more integrated into global markets. Coffee production, for instance, is practiced by 100,000 producers in Honduras, 90 percent of whom are smallholders, and the entire coffee chain creates around 1 million jobs between picking, processing, and transportation. There has been growth in contract farming for supermarket chains,¹⁷ and coffee farms are increasingly exporting to niche markets in Europe, USA, and Asia.

5. On the other hand, food imports comprise a significant share of merchandize imports, and are equivalent to the entire agri-food sector in El Salvador. The basic staples for the region are maize, beans, sorghum, and rice, with livestock production accounting for large shares of agricultural land. However, all three NCA countries depend on imports of crucial food staples (e.g. cereals), and food imports are equivalent to 18% of total imports in El Salvador (US\$1.8 billion) and Honduras (US\$2.9 billion).¹⁸ This dependence on food imports represents a vulnerability during periods of trade disruptions, and is further exacerbated by large and unanticipated drops in household income, as has been the case due to COVID-19-induced shocks since March

¹⁶ World Bank - World Development Indicators (2022b).

¹⁷ Lopez-Ridaura et al. (2021).

¹⁸ FAOSTAT (2018) and World Bank - World Development Indicators (2022b).

2020. Moreover, since March 2022, the war in Ukraine and consequent supply chain disruptions have further amplified this vulnerability, with food price inflation in key imports like cereals, cooking oil, and fertilizers (see Box 2.2 below). Intra-regional trade in agri-food products (both primary and processed) is also substantial, creating high regional interdependence and exposure to correlated price and weather shocks across Central America. For example, El Salvador sources more than 50% of its total food imports from within the region.¹⁹ At the same time, the farming sectors in NCA are reviving from recent shocks as producers aim to seize new opportunities to meet demand in domestic markets and to take advantage of ‘Nearshoring’ (see Section 2.4 below).²⁰

2.2 Megatrends in Central America’s Agri-Food Systems

6. Agrologistics in Northern Central America are being transformed by climate change; migration; urbanization; growing domestic markets; dietary shifts; the supermarket revolution, and the growing importance of international markets. These megatrends are reshaping the context in which agri-food systems operate. This section discusses these trends in turn.

2.2.1 Climate Change

7. Climate change is the megatrend that will have the largest long-term impact on agri-food systems and the welfare of smallholder farmers in NCA. The Global Climate Risk Index ranked Guatemala and El Salvador as the 16th and 25th countries most vulnerable in the world to extreme weather events for the 1999-2018 period, taking into consideration fatalities due to climate-related loss events, both in absolute number and as a share of the population; the absolute value of economic losses and their share of GDP, and the number of major events to which the countries have been exposed.²¹ Honduras, which is also ranked in the first quartile of the global vulnerability distribution, has been struck by half of the dozen severest hurricanes of the twentieth century.²² More recently, in November 2020, tropical storms Eta and Iota in 2020 affected 72 percent of cropped area in Honduras at a cost estimated at over US\$2 billion.

8. More broadly, estimates of the expected cost of agricultural production loss across Central America due to extreme events average around 7.21 percent of the gross value of regional agricultural production, or US\$ 1.67 billion per year. Between 2000 and 2050, climate change is expected to reduce the yields of various crops across Central America, including a median decline of 14 percent reduction in maize yields or 44 percent yield loss for rainfed sugarcane.²³ In the case of Honduras, actual yields of rainfed maize and sugarcane are expected to decrease by 12 and 37 percent, respectively (Table 2.3). These projections present challenges to subsistence farmers and to the countries’ food sovereignty as annual imports of maize are likely to increase by 50,500 tons compared to no climate change scenarios.

Table 2.3: Projected impacts of climate change on crop yields in Honduras between 2000 and 2050²⁴

Crop	Effect on Yields
Rainfed maize	12% reduction, especially in the far west
Rainfed beans	<10% reduction, in south and west
Rainfed sugar cane	37% reduction, geographically uniform

¹⁹ UN COMTRADE (2022).

²⁰ Morris et al. (2020).

²¹ Eckstein, Künzel and Schäfer (2021).

²² Trocaire (2014).

²³ Sanders A, Thomas TS, Rios A, Dunston S. 2019. Climate Change, Agriculture, and Adaptation Options for Honduras. IFPPRI Discussion Paper 01827, April 2019.

²⁴ *ibid.*

Crop	Effect on Yields
Irrigated sugar cane	30% reduction
Coffee	21% - 26 % reduction
Oil palm	Little effect
Livestock	Grasslands unaffected. Animal production in the south will decrease due to heat stress.

Source: Sanders et al. (2019)

9. By 2050, average temperatures are projected to increase by 1.0–2.5°C in Northern Central America, whereas annual rainfall is projected to decrease by 9–14 percent. In Honduras, for example, the 2018 drought affected 1.3 million people and on average small-scale farmers lost about 80 percent of their production, causing an increase in food insecurity and driving farmers to migrate to other countries.²⁵ With less than 15 percent of cultivated land under irrigation in the country (mostly on medium-scale and export-oriented farms), intensified drought conditions are projected to pose a significant threat to agri-food systems and to the livelihoods of vulnerable farmers in Honduras, especially across the Dry Corridor. Climate change is also projected to reduce the median area suitable for growing coffee in the country by 26 percent by 2050.²⁶ This will force Honduran coffee growers to move to higher elevations, which are often forested, and therefore could result in conversion of long-standing forests to agriculture or to convert coffee to other crops.

10. The combination of temperature rise and more extreme weather events is expected to have extremely disruptive effects on the resilient development of various stages of agrologistics value chains in NCA. In particular, climate change is expected to increase pest infestations in crops and cause crop losses through droughts and floods; reduce feasible storage times without cool storage, and heighten the frequency and severity of damages to both standing crops and to agrologistics infrastructure. For example, storm-related damages are likely to disrupt agrologistics by precipitating surges in transport-related blockages and costs as a result of impassable roads and damages to storage, processing and distribution facilities.

2.2.2 Migration

11. The NCA countries have experienced exceptionally high rates of emigration relative to immigration by global standards. In mid-2020, there were 280.5 million international migrants around the world living outside their countries of origin, of whom 42.9 million (15.3%) had left from countries in Latin America and the Caribbean.²⁷ Only 14.8 million people had emigrated to countries in the LAC region, so the region has generated three times more emigrants than immigrants, a ratio that is higher than for any other region of the world. This ratio of emigrants compared to immigrants is particularly high for Central America and Mexico, with 16.2 million emigrants vs. only 2.3 million immigrants (a ratio of 7 to 1), and is even higher for the three NCA countries, with 3.6 million emigrants compared to 162,000 immigrants, for a ratio of over 22 emigrants for every immigrant. Although the number of Salvadoran emigrants abroad is equivalent to one-quarter of the population in El Salvador, fully one-third (34%) of the population in El Salvador has considered living in another country.²⁸ According to a report jointly published by the Migration Policy Institute (MPI), WFP, and the Civic Data Design Lab at MIT, an estimated annual average of 378,000 Central Americans migrated to the US during the

²⁵ Bermeo and Leblang (2021).

²⁶ Ovalle-Rivera, O., P. Läderach, C. Bunn, M. Obersteiner, and G. Schroth. 2015. "Projected Shifts in *Coffea arabica* Suitability among Major Global Producing Regions due to Climate Change." *PLoS ONE* 10 (4): e0124155. doi:10.1371/journal.pone.0124155.

²⁷ United Nations Department of Economic and Social Affairs (UNDESA) (2020).

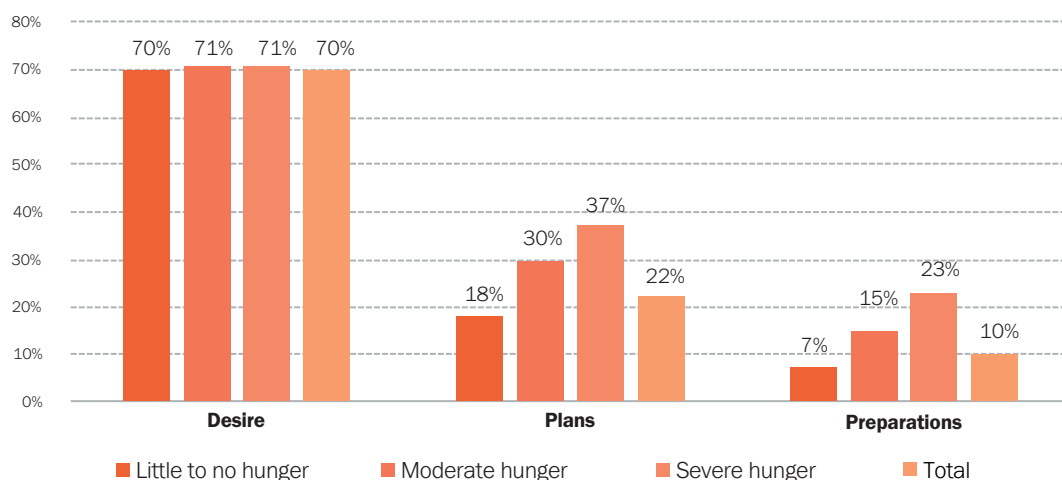
²⁸ Latinobarómetro (2020). In the case of Guatemala, 16% of the population affirmed they had concretely considered living abroad (compared to a stock of emigrants equivalent to 7.3% of the population in Guatemala), whereas for Honduras, although the stock of Hondurans living abroad is equivalent to 8.3% of the population in the country, fully one-third (33%) of Honduras surveyed by Latinobarómetro affirmed they had concretely considered the possibility of living in another country.

last 5 years.²⁹ In the cases of El Salvador and Guatemala, the emigrants are fairly evenly divided between male and female (50.3% of Salvadoran emigrants and 50.6% of Guatemalan emigrants are female), however the proportion of female to total emigrants for Honduras is significantly higher at 59%.

12. There are several drivers that motivate these significant migratory flows from NCA, including very high levels of crime and violence, extreme poverty and lack of opportunities, food insecurity and the devastating impacts of natural disasters and climate change. These factors are major impediments for inclusive development. For example, food insecure people are three times more likely to make concrete plans to migrate than people who are not (see Figure 2.1),³⁰ and as of October 2021, the World Food Programme (WFP) estimates that the number of food insecure people in El Salvador, Guatemala, and Honduras grew three-fold to 6.4 million, from 2.2 million people in 2019.³¹ A recent survey found that 94 percent of Hondurans reported economic challenges as the reason for migration, while 46% cited environmental concerns.³² In addition, a recent report that studied Honduran migration, climate change and violence confirmed that decreases in precipitation are associated with increased migrant flows and that the magnitude of this effect increases with higher levels of violence. The same report concluded that family migration from Guatemala to the USA was associated with rural poverty and agricultural stress linked to climate change, even prior to the pandemic.³³

At the same time, violence in turn can result in forcible displacement of farmers, land abandonment, extortion, and control of limited resources such as water. The impacts of insecurity and praedial larceny on agri-food systems can be significant in terms of both actual costs and of risks that discourage economic activity. Emigration in turn can affect agri-food systems by reducing the availability of workers at peak harvest times, whether on-farm or at processing centers. Women-headed farms in particular have reported struggling at times to obtain adequate labor.

Figure 2.1: Experiencing Moderate to Severe Hunger Spurs Emigration from Northern Central America



Source: Ruiz Soto et al. (2021)

²⁹ Ruiz Soto et al. (2021).

³⁰ *ibid.*

³¹ World Food Programme (2021)

³² USAID (2021)

³³ Bermeo and Leblang (2021). This analysis shows that a change in the value of agricultural stress from 0% to 9% percent of cropland affected is associated with an increase in the department's apprehension rate from 31 to 57 people per 100,000 population the following year. If 24% of cropland is under agricultural stress (95th percentile in data), average apprehensions for the department rise to 62 per 100,000 population—double the baseline scenario.

13. At the same time, there is untapped potential to channel the remittances associated with migration back into productive uses in agri-food value chains. Remittances to NCA have increased more than tenfold since 2000 to US\$30.1 billion in 2021, equivalent to more than 21% of GDP on average for the three countries.³⁴ Indeed, remittances accounted for more than one-quarter of GDP in El Salvador and Honduras in 2021 (26.4% and 25.5%, respectively), placing both countries among the top ten recipients of remittances in the world as a share of GDP. Remittances to Guatemala totalled US\$15.4 billion (18% of GDP), placing Guatemala 17th in the world in terms of the absolute value of remittances received. Although a large share of remittances are dedicated to essential household expenditures, there is still significant potential to galvanize this important resource for strengthening agri-food systems.

2.2.3 Urbanization

14. The rapid urbanization of NCA is generating growing demand for nutritious, safe and sustainable food. Urbanization is a powerful driver of change in agriculture and food systems in Northern Central America, where the urban population has increased by almost 70% since 2000. Close to 60% of the sub-region's population now lives in urban areas, and this share is expected to increase to 72% within the next generation, requiring that food systems produce and deliver significantly larger quantities of food for an additional 13.4 million new urban dwellers by 2050.³⁵ As described in the Future Foodscapes report published by the World Bank in 2020, to meet the increased demand, supply chains will have to transition to rapidly deliver significantly larger quantities of food and penetrate further into rural areas, providing income opportunities for farmers, off-farm rural entrepreneurs, and the millions of rural wage earners working for them.³⁶ A significant challenge with urban food systems will be to ensure that nutritious, safe, sustainable food is available for all urban consumers, including the many urban poor.

15. The high rate of urbanization has also created an emerging segment of medium and small sub- and peri-urban farming systems. It is estimated that in Guatemala, for example, 20% of households practice urban and peri-urban agriculture.³⁷ Those systems produce high-value crops, mainly vegetables, for supermarkets and wet markets. Often these farmers complement their livelihood with jobs and service provision in the nearby towns and cities. In the context of the three NCA countries, the practice of urban agriculture is embodied in traditional home gardens, which are widespread not only in urban and peri-urban areas, but also in rural areas across the sub-region. The practice contributes in different ways to inclusive development via the family economy: in urban households in parts of Honduras, the main contribution has been food with high nutritional value, especially from fruit trees and animal species, but monetary benefits have also been reported, with food produced in home gardens accounting for 10% to 26% of family income.³⁸

2.2.4 Growing Domestic Markets

16. The market size of the food sector in NCA totals over US\$40 billion.³⁹ The 33.2 million people in NCA dedicate on average 33.5% of their consumer expenditures to food. Thus, the estimated market size for food amounts to almost US\$6.4 billion in Honduras, US\$6 billion in El Salvador and almost US\$28 billion in Guatemala, substantially more than the sub-region's agricultural GDP of US\$12.1 billion (Tables 2.1 and 2.4). In addition, Costa Rica, Nicaragua and Panama, which are important regional trading partners, together amount to an additional market size for food of almost US\$24 billion (Table 2.4).

³⁴ KNOMAD (2022).

³⁵ Maria et al. (2017) and World Bank - World Development Indicators (2022).

³⁶ Morris et al. (2020)

³⁷ *ibid.*

³⁸ Héctor Ávila Sánchez, (2019).

³⁹ By extrapolating from the last data point available per country for food and beverages expenditure per capita, and using the country's average GDP per capita growth rate.

Table 2.4: The Domestic Market for Food is Growing Significantly in Northern Central America

1	2	3	5	6
Country	Population ('000s)	Share of Consumer Expenditures on Food (%)	Food Consumption per capita estimate (US\$)	Estimated Market Size (US\$ millions)
NCA				
El Salvador	6,486	26.5	922	5,980
Guatemala	16,858	41.2	1,663	28,035
Honduras	9,905	32.8	646	6,399
Total Market Size in NCA	33,249	33.5	1,077	40,414
Other Central American Countries				
Costa Rica	5,094	25.7	2,143	10,916
Nicaragua	6,624	45	1,048	6,942
Panama	4,315	15.7	1,406	6,067
Total Market Size in Central America	49,282	31.15	1,305	64,339
Total Market Size in LAC	652,365	25.8	1,319	860,469

Source: Authors, based on World Development Indicators, and USDA Economic Research Service (2019)

17. Sudden shocks, like the Covid-19 pandemic or escalating political tensions worldwide, have given rise to the implementation of sudden trade barriers (including export bans at times of food shortages), testing the resilience of agri-food systems. At the same time, the farming sectors in many net importing countries, including the three NCA countries, have revived as producers seize new opportunities to meet growing demands in domestic markets.⁴⁰

2.2.5 Dietary shifts

18. Growing populations, rising incomes and higher urbanization rates are also driving significant changes in dietary choices, through their multi-faceted influence on consumer preferences and lifestyles.⁴¹ As in other urbanizing regions in the world, a growing number of urban consumers in Central America have developed preferences and made dietary choices that are shifting towards more meat, processed food and convenience food prepared outside the home. The rise in meat import trends and the penetration of processed vegetables and sweeteners in the region point to important changes in local diets: between 1996 and 2006 poultry imports to the region increased five-fold. The establishment of the Dominican Republic-Central America Free Trade Agreement (CAFTA-DR) in 2006 led to large increases in meat imports from the United States, equivalent to 2,153% for bovine, 1,135% for swine, 460% for poultry, and 488% for prepared and processed meats by 2015/16, compared to 2004/5. In Guatemala, domestic poultry production increased by 20% following CAFTA-DR and imports almost doubled. Similarly, the per capita consumption rates of processed vegetables and sweeteners have sharply increased across the region. For processed sweeteners, the strongest increases in domestic supply were evident in Guatemala and Nicaragua, with 85% and 3,347% increases, respectively, between 2003/5 and 2011/13.⁴² Shifts in diets towards less nutritious foods and to increased food consumption outside the home have led to increased overweight and obesity among all age groups.⁴³ Changing consumer preferences and diversifying food consumption patterns in Central America and the region's main export markets will likely increase the need for food systems to produce more healthy, safe, and high-quality food products that increasingly satisfy adequate standards in terms of carbon footprints, energy use, impact on biodiversity, and fair-trade approaches.⁴⁴

⁴⁰ Morris et al. (2020).

⁴¹ Morris et al. (2020).

⁴² Werner et al. (2019).

⁴³ Popkin and Reardon (2018).

⁴⁴ Díaz-Bonilla et al. (2014).

19. An example where this change in demand is already visible can be found the coffee sector. Global coffee consumption has increased by 2% annually since 1990,⁴⁵ driven especially by the growth in consumption from Europe, North and South America, and Asia. In industrialized countries, consumption patterns have changed as coffee has evolved from a plain cup of black coffee to a multitude of forms, flavors, and origins, stemming from a coffee shop culture that has dramatically evolved during this time frame.⁴⁶ Consumers also tend to pay much more per cup of coffee than they did in 1990⁴⁷ and are increasingly demanding ethical, sustainable and fair-trade coffee brands that result in greener, more inclusive development. For instance, in North America, sales volumes of fair-trade coffee increased by 16% in 2021 compared to 2020 and are expected to continue to grow at a compound annual growth rate of 8.7% through to 2025.⁴⁸ Given the historical export nature of the coffee sector in NCA, this expected growth offers ample opportunities for those coffee producers who are willing to implement the required technologies and processes that would enable them to sell certified coffee and receive a premium price for the sale of their produce. Some of the agrologistics innovations and the new business/trade models that would contribute to unleashing the potential of this opportunity are described in the Agrologistics Deep Dive for the Coffee Sector in Chapter 4 of this study.

2.2.6 The Supermarket Revolution

20. Economic growth and consumer demand have driven supermarket expansion in NCA countries, where they are replacing traditional food retail outlets and are dramatically transforming existing food supply chains. During the past two decades, the sub-region has undergone one of the world's most substantial shifts from primary reliance on traditional agricultural supply and domestic food distribution to supply chains driven by supermarkets. For example, in Guatemala, 30% of total food sales are made by supermarkets and, according to Euromonitor, supermarkets sales increased by 6% in 2019 year-on-year.⁴⁹ More broadly, during the last decade, Walmart has become the largest supermarket chain in Central America, growing from 40 stores in 2010 to 838 retail outlets today.

21. Supermarkets have stimulated an upstream transformation of the agri-food marketing system, especially for the fresh fruit and vegetables sector. Supermarkets rely on both national and international suppliers, and the proportion of imported and local products varies by establishment. In Honduras, in the case of some supermarkets, imported products may represent up to 70% of the products available for purchase. In other cases, the ratio is 75% national and 25% imported, while there are smaller sized supermarkets that only sell national products.⁵⁰ As such, supermarkets have become crucial buyers of local produce in the region. In countries with dual produce markets, like those in NCA (higher quality export market and a lower quality domestic market), local supermarkets have created an additional market for intermediate to high quality products. At the same time, these retailers are pressuring producers to improve product quality and food safety in the domestic market, and the difference in quality between products destined for local and export markets is narrowing.⁵¹ The expanding retail market share of supermarket chains also have adverse implications for inclusive development: if local producers are unable to fulfil increasingly demanding and capital-intensive standards, they are likely to be squeezed out of the market, making them more vulnerable to downturns and more dependent on informal sector wages and remittances.

2.2.7 International Markets and Free Trade Agreements

22. An essential feature of the agricultural sector in NCA is the growing trend in recent decades to focus on high-value agricultural exports of luxury or niche products, such as coffee, cacao, fruits and vegetables

⁴⁵ International Coffee Organization (2020).

⁴⁶ Fromm (2022).

⁴⁷ Meister (2017).

⁴⁸ Fair Trade America (2021).

⁴⁹ Reported in USDA (2020).

⁵⁰ Commission for the Defense and Promotion of Competition of Honduras (2012).

⁵¹ USDA (2005).

to markets in North America, Europe, and Asia.⁵² The dependence on agricultural exports, expressed as a share of total country exports, ranged from 21% in El Salvador and Honduras to 31% in Guatemala in 2018.⁵³ That same year, coffee and bananas alone jointly accounted for 24.4% of the total products exported from Central America to the rest of the world.⁵⁴ The USA is the main destination country, concentrating around 50% of Central America's agricultural exports.

Box 2.1: SIECA has Adopted Two Meta-Objectives to Identify and Prioritize Regional Value Chains

Two meta-objectives adopted by the Secretariat for Central American Economic Integration (SIECA) to identify and prioritize regional value chains are to strengthen productive and commercial complementarity and to promote the competitive insertion of Central America in international markets. The Central American Council of Ministries for Economic Integration (COMIECO) defined the following two meta-objectives in 2014: (i) strengthening productive and commercial complementarity, and (ii) promoting the competitive insertion of Central America in international markets. Quantitative, qualitative and political criteria, including intra-regional export capacity, commercial complementarity, trans-border and intra-sectoral linkages, growth potential, external demand, the participation of women, SME involvement, relevance to food security, sustainability, and resilience to climate change, were among the factors that determined the methodology for the selection process. This process ended with a dialogue that engaged the key decision-makers in each member country at a regional roundtable.

The top 40 regional value chains prioritized by SIECA include the following: (1) Flours and milling products; (2) Food preparations (tomato sauces, soup preparations, coffee extracts and animal feed); (5) Dairy products; (7) Bottled water; (8) Salt; (10) Vegetable fats and oils; (11) Rice; (12) Bananas and plantains; (18) Pineapples; (19) Coffee; (20) Cocoa; (23) Poultry; (26) Spices; (27-29) Meat, pork meats and seafood; (30) Cantaloupes and watermelons; (32) Avocados, sour sops and passion fruit; (36) Sugar; (39) Roots and tubers, and (40) Carrots and turnips.

Source: SIECA (2018)

23. Despite the differences in scale and internal structure, both small and large farms are becoming more integrated into global markets. New forms of social relations and agricultural production, including small export-oriented coffee farmers producing certified coffee for niche markets in Europe, USA, and Asia; contract farmers for supermarket chains, or productive alliances between rural producer organizations and commercial partners, have been increasing in numbers in recent years, thereby connecting producers, including smallholders, with opportunities in international markets.⁵⁵

24. The NCA countries and their partner countries in Southern Central America have been adopting a policy of trade liberalization in recent decades that has led to the signature of various free trade agreements (FTA) that offer growing opportunities in export markets for agri-food products. In 2006, El Salvador, Guatemala and Honduras, together with Costa Rica, the Dominican Republic, Nicaragua, Panama and the United States, entered into the Dominican Republic-Central America Free Trade Agreement (DR-CAFTA). The DR-CAFTA Agreement provides direct access to the US market for most agricultural and agro-industrial products from Central America. Consequently, the US has become the top destination for CA products, accounting for 50

⁵² Piñeiro (2005).

⁵³ IICA (2019). By comparison, these shares were 12% for Panama and 43% for Costa Rica and Nicaragua in 2018.

⁵⁴ *ibid.*

⁵⁵ López-Ridaura et al. (2021).

percent of the region's exports. It has resulted in US\$53 billion in total goods trade between the trading partners in 2015 alone.⁵⁶ In parallel, in 2012, the Central American countries and the European Union (EU) signed an Association Agreement that went into effect at the end of 2013.⁵⁷ The agreement eliminated most import tariffs, strengthened regional integration in Central America via more consistent trade regulations, and generated more trade predictability between Central America and the EU.

25. These free trade agreements have the potential to generate important income generation and job creation opportunities in Northern Central America, once producers can comply with growing export requirements for agri-food products in terms of quality, sustainability and food safety guarantees. In fact, the European Farm-to-Fork (F2F) strategy, issued in May 2020, sets clear goals for reducing the use of pesticides and antibiotics, boosting sustainable agriculture, promoting the consumption of plant-based protein, and making each of the elements of the supply chain more sustainable.⁵⁸ Mandatory and binding aspects—such as maximum pesticide residue limits—will place a heavier demand on international exporting producers, by banning a number of nitrogenous and phosphoric agrochemicals, as well as antibiotics traditionally used to ensure plant and animal health, even as producer seek to maintain their productivity. Although these measures will contribute to greener development, the NCA countries are still lagging significantly in their capacity to ensure traceability and comprehensive quality and safety management standards, as well as in international marketing of their agri-food products, which would enable them to take greater advantage of these opportunities.

2.2.8 Recent Disruptors

26. In addition to the above megatrends, agri-food systems have been shocked by major recent disruptors. These include the COVID-19 pandemic, tropical storms Eta and Iota in November 2020, and the recently war between Russia and Ukraine launched in February 2022. Their impacts on the three NCA countries are discussed briefly in Box 2.2 below.

Box 2.2: Recent Disruptors are Impacting Agri-food Systems in Northern Central America

Agri-food systems in NCA have experienced strong negative socio-economic impacts from recent shocks driven by the COVID-19 pandemic. These events have added to pre-existing systemic constraints and to the impacts of natural disasters on agri-food systems, and have resulted in tragic losses of life as well as increased health risks. Across the region, the effects from the COVID-19 pandemic have also been evident since early 2020 in terms of their impacts on agrologistics, notably supply and distribution chain disruptions, domestic and international mobility restrictions, contraction of supply and demand, reduction of traditional marketing outlets, price volatility, and reduced liquidity and working capital for agricultural medium small and micro enterprises (MSMEs). These effects have resulted in job losses, lower (or negative) GDP growth, and an increase in poverty and food and nutrition insecurity, especially for vulnerable groups, including informal workers, women, children and indigenous people.

The invasion of Ukraine by Russia has further exacerbated conditions of food prices and input supplies. The sharp increases in international fertilizer prices since the beginning of the Russia-Ukraine war in February 2022 directly affect the region's agricultural sectors, as Honduras and Guatemala are the fourth and fifth largest net importer of fertilizers per arable land in Latin America and the Caribbean. In the same vein, El Salvador is highly dependent on imports of

⁵⁶ The Office of the United States Trade Representative, (accessed April 2022).

⁵⁷ European Commission (2022).

⁵⁸ European Commission (2022).

food, inputs and intermediate goods. The simultaneous surge in international oil prices has further increases input and transport costs, further weakening the agri-food systems of the sub-region.

The impact of these two recent disruptors on agri-food systems in El Salvador has been significant. The negative impacts of the COVID-19 pandemic reduced national GDP by 8.7% in 2020 and contributed to an increase in public debt to nearly 100% of GDP in 2021. The Russia-Ukraine war further exposed pre-existing vulnerabilities of the Salvadorian agri-food sector system to risks associated with external market shocks. In particular, prices for imports of food, feed and fertilizers are expected to increase significantly in the short- and medium-term, due to the input supply gap and the higher energy costs resulting from the war. Prior to the war, El Salvador imported 17% of its fertilizer from Russia, and the anticipated supply shortages are expected to negatively affect domestic food production and prices.

In Guatemala, the impact of the COVID-19 pandemic was amplified by tropical storms Eta and Iota in November 2020. That year, Guatemala's GDP contracted by 3.5% and poverty rates rose by 3.5% above 2019 levels to 54.9% of the population, one of the highest poverty rates in the region. The pandemic pushed thousands more below the poverty line, increased widespread food and nutrition insecurity and reversed years of progress. Moreover, the early impact of the Russia-Ukraine war is being felt through spiking fertilizer and fuel prices. Prior to the war, Guatemala imported almost 20% of its nitrogen and 37% of its potassium from Russia and Belarus, and a disruption in supply is expected to lead to significant input shortages and to price increases for agricultural producers.

In Honduras, the socio-economic impacts of the coronavirus pandemic combined with the effects of tropical storms Eta and Iota were particularly devastating, leading to a 9% fall in GDP in 2020. The collapse in private consumption, export demand and both public and private investment contributed to the permanent closure of more than 40% of the country's MSME since the start of the pandemic, according to estimates by the Honduran Council of Private Enterprise. Moreover, poverty in households under the US\$5.50 line is projected to have increased from 49% in 2019 to 55.4% in 2020—an increase of more than 700,000 people. Real GDP is not expected to reach its pre-pandemic level until 2023, with agriculture projected to recover more slowly due to the severe damage to crops and land provoked by the storms and the impacts of the Russia-Ukraine war.

Sources: FAO-World Bank Policy Notes for El Salvador, Guatemala and Honduras (2022); World Bank (2021b).

2.3 Challenges in Agrologistics in Northern Central America

27. Agrologistics are critical for both consumers and for the family farms that supply 70-80% of the food consumed in the sub-region. Agrologistics allow agri-food products to move from the original point of production to the final point of consumption, and account for a significant share of value added (anywhere from 40-80%) along the value chains. Strengthening agrologistics, both on-farm post harvest and beyond the farmgate, can boost farmers' incomes by greatly reducing food loss and waste, and thereby increasing returns on inputs, as well as by providing more inclusive linkages for family farmers to broader markets that can offer higher prices. Moreover, linkages to more sophisticated purchasers through more vertically integrated agrologistics value chains can result in improved technologies for farm-level production and risk management.

28. The NCA countries face a range of common challenges in strengthening their agri-food systems to ensure green, resilient and inclusive development. These include inadequate quality and quantity of storage capacity for agricultural products, both on-farm and beyond the farmgate; challenges in terms of logistics

efficiency; under-investment in rural infrastructure, notably in upgraded road networks, and challenges with regard to access to affordable electricity and renewable energy.

2.3.1 Storage and Cooling

29. Food losses incurred during storage are significant, with on-farm storage losses contributing to approximately 20% of all food loss and waste in Central America. For example, a study examining food loss across key value chains in multiple countries in Central America indicates that post-harvest storage is correlated with increased loss in the bean value chains in Guatemala and Honduras, and that in Honduras longer storage duration is correlated with increased production losses.⁵⁹ The study also indicates that investment in improved storage (for example silos or granaries) results in a 18-31% reduction in the likelihood of incurring a loss.

30. Cold storage capacity is particularly low in NCA and exacerbates food loss and price volatility for perishable produce. Inefficient or non-existent cold storage facilities have a clear and measurable impact on the quantity, quality, and product life of perishables delivered to processing plants for manufactured agricultural goods, supermarkets, and at urban retailers. The same is true for post-harvest processing and conditioning centers which lack appropriate sorting and packaging lines, cold rooms, and pre-cooled facilities, and for wholesale centers, which do not have adequate cold rooms and traceability systems. Since perishable products require temperature control, and often cannot be consolidated easily with other types of cargo, including other refrigerated cargo, there is a need for uninterrupted cold chain storage and transport systems for high-value exports. These deficiencies affect the competitiveness of agri-food production in the sub-region, hampering access to high-end points of sale. In particular, cold storage capacity is undersized in all three countries, contributing to food loss and waste and jeopardizing livelihoods and food security. In 2018, there were only 12 refrigerated warehouses in Guatemala, resulting in a refrigerated warehouse capacity of 0.125 million m³ with 0.014 m³ per urban resident. In El Salvador, in 2014 the refrigerated warehouses were as few as four, with refrigerated warehouse capacity of 0.02 million m³ and 0.005 m³ per urban resident. These values are extremely low relative to regional comparators such as Chile and Mexico (see the fresh fruits and vegetables deep dive in Chapter 4).

31. There is substantial evidence that investments in cold storage can improve farmer incomes, reduce food losses⁶⁰ and make food product value chains more resilient to shocks like those experienced during the COVID-19 pandemic.⁶¹ Investments in such technologies is especially critical when there is potential for high-value exports of fragile horticulture produce. Innovations in cold storage technologies include Cool-Bot, a low cost innovation that is currently being implemented in several countries, including Honduras, as well as off-grid solar-powered refrigeration units.^{62,63}

2.3.2 Logistics Efficiency and its Bearing on Agri-food Systems

32. The Central America and Caribbean region as a whole lags most of the world in terms of logistics efficiency. In 2018, according to the World Bank's Logistics Performance Index (LPI), the logistics performance of the region reached just 2.66 points out of 5, well below the levels of Europe and Central Asia (3.40) or East Asia and the Pacific (3.13), and only close to the Middle East and North Africa (2.78).⁶⁴ Indeed, the region

⁵⁹ Delgado, Schuster and Torero (2021).

⁶⁰ UNDP (2021).

⁶¹ Trotter & Mugisha (2020).

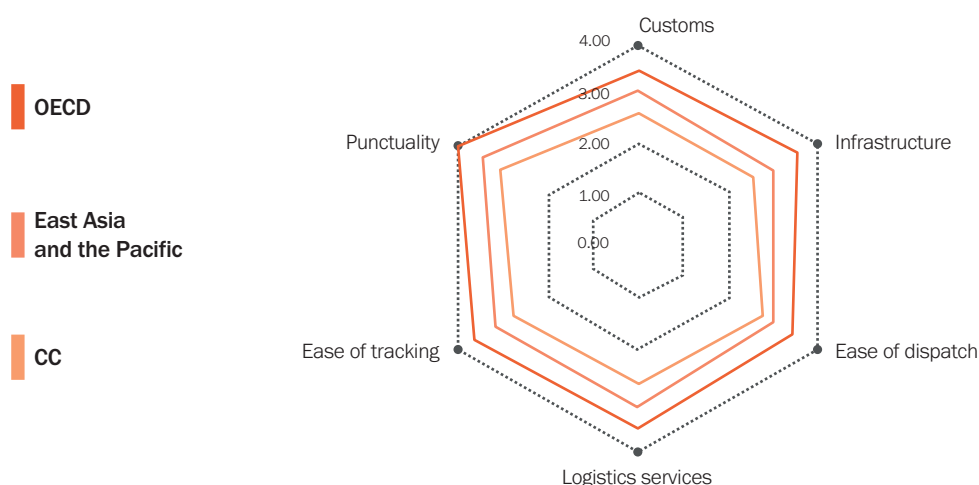
⁶² The CoolBot cool room system is a single-purpose post-harvest cold storage technology that transforms a wall-mounted air conditioning unit into a small-scale refrigeration system. See: Feed the Future Innovation Lab for Horticulture (2011).

⁶³ Cold storage rooms consume considerable amounts of energy. Within cold storage facilities 60-70% of the electrical energy may be used for refrigeration. See: Chopra et al. (2022).

⁶⁴ World Bank - Logistics Performance Index (2018).

consistently scored below all regions, except for Sub-Saharan Africa (Figure 2.2). Moreover, a World Bank study of logistics in Central America showed that, in 2012, the region's logistics bottlenecks more than doubled logistics costs for both high and low value goods.⁶⁵ In addition, data on time delays to import and export cargo indicate that, in spite of some improvements over the past decade, time delays at the borders remain uncompetitive, except in the case of exports from El Salvador (Table 2.5).

Figure 2.2: Logistics Efficiency in Central America and the Caribbean Lags Other Regions



Source: World Bank - Logistics Performance Index (2018)

Table 2.5: In Spite of Improvements during 2010-2020, Import and Export Delays Remain Significant in Most of Northern Central America

Country	Time to import (days)		Time to export (days)	
	2010	2020	2010	2020
El Salvador	10	8	14	4
Guatemala	16	13	17	11
Honduras	22	21	19	20

Source: World Bank - Doing Business (2020)

33. Severe transport and logistics bottlenecks continue to hamper the performance of Central American agri-food value chains. The Guatemala Logistics Union estimates that domestic logistics costs amount to 30-40% of total export costs borne by Guatemalan agri-food exporters. Three primary bottlenecks affect the exportation of perishable agricultural products: (i) poor rural road access and quality; (ii) border management and infrastructure weaknesses, including specific aspects of customs services; and (iii) sanitary and phytosanitary review and inspection processes. Secondary bottlenecks that also affect many value chains included container security risks, poor port performance, city congestion, and transport regulation. During the pandemic years of 2020-2021, the impact of weak logistics performance was particularly strong on smallholder producers in rural areas, as they encountered difficulties regarding access to and availability

⁶⁵ World Bank (2012).

of inputs, logistical disruptions that included a lack of storage opportunities, and limited access to markets. At the same time, the impediments in moving produce efficiently within NCA countries also affects the food and nutritional security of local consumers who do not receive food in sufficient quantity and of good quality throughout the year, particularly in the absence of efficient cold chains.

2.3.3 Deficiencies in Rural Road Infrastructure and their Impacts on Agri-food Systems

34. Deficiencies in road infrastructure, notably in rural areas, are hindering the ability of the region to build forward better post Covid-19. By strengthening and expanding the region's road connectivity with a focus on "last mile" segments in existing networks, and ultimately increasing the coverage and quality of rural road infrastructure, the region would be able to address climate vulnerabilities, increase the competitiveness and job creation of smallholder farmers in the agri-food system, and support a green, sustainable and inclusive economic recovery. Rural and tertiary roads represent key areas for investment.

35. Severe transport bottlenecks have continued to hamper the performance of NCA agri-food value chains and affected the ability of farmers and other value chain actors (especially smallholders) to access national and international markets. These include poor rural road access and quality, security risks, road congestion, inadequate transport regulation and weak traceability systems. An estimated 60% of the road network in all of Central America is in poor or very poor condition, so that on average trucks travel at 17 km/hour, less than one-quarter of the international standard speed of 80 km/hour.⁶⁶ In the 2019 Global Competitiveness Index (GCI), the NCA countries were ranked in lagging positions in the global ranking (90 to 99 positions from the top, see Table 2.6).

Table 2.6 The NCA Countries are Lagging in Infrastructure Competitiveness and Investment

Country	Infrastructure GCI ranking ¹	Transport infrastructure investment (% of GDP) ²
Northern Central America		
El Salvador	90	0.68
Guatemala	98	0.72
Honduras	99	0.97
Southern Central American Countries		
Costa Rica	63	1.39
Nicaragua	104	2.13
Panama	59	2.19
Average for LAC	82	1.10

Sources: World Economic Forum (2019), and Infralata (2019)

36. While public investment in transport infrastructure is generally low across all of Central America (less than 2.5% of GDP in each country), countries such as Panama or Nicaragua invest more than three times as much as countries like El Salvador or Guatemala (Table 2.6).⁶⁷ Overall, automotive freight transport is the key transportation mode for the NCA countries, absorbing over 90% of public investment in transportation in both El Salvador and Guatemala in 2019. Investments in air and sea transport have smaller shares in total national volumes, while rail transport is very scarce in the sub-region due to the obsolescence of the system. Table 2.7 quantifies the total investments needed to close the road infrastructure gap for transportation

⁶⁶ SICA (2019).

⁶⁷ Infralata (2019). Data are for 2019, except for Honduras (2018). Public Investment in Economic Infrastructure 2019 (2018 for Honduras).

services in rural environments in Central America, estimated at US\$9.1 billion for Guatemala and Honduras (no data were available for El Salvador).

37. Underinvestment in road infrastructure has significant implications for inclusive development. A World Bank paper on agro-logistics in Central America, published in 2012, found that, for large-scale producers, transporting tomatoes from their farms to the border represented 7% of the sales price whereas for smallholder farmers, transport costs accounted for 23% of the sales price, i.e., over three times more than for larger producers. The study concluded that the lack of quality secondary roads, costly land transport services and lengthy customs clearance procedures were the main hindrances to trade.⁶⁸

Table 2.7: Substantial Investments are Needed to Close the Road Infrastructure Gap in Rural Environments in Central America, Including in the NCA Countries, by 2030

Country	New Rural Road Infrastructure	Maintenance and Asset Replacement	Total (US\$ billion)
El Salvador	N/A	N/A	N/A
Guatemala	1.9	3.4	5.3
Honduras	1.6	2.2	3.8
Costa Rica	4.6	6.5	11.0
Nicaragua	2.4	2.9	5.3
Panama	1.8	3.3	5.1
Total*	12.3	18.3	30.5

Source: Authors elaboration based on data from IDB (2021). *The total for Central America does not include El Salvador as there are no data available for the country.

38. The importance of rural roads and other rural infrastructure for agriculture productivity and growth is well documented.⁶⁹ Investment in rural roads has been shown to translate into farming households increasing production, raising non-farm incomes, adopting new technologies, increasing labor use and improving risk management by diversifying production.⁷⁰ Infrastructure is key to the development of rural-urban linkages and to a region's access to the international market for agricultural produce. Research that is highly relevant to the NCA context, namely an evaluation of the impact of road connections between a rural area and a large urban area in Nicaragua, found that while the price of consumer goods flowing in from the urban area decreased, the price of fish produced in the rural area and sent to the urban area increased.⁷¹ Additional evidence regarding bean producers in Nicaragua found that a 25% reduction in travel times to markets translates into increases in income of 3% to 12% of an average smallholder's annual income from bean sales.⁷² The implications of transport costs for the agri-food systems in El Salvador, Guatemala and Honduras are analyzed in detail below in the respective deep dives in Chapter 4.

2.3.4 Electrification and Renewable Energy

39. Large proportions of the populations in Northern Central America have access to electricity, including in rural areas. For example, in El Salvador close to 100% of the rural population has access to electricity,

⁶⁸ World Bank (2012).

⁶⁹ Llanto (2012).

⁷⁰ See: Shamdassani (2021), Dorosh et al. (2012), and Jacoby and Minten (2009).

⁷¹ Parada (2016). The roads being rehabilitated consisted of 42 miles in two secondary roads, Somotillo-Cinco Pinos and León-Poneloya-Las Peñitas, and one secondary trunk road, Villanueva-El Guasaule

⁷² Ebata et al. 2017

while the proportion in Guatemala is 94%.⁷³ The proportion is somewhat lower in Honduras, where 84% of the rural population has access to electricity. Electricity prices range from US\$0.13-0.17 per kilowatt-hour (kWh) in Guatemala, US\$0.16-0.22/kWh in El Salvador and US\$0.17-0.20/kWh in Honduras.⁷⁴ These prices are comparable with those prevailing in Costa Rica and Chile, but are significantly higher than prices in Argentina.

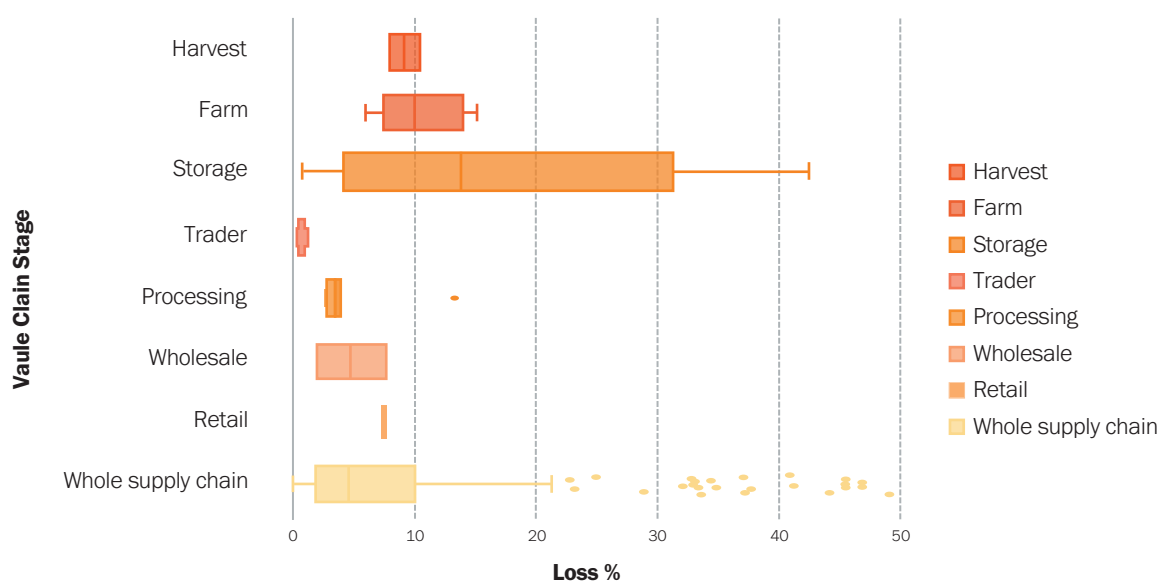
40. Renewable energy sources are an important share of total energy consumed with the potential to grow.

The share of renewable energy in total final energy consumption in the NCA countries ranged from 23% in El Salvador to 50% in Honduras and 64% in Guatemala in 2018.⁷⁵ The primary renewable source in the region is hydropower, followed by onshore wind and solar photovoltaics (PV). Future projections can feasibly consider expansion of renewable energy, bearing in mind declining cost trends. For example, total solar PV costs have fallen in the LAC region by nearly 80% over the past decade.⁷⁶

2.4 A Key Consequence of the Challenges: Food Loss and Waste

41. While there are a range of potential consequences from weaknesses in agrologistics systems, including the loss of food quality and the loss of market opportunities, one of the most critical consequences is substantial food loss and waste. Food loss and waste is well recognized globally as a serious challenge in ensuring environmentally sustainable food production and food security. Data from FAO's Food Loss and Waste Database underscores the severity of this concern in the NCA countries. Losses across value chains in the sub-region can be as high as 40%, with the highest level of losses occurring during storage, due to limited uptake of technologies such as silos and cool storage rooms, thereby undermining green development (Figure 2.3).⁷⁷

Figure 2.3: Food Losses are Highest in the Storage Phase of Central American Agri-food Value Chains



Source: FAO (2022)

⁷³ World Development Indicators (2022). Also see the Tracking SDG 7: The Energy Progress Report 2021, led jointly by the custodian agencies: the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank and the World Health Organization (WHO).

⁷⁴ See OLADE (2021) and Abuelafia, et al. (2019)

⁷⁵ International Energy Agency et al. (2021).

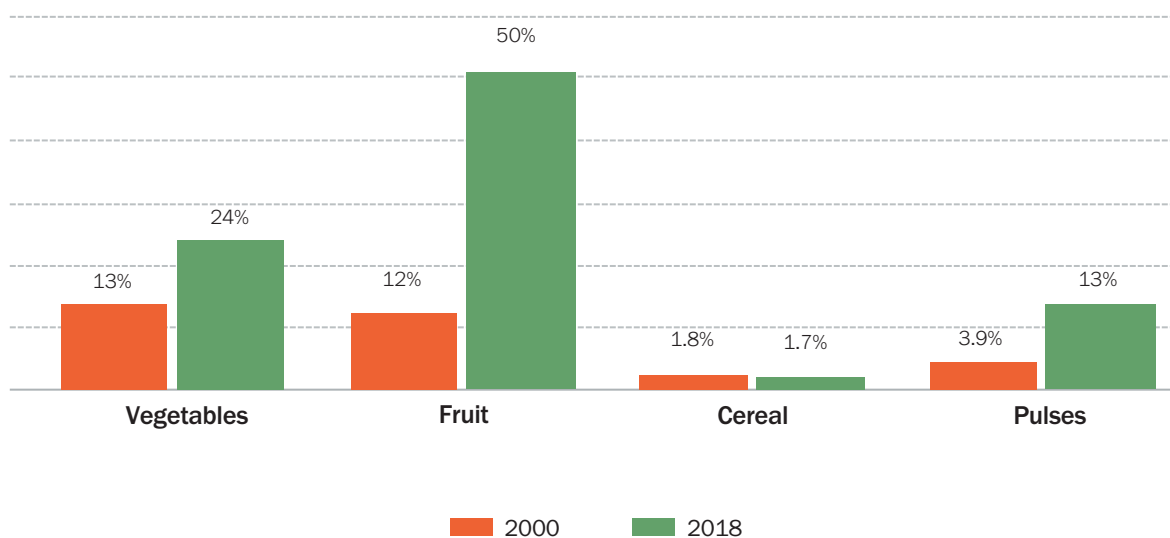
⁷⁶ International Renewable Energy Agency (IRENA) (2022).

⁷⁷ Taken from FAO's Food Loss and Waste Database <https://www.fao.org/platform-food-loss-waste/flw-data/en/>

This figure aggregates data from various value chains in the countries of Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua. The data is from between 2001-2021

42. Losses of vegetables, fruits, cereals and pulses across value chains in Central America have either increased or remained stagnant between 2000 and 2018, pointing to the persistence of this problem.⁷⁸ For example, an in-depth diagnostic for Guatemala indicated that in 2018 the country lost 20 million tons of food, costing it 4.2% of Gross Domestic Product (GDP). A specific examination of Guatemala's value chains indicated that 34% of maize, 26% of beans, and 54% of tomatoes were lost in 2018 at various stages of the value chain, and that food losses have increased in most key value chains since 2018 (Figure 2.4). Moreover, inadequate storage capacity has resulted in maize produced in Guatemala being more likely to be contaminated with potentially carcinogenic aflatoxins and fumonisins, and in beans being more likely to be contaminated with mycotoxins.⁷⁹

Figure 2.4: Food Losses for Fruits, Vegetables and Pulses have Increased in Guatemala since 2000

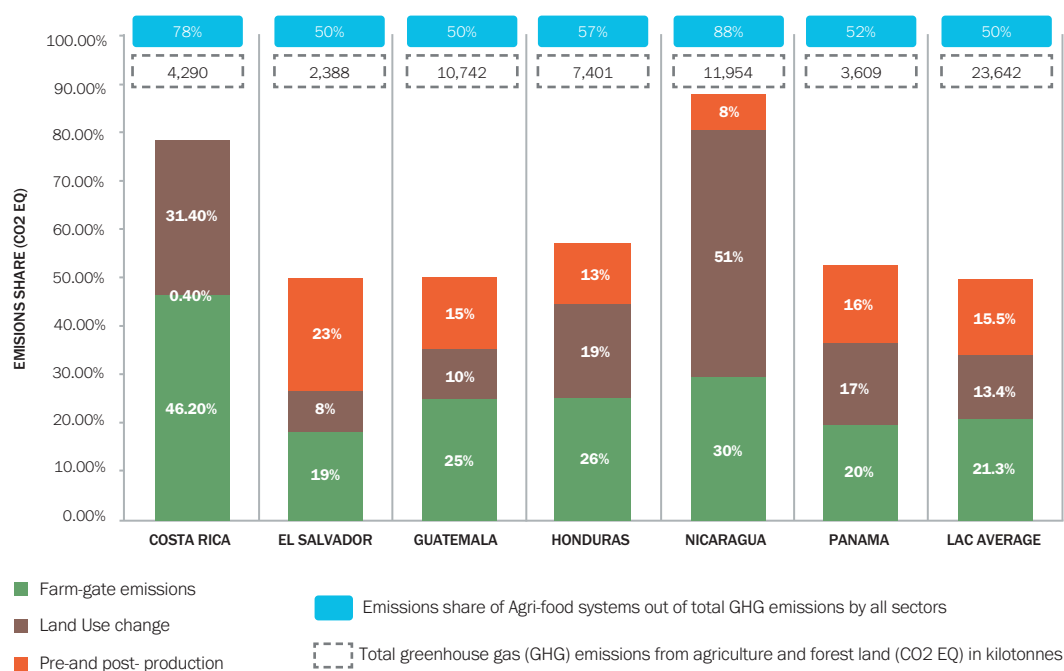


Source: FAO (2022)

43. Food loss and waste have significant implications in terms of greenhouse gas (GHG) emissions. In fact, GHG emissions from agri-food systems account for 50% or more of all GHG emissions in El Salvador, Guatemala and Honduras (Figure 2.5 below). Given the agri-food system's large shares of GHG emissions, the potential returns from agrologistics investments are significant, in terms of reducing the carbon footprint and greening CA's economies. The deep dives in the fruits and vegetables value chains and the basic grains value chains in Chapter 4 present estimates of the significant potential annual savings from reducing GHG emissions via improved agrologistics.

⁷⁸ Food Systems Dashboard (2020).

⁷⁹ World Bank (2020). Aflatoxins are toxins produced by fungi found on agricultural crops such as maize, peanuts, cottonseed, and tree nuts. The main fungi that produce aflatoxins are *Aspergillus flavus* and *Aspergillus parasiticus*, which are abundant in warm and humid regions of the world. Aflatoxin-producing fungi can contaminate crops in the field, at harvest, and during storage. Exposure to aflatoxins is associated with an increased risk of liver cancer.

Figure 2.5: Agri-food Accounts for More than Half of Total GHG Emissions in NCA

Source: Authors, based on data from FAOSTAT (2019)

2.5 Emerging Trends and Innovations in Agrologistics

44. This section analyzes emerging technologies and practices that can boost green, inclusive growth by improving productivity and market connections for small to medium scale farmers and agro-processors. This includes models that have already proven effective in Northern Central America as well as others that are newer to the region, and they include the automation and digitization of agri-food value chains; farm-to-fork (F2F) initiatives that connect producers directly to markets, and nearshoring opportunities that take advantage of the sub-region's proximity to the North American market.

2.5.1 Automation and digitization of agri-food value chains

45. Digitalization can significantly improve the efficiency and management of agri-food supply chains. In particular, the application of specific digital technologies and innovations (including remote sensing technologies, farm management information systems, precision agriculture and agronomic decision support systems) can have a significant impact on the productivity and resilience of agri-food supply chains, by driving a transition from more traditional agriculture systems to data-driven, smart, agile and autonomous connected agri-food systems (see Chapter 3). Digitalization across the value chain can also provide an important avenue for increased youth employment in both urban and rural segments of agrologistics value chains. This is critical for the agriculture sector in the region as many countries have young populations (Guatemala and Honduras have a higher population of 0-14 years than the world proportion of 26%) who do not naturally gravitate towards the sector. Two of the mechanisms by which digitalization can increase youth engagement are: (i) by changing the perception of farming as an unprofitable and hard-labor-intensive activity; and (ii) by increasing the profitability of farming through adoption of new technologies that younger farmers are more likely to adopt.

46. ICT technologies provide an opportunity to improve traceability of agri-food products during transport, thereby facilitating both phytosanitary controls and obtention of premium prices linked to certifications.

The use of digital technology applied to logistics management in the agri-food system chain requires precise interactions, since the profitability of the sector depends largely on the ability to accurately place a product in space and time. Digital applications in logistics increase efficiency by allowing real-time quantification of stocks, product tracking throughout the chain to avoid losses, and contributions to the efficiency in transport, among others.

47. The application of digital technologies in transport and through the entire value chain also represents an opportunity for improving information, innovation and entrepreneurship. For example, a seminal paper in Niger showed that improved access to market information reduced price dispersion and that the effect was larger when transport costs were higher.⁸⁰ In another example from Indonesia, the KARGO company offers logistics services to improve the resilience of supply chains, using state-of-the-art technology to connect more than 50 thousand transport vehicles. This has included the use of electronic vouchers to minimize human contact during the current pandemic.⁸¹

48. The Covid-19 pandemic has accelerated the development of e-commerce and the digital transformation of the rural sphere. One study of 1,478 participants across the Americas found interesting patterns with regard to the adoption of technology to deal with the effects of the COVID-19 crisis.⁸² It found that 30% of actors in value chains started incorporating the use of digital technology for their purchases and sales (via apps and the internet). Almost 40% of these actors modified or adapted their businesses to deliver their products directly to the final consumer. In addition, initiatives by local suppliers, such as weekly fresh produce orders for home delivery ordered via WhatsApp groups, contributed to keeping farmers' businesses going during the pandemic.⁸³

2.5.2 Farm to Fork Initiatives

49. One of the most stunning effects of the COVID-19 pandemic has been the emergence of alternative food chains and the integration of networks between farmers and consumers.⁸⁴ Many short value chains have emerged, e.g., via local grocery stores and producers/processors moving along the value chain to reach customers locally. Initiatives to link farmers to markets have emerged both as acts of solidarity with farmers suffering disruptions in their usual value chains as well as for consumers, who faced the closure of markets, to obtain fresh produce.⁸⁵ This phenomenon is causing positive disruptions in value chains, allowing, on the one hand, better access to markets and better prices for producers, and on the other, improved access to fresh produce at better prices for consumers. Farm to fork initiatives offer an interesting opportunity to smallholders in the NCA countries, especially producers of fresh fruits and vegetables, to diversify markets and adopt alternative sales strategies that reach consumers directly, thus reducing the number of intermediaries that participate in the food chain and increasing farmers' margins.

50. Agricultural e-commerce and hyperlocal supply chains, including business-to-consumer (B2C) and business-to-business (B2B) e-commerce platforms, have increased exponentially in recent years. This has occurred both via mobile modalities (e.g., web platforms or dedicated applications) and via social e-commerce (using social networks as marketing platforms). In order to access these alternative ecosystems, agricultural producers require ensure access to: (i) a platform; (ii) electronic payment system or payment transfer intermediation; (iii) logistics; and (iii) an adequate legal and regulatory framework.⁸⁶

⁸⁰ Aker (2010).

⁸¹ See Oxford Business Group (2020), and ECLAC and FAO (2020).

⁸² Borja et al. (2020).

⁸³ Lopez-Ridaura et al. (2021).

⁸⁴ Lopez-Ridaura et al. (2021).

⁸⁵ *ibid.*

⁸⁶ ECLAC and FAO (2020).

51. Another mechanism with potential to connect farmers and small agro-processors is agri-tourism.

Agri-tourism benefits farmers and small-scale processors by directly connecting tourists to farms or small processing locations, or via intermediaries such as hotels and resorts. The tourism sector was negatively affected by COVID-19 but is generally an important sector for the NCA economies, especially for El Salvador, where it contributed to more than 20% of export revenues in 2019, while in Guatemala and Honduras it accounted for 9% and 8% of export revenues, respectively, in 2019.⁸⁷ Agri-tourism can deliver the benefits of other farm-to-fork initiatives to farmers, in the form of an alternative market with fewer intermediaries and with attractive price premia for quality produce.

2.5.3 Nearshoring

52. The COVID-19 pandemic has disrupted global supply chains in an unprecedented way since the first measures were implemented early in 2020 to contain the spread of the virus. For example, as early as February 2020, shipping between China and California ports - a key global supply corridor - had fallen by more than a third, while United States imports from China fell by nearly 45% year on year.⁸⁸ Therefore, in the post-pandemic era, the trend towards geographic diversification and the reduction of distances between suppliers and buyers, also known as nearshoring, is becoming increasingly important for the reconfiguration of supply chains.

53. Nearshoring presents a major opportunity for the NCA countries. Because of their proximity to the United States, the existence of free trade agreements, and the experience gained in exporting agri-food products to their major trade partner, this sub-region and its agri-food producers stand to benefit from the trend toward nearshoring, diversification of suppliers and shortening of supply chains. In order to take advantage of this unique opportunity for economic recovery and job creation, the NCA countries will need to upgrade their agrologistics infrastructure and services, so as to enable smallholders to access international agri-food value chains.

2.6 Summary of Findings

54. The broader context for agrologistics in Northern Central America is characterized by several megatrends that present major challenges and opportunities for smallholder farmers, as well as by persistent local challenges and emerging trends and innovations that can shape the future development of the agri-food sector in the sub-region. The key megatrends that are defining the context for green, resilient and inclusive agri-food development in the NCA countries are climate change, migration, urbanization, growing domestic markets, shifting dietary patterns, the supermarket revolution and growing opportunities in international markets. To succeed in this rapidly evolving environment, the NCA countries will need to address gaps in agrologistics that include reducing food loss and waste; upgrading storage technology and capacity; investing in rural infrastructure, especially rural roads, electrification and renewable energy, and accelerating the rollout of digital infrastructure. The automation and digitization of agri-food value chains constitutes one of the major trends and innovations that can revolutionize agrologistics and contribute to inclusive and sustainable growth and productivity improvements in the sector. Other innovations that are emerging in Northern Central America include Farm-to-Fork initiatives, including business-to-consumer and business-to-business e-commerce platforms, as well as opportunities for nearshoring, which are examples of tools and mechanisms that warrant further development to promote green, resilient and inclusive agri-food systems in NCA. Agri-food value chains depend on a strong policy environment, public investment, and private capital and business practices for their success. These critical dimensions of the enabling environment for agrologistics value chains in Northern Central America are analyzed next in Chapter 3.

⁸⁷ World Bank - World Development Indicators (2022b).

⁸⁸ The Wall Street Journal (2020).

Public and Private Roles for an Enabling Environment

1. This chapter reviews the enabling environment for agrologistics value chains in Northern Central America. The enabling environment shapes how goods and services move between the different stages of NCA agrologistics value chains. It arises out of a variety of policies, investments and institutions interacting with the local realities and market conditions. During the past decade, public and private awareness of the strategic importance of these policies has increased in the region, with Chile and Colombia standing out in the LAC region for their early and sustained commitment to both national infrastructure and regulatory practices to facilitate logistics to decrease transaction costs.⁸⁹ This chapter characterizes the national policy frameworks for agrologistics of the three NCA countries, as well as the regional policy framework under the auspices of the Central American Integration System (SICA), and briefly reviews the status of regulations and practices related to sanitary and phytosanitary (SPS) measures, which are critical for both national and cross-border commerce. The chapter then analyzes the current status of public expenditures on agrologistics in Northern Central America, notably with regard to research and development (R&D) and essential public infrastructure. Finally, the chapter considers the central role of the private sector in spurring changes in agrologistics via investments, common practices and standard-setting.

3.1 National and Regional Policy Frameworks for Agrologistics

2. El Salvador, the NCA country with the smallest agricultural sector, has recently embraced a national strategy designed to redouble its agricultural competitiveness and agrologistics efficiency. The strategy is articulated in the country's 2021 Agricultural Recovery Master Plan.⁹⁰ It argues that public investment in their agriculture sector has languished for more than a decade, during which the coffee export sector contracted from being one of the world's leading exporters to becoming a residual producer. Within the framework of the Master Plan, El Salvador has committed US\$637 million to the recovery of the coffee sector alone, and has placed the acceleration of technological adoption as the cornerstone of their policy, including the ambitious goal of being the first country to offer internet access to 100% of its communities nationwide.

3. In 2021, the Government of Guatemala announced a national economic plan with a ten-year horizon. Known as "Guatemala No Se Detiene" (Guatemala Does Not Stop), the plan includes agriculture among 20 production areas, although it focuses more on employment generation, particularly for industries such as bio-medical manufacturing. The plan recognizes the importance of improving road and port infrastructure and reducing times of customs administration, and lays out Guatemala's aspiration to become the third most important port in the region after Mexico and Panama. However, there are few details in the plan with regard to the handling of perishable agri-food exports, or to domestic logistics.

4. The Government of Honduras launched a plan in 2022 to re-found the country ("Plan de Gobierno para Refundar Honduras 2022-2026"). The plan addresses issues related to the rural sector, climate change, watershed management and irrigation, but contains few details with regard to logistics. One of the few topics that is germane to agrologistics is the proposal to reestablish a basic grains strategic reserve initiative via public silo infrastructure and management. The Plan addresses digital economy, technology, and social inclusion, but does not expand on issues of rural connectivity or agricultural research related to production or post-harvest innovations. Although the plan recognizes the urban-rural infrastructure divide, the treatment of public investment in infrastructure focuses primarily on social infrastructure (health, education, housing, culture) and on post-hurricane recovery. Thus, there remains a need to strengthen the visibility of, and attention to, agrologistics policies and investments as essential contributors to green, resilient and inclusive development in the broader planning and policy frameworks of all three NCA countries.

⁸⁹ FAO (2015) provides a summary of agrologistics policies in selected countries in the LAC region.

⁹⁰ Gobierno de El Salvador (2021).

5. At the regional level, SICA has established and promoted a regional policy framework underpinning agrologistics in Central America. The Agriculture Ministries of all the Central American countries formally joined forces under the auspices of SICA's Central American Agricultural Council (CAC) to issue policy priorities for 2019-2030 that are focused on inclusive, sustainable, and resilient value-chains.⁹¹ The six priority policy areas that emerged were: (1) Agro-Business Competitiveness & Trade; (2) Sustainable Development Adapted to Climate Change and Integrated Risk Management; (3) Innovation and Technological R&D, Transfer, and Innovation; (4) Agricultural Health and Food Safety; (5) Implementation of the Peasant, Indigenous and Afrodescendant Family Farming Policy (PAFCIA),⁹² and (6) Effective Institutional Regional Technical Articulation. While these policy areas bear directly on agrologistics with GRID and efficiency perspectives, the Ministers of Agriculture explicitly recognized that the responsibility for coordinating and harmonizing actions on transport, mobility and logistics lies with the Sectoral Council of Ministers of Transport of Central America (COMITRAN).⁹³

6. SICA's agrologistics policy framework provides guidance across the array of issues embedded within the six priority policy areas. SICA established Technical Groups and Technical Committees to coordinate Central American cooperation on initiatives financed via national budgets. The framework document enumerates certain priority lines of action more specifically, including to: 1) promote business development endeavors, including associativity; 2) promote risk management and adaptation to climate variability and climate change; 3) articulate regional schemes for R&D and innovation that improve knowledge management in the agricultural sector; and 4) collaborate on regional agricultural health and food safety programs, including surveillance, early detection, and eradication campaigns for diseases and pests. As such, the priority lines address green, resilient and inclusive dimensions of agrologistics development.

7. A Regional Mobility and Logistics Framework Policy (PMRML) established under SICA proposes a shared vision for regional mobility. The PMRML addresses modal elements (maritime, airports, railroads, roads, coordinated border management, and urban logistics), as well as cross-cutting elements (production, trade, and the mobility of people). The Policy was approved by SICA member countries and launched in 2018 as part of the Central American Strategy for Trade Facilitation, and gave priority to coordinated border management. The PMRML aspires to serve as a world-class logistic platform for the movement of cargo and passengers to, from, and within Central America. It recognizes that the region's baseline movement of 450 million tons of cargo and US\$30 billion in exports annually offers a solid foundation upon which to expand. The region's current endowment includes 126,000 km of highway, 264 km of rail, 20 international airports, 34 maritime ports, 19 border crossings, and access to two oceans via the Panama Canal. To achieve its potential, the Plan focuses on reducing logistics costs; efficient harmonization of intraregional logistics; attracting national, regional, and foreign direct investment in infrastructure, and the development and diversification of Central American value chains. Given the preponderant role of agricultural exports within the NCA sub-region, the reductions in costs and the expansion and diversification of market share will depend disproportionately on improvements in agrologistics to fulfill the Plan's vision for Central America.

8. Within the context of the PMRML, each NCA country has developed a National Cargo Logistics Plan (PNLOG) that provides strategic guidance for the development of logistics. As a regional policy framework, the PMRML does not purport to prioritize budget resources for each country. Rather, each government's PNLOG delineates the respective country's investment priorities and processes.⁹⁴ The PNLOGs focus on investment priorities in logistics, organized by main productive sectors, and identify priority logistics corridors as well as

⁹¹ See IICA (2019). The SICA policy document was externally financed under the auspices of a program for the "Promotion of Regional Agribusiness Value Chains and Family Farming inclusion with a Climate Change Approach".

⁹² See Programa de Diálogo Regional Rural (2017).

⁹³ The Protocol of the General Treaty on Central American Economic Integration, better known as the Guatemala Protocol, establishes in articles 28 and 41 that SIECA is the Secretariat of the Sectoral Council of Transport of Central America (COMITRAN), which is constituted by the Infrastructure Ministers of each member country.

⁹⁴ The plans were developed with IDB assistance following a standardized framework.

short, medium, and long-term investment projects. They address upgrades of specific road segments, port issues, border crossings and cargo logistics that would increase efficiency and reduce costs for all sectors. The Secretariat for Central American Economic Integration (SIECA) estimates that, to date, around 10% of the plans have been implemented.

9. El Salvador's PNLOG (2018-2032) seeks to rationalize cargo handling and increase the efficient flow of inputs and outputs, explicitly including the livestock and agriculture sector.⁹⁵ The Plan aims to reduce port congestion by increasing physical capacity and equipment for both bulk and containerized cargo, particularly in the port of Acajutla, as well as improved port coordination with Honduras at Puerto Cortes. It also highlights the cross-cutting issue of crime and security in transit. The Government plans to rationalize port management practices such as the hours and place of reception, as well as the clearance process, to accommodate the distinct requirements of different food and agricultural products, including fish. It highlights the needs of Salvadoran dairy products for refrigerated tanker-trucks and milk and cheese (queso blanco) handling logistics, and producers' needs for timely access to inputs such as vaccines, supplements, feedstuff, and equipment.

10. Two prime drivers of the Guatemalan PNLOG (2015-2030) are investments and practices aimed at reducing bottlenecks in the ports, and measures to improve logistics for high-value horticulture. The PNLOG proposes agricultural centers (agrocentros) in rural staging (acopio) areas, offering a variety of services by inducing small-scale specialized businesses to offer support services such as mobile solar-powered storage, shipment tracking support, phyto-sanitary facilities, certification, third-party logistics (3PL), and pre-clearance brokerage. Port improvements aim to reduce the delays that can currently reach up to twenty days. The plan proposes physical infrastructure investments, improved management, and addressing the varied needs of different agricultural value-chains and their distinct post-harvest handling requirements.

11. The Honduras PNLOG (2015-2030) prioritizes upgrading infrastructure and management, and establishing a network of agro-centers, notably along six geographic productive corridors. The Plan shares many features in common with that of its neighbors, including a focus on efficient and improved port facilities to reduce congestion and time in transit. It focuses its interventions on six corridors or strategic geographic axes across all productive sectors. As in the case of Guatemala, the agro-centers are conceived as hubs to attract private businesses to provide a range of logistic services.

12. A critical policy challenge for all three countries is that customs clearance operations and certification requirements continue to present serious obstacles for importers and exporters alike at border crossings. An integral part of food safety and agricultural trade, sanitary and phytosanitary (SPS) standards are designed to guarantee the safety of all imported products for domestic consumption, as well as the safety and compliance of domestic production and exports with the standards and norms of the destination market. However, customs administrations in the sub-region lack institutional continuity and often fail to comply with standards set by the World Customs Organization and by the Free Trade Facilitation Agreement of the World Trade Organization. Poor technical capacity; outdated paper document processing; a lack of inter-agency coordination; inconsistencies in export laws, regulation and practices, as well as inadequate infrastructure all converge in backlogs of paperwork, duplicated procedures, and additional costs and fees. In addition, sanitary and phytosanitary (SPS) measures to release agri-food produce are poorly administered: high fees and long waits for laboratory analysis required for SPS certificates raise costs and times to export and can reduce the shelf life of produce, while the right to inspect, review, sample, and reject cargo upon arrival is also often used as a non-tariff barrier to importation. Policies and practices with regard to the efficient application of SPS standards, certifications and customs clearances constitute a key priority area for further improvements.

13. Guatemala, El Salvador and especially Honduras made significant progress on trade facilitation in response to the COVID-19 pandemic containment measures (Table 3.1). Agricultural and animal health, food safety and food authorities significantly improved on-line services platforms for requests, issuance and the management of import permits, SPS certificates and product sanitary registration certificates.

⁹⁵ Fioravanti et al. (2019).

Table 3.1: Customs clearance and SPS Present Several Challenges for Importers and Exporters

Country	El Salvador	Guatemala	Honduras
Import permit (working days)	0.1	10	1
Product registration (working days)	10-15	>10	<20
Customs Clearance Challenges	Lack of an overarching food safety, animal and plant health authority creates overlap problems. No pre-clearance or advance ruling programs	Limited inter-agency coordination and inconsistent application of regulatory compliance framework	Inconsistent application of regulatory compliance with local labeling requirements, customs product classification based on basic basket law
SPS Challenges	Inconsistent application of pest detection and fumigation procedures at port	Rule implementation subject to inconsistent regulatory structure, imposing non-technical measures to importers	Limited inspection staffing at Corinto Guatemala-Honduras Customs

Sources: USDA GAIN Guatemala, Honduras and El Salvador Exporter guides and Import Regulation reports 2021

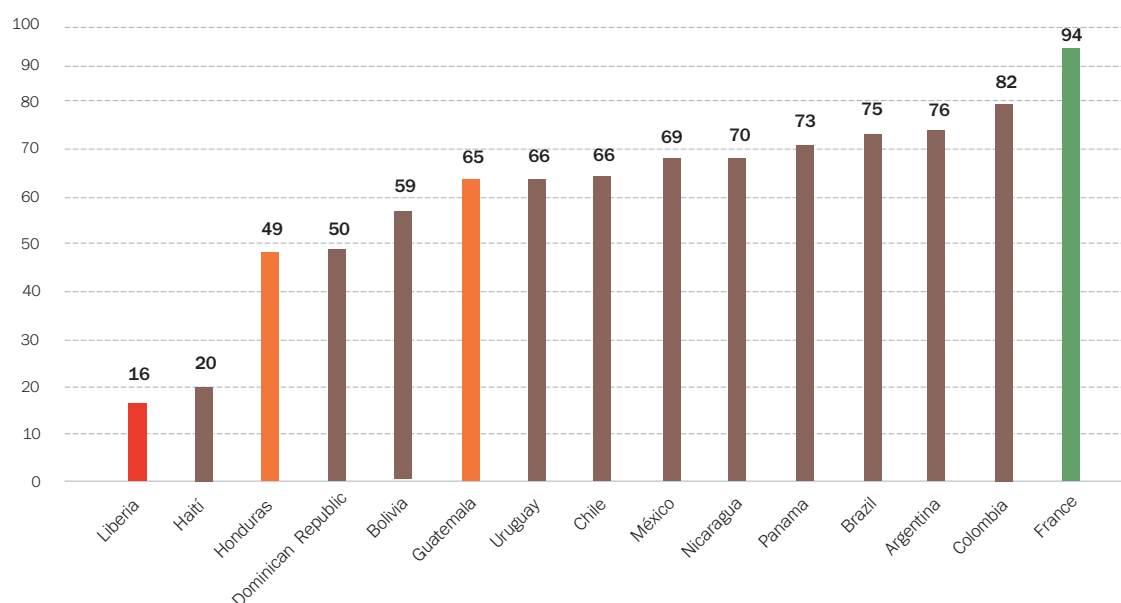
14. Honduras's National Health and Food Safety Service (SENASA) reported a 96% reduction in the time to issue import permits (down to 3-5 hours) that has been confirmed by importers, especially those located outside Tegucigalpa (where SENASA is headquartered). ARSA (Honduras' Food Authority) also reported a significant reduction in the time for issuing Sanitary Registration certificates from six month to one at the standard fee, with an option to obtain it in five working days with an expedited fee. In addition, a single-window and on-line advance clearance program (Single Central American Invoice and Declaration, FYDUCA) at the Honduras-Guatemala border has significantly expedited imports and export of fruits and vegetables, reducing customs delays to less than 10 minutes for products that are not in unified quarantine lists.

15. However, significant challenges remain: a new Central American Technical Regulation (RTCA 67.01.31.07) for sanitary registration is being implemented in 2022 for importing food products that will require companies to comply with more paperwork to enter the local market. Limited agency staffing and hours of operation (6 am to 6 pm, with a one-hour lunch break) still delay custom clearances for many clients. The lack of overarching animal and plant health, and food authorities in Guatemala and El Salvador continues to create overlaps and lack of coordination at customs that augment clearance delays. Moreover, quarantine inspection units at ports and land customs are still understaffed, with personnel having to share duties at more than one post, as is the case of Puerto Cortes and Corinto customs in Honduras. In addition, the inconsistent application of quarantine protocols (especially fumigations) at bulk grain terminals continues to draw frequent complaints from importers.

16. More broadly, the NCA countries face several shortcomings in the overall policy environment for enabling the business of agriculture. This can be seen in relatively low scores not just on agrologistics-related dimensions, but also on low levels of entrepreneurship, especially in agricultural technology (AgTech) and innovative sectors. The Enabling the Business of Agriculture index (EBA), calculated by the World Bank, measures how regulation affects the livelihood of domestic farmers. In particular, the index gauges how government-designed regulations and processes either facilitate or hinder the agricultural activities of domestic farmers. The index provides data on eight quantitative indicators: supplying seed, registering fertilizer, securing water, registering machinery, sustaining livestock, protecting plant health, trading food, and accessing finance. Overall, Honduras has an EBA index value of 49 and Guatemala was rated with an EBA index value of 65,

compared to regional and global maxima of 82 for Colombia and 94 for France.⁹⁶ Within the index components, there are opportunities for knowledge sharing among the NCA countries: for example, Honduras rated strongly relative to Guatemala with regard to the “protecting plant health” subset (80 vs. 50), whereas Guatemala rated more strongly than Honduras with regard to the “trading food” subset (77 vs. 31). The latter subset measures the time and cost to obtain documents to trade agricultural goods, and the quality of the food regulation system. Figure 3.1 shows the overall EBA scores for countries rated in LAC as well as the highest and lowest global ratings. Higher scores correlate with lower poverty rates, better income for farmers, more employment opportunities, and higher food security.

Figure 3.1: Honduras and Guatemala Rank Fairly Low in LAC on Enabling the Business of Agriculture



Source: The World Bank - *Enabling the Business of Agriculture* (2019)

3.2 The Current Status of Public Supports for Agrologistics in the NCA Countries

17. Although public financing for agri-food systems in Northern Central America is generally low, there is ample heterogeneity in the composition of public support for agri-food systems. In particular, the three NCA countries have sharply different balances between expenditures on public goods and services on the one hand, and private sector subventions on the other. El Salvador, with the smallest agricultural sector of the sub-region, provides a higher degree of policy protection to its producers than do its neighbors, while Honduras invests more than either Guatemala or El Salvador in public goods and services that bear directly on agricultural and agrologistic development (Table 3.2). The Producer Support Estimate (PSE) measures the support agricultural producers receive at the farmgate level via trade policy or direct subsidies to private ventures, as a percentage of gross farm receipts. Table 3.2 indicates that El Salvador has a PSE that is double that of Honduras and more than ten times larger than Guatemala, the country with the largest agricultural sector. The General Services

⁹⁶ The World Bank - *Enabling the Business of Agriculture* (2019). Note, within Central America, there is no evaluation for El Salvador or Costa Rica.

Support Estimate (GSSE) measures the share of total public support to the agricultural sector (provided to agricultural producers by taxpayers and consumers as a result of public policies), that takes the form of public financing for research, agricultural health services, infrastructure, marketing and other direct support that is not paid to individual agricultural producers. Table 3.2 points to comparable investment levels in GSSE in El Salvador and Guatemala, with twice as much investment in GSSE in Honduras, and highlights that all three countries invest more than the LAC average in both PSE and GSSE. Table 3.3 indicates that in absolute amounts, Honduras invests almost twice as much as Guatemala and almost three times as much as El Salvador in GSSE. Tracking GSSE across OECD countries for several decades, the consensus has emerged that the return on public investment in GSSE has a disproportionately positive impact on the sector.

18. Within the different GSSE expenditure categories, the three NCA countries dedicate the largest shares of support to R&D and to physical infrastructure, with the latter being particularly prominent in Honduras. To understand the relevance that these policies and public investments hold for agrologistics, it helps to distinguish the functional areas that are targeted by the policies. The OECD methodology provides for a disaggregation of that direct public investment (GSSE) into six subcategories: Agricultural Knowledge & Innovation Systems (GSSEA), or R&D; Inspection & Control (GSSEB) for Phyto-Zoo-Sanitary Protection & Food Safety; Development & Maintenance of Infrastructure (GSSEC); Marketing & Promotion (GSSED); Cost of Stockholding, referring to public storage or costs of destruction of grain or other physical stocks publicly stored; and Miscellaneous (GSSEF). All three countries direct relatively large portions of their GSSE budgets to Knowledge & Innovation, as do the most competitive OECD countries, with positive implications for various Value Chains. At the same time, the absolute values of investments are relatively low when compared to the agricultural GDPs of the three countries, ranging from 1.1% of agricultural GDP in El Salvador to 0.8% in Honduras and just 0.2% in Guatemala. Overall, El Salvador and Honduras dedicate over 2% of agricultural GDP to GSSE, four times more than the proportion for Guatemala, although the latter has the largest agri-food sector. A further outstanding feature of Table 3.3 is the level of Honduran investment in Infrastructure & Maintenance, which is contributing directly to the country's agrologistic endowment. At the same time, the fact that investment in "Cost of Stockholding" receives minimal public investment in Honduras and none in its neighbors reflects the policy of divestment of public storage and handling that formerly crowded out the superior efficiency and transparency of private storage and logistics, even though it can complicate the management of emergency food stocks.

Table 3.2: El Salvador Prioritizes Agricultural Producer Subsidies while Honduras Emphasizes Public Investments in Agri-food Systems

OECD Methodology ⁹⁷	El Salvador	Guatemala	Honduras	LAC Average
Producer Subsidy Estimate (PSE)	26.7%	2.0%	13.5%	6.3%
General Services Support Estimate (GSSE)	6.5%	7.9%	13.6%	2.6%

Source: IDB Agrimonitor data, analyzed in Egas Yerovi and DeSalvo (2018) Note: LAC average excludes Argentina, which is the only country in LAC with a negative PSE.

⁹⁷ See Egas Yerovi and DeSalvo (2018). The OECD developed the methodology to be able to compare direct and indirect public support to diverse agricultural sectors in countries around the world, disentangling the web of policies that makes those calculations challenging. The IDB has continued to apply that methodology to analyze each of the countries in the LAC region over the last two decades under the AGRIMONITOR initiative.

Table 3.3: The NCA Countries Prioritize Public Agricultural Investment in R&D and Infrastructure

Components of GSSE	El Salvador (2017)		Guatemala (2018)		Honduras (2017)	
	US\$ millions	Percent	US\$ millions	Percent	US\$ millions	Percent
GSSEA: Knowledge & Innovation	14.4	53.6%	13.9	37.4%	24.3	36.5%
GSSEB: Inspection & Control	3.9	14.5%	5.7	15.3%	6.1	9.2%
GSSEC: Infrastructure	7.1	26.4%	9.8	26.5%	33.4	50.2%
GSSED: Marketing & Promotion	1.5	5.7%	2.1	5.8%	0.2	0.0%
GSSEE: Stockholding/Storage	0.0	0.0%	0.0	0.0%	2.6	3.9%
GSSEF: Miscellaneous	0.0	0.0%	5.6	15.0%	0.0	0.0%
GSSE: TOTAL	26.9	100.0%	37.1	100.0%	66.6	100.0%

Source: IDB Agrimonitor (Accessed 2022)

3.3 Advances and Limitations in Private Sector Engagements in Agrologistics

19. Private investments by both national and international companies play the leading role in developing NCA agrologistics value chains. Private investment can equal or surpass total public financial outlays in the respective segments of the agrologistics chain. Foreign Direct Investment (FDI) in supermarket chains in recent decades represents the largest and most transformative private investment in agrologistics (see Chapter 2). The increasing importance of supermarket chains in consumer food purchases, and the development of backward linkages from supermarkets to agricultural producers as suppliers, has transformed the Distribution segment of NCA food supply chains over the last twenty years.⁹⁸ Other wholesale buyers sourcing directly from local suppliers include companies engaging in high value exports of coffee or horticulture. While the lion's share of total FDI in Central America has gone to Costa Rica (nearly two-thirds), Guatemala and Honduras have also been capturing around US\$1 billion per year in recent years, prior to the onset of the COVID-19 pandemic, with annual FDI into El Salvador fluctuating but averaging more than US\$500 million (Table 3.4).

20. The FDI has largely targeted the services, manufacturing, hospitals, and utilities sectors, although investments have also poured into two sectors with direct relevance to agrologistics, namely renewable energy and wide-band internet. This is of great importance, because two limitations that cut across entire agri-food value chains in NCA are low levels of ICT connectivity, especially in rural areas, and the related low level of digital applications to agrologistics. Enhanced connectivity in these areas is the sine qua non for significant advances in terms of all GRID dimensions, including boosting incomes, managing price volatility and production risks, and accessibility and inclusion of low-income families.

Table 3.4: Annual FDI in Northern Central America Averaged over US\$2.8 billion prior to the Pandemic

US\$ millions	Guatemala	Honduras	El Salvador	Total
2016	1,185	1,139	348	2,672
2017	1,147	1,186	792	3,125
2018	1,032	1,226	840	3,098
2019	975	947	636	2,558
2020	915	224	201	1,340

Source: ECLAC Annual FDI Reports (2016) through (2020)

⁹⁸ Since its formation in 2010, Walmart de México y Centroamérica has become the largest supermarket chain in Central America, growing from 40 Walmart stores to 838 retail outlets today, with a presence in both cities and small towns across Central America, in addition to over 2500 stores in Mexico.

21. The NCA countries generally lag behind peers in Central America and globally with regard to indicators for digital connectivity.

The share of internet users in Northern Central America in 2020 ranged from 42% in Honduras to 50% in Guatemala and 55% in El Salvador, compared to 64% in Panama and 80% in Costa Rica.⁹⁹ The reasons for limited internet adoption include a lack of digital skills among citizens, limited rollout of more advanced (4G+) technologies, low download and upload speeds, and high prices.¹⁰⁰ While El Salvador has a high rate of cellular subscriptions at 161 per 100 inhabitants as of 2020, the rates are significantly lower in Honduras (70 per 100 inhabitants) and Guatemala (113 per 100 inhabitants), and well below the rates in Panama and Costa Rica (135 and 147 per 100 inhabitants, respectively).¹⁰¹ A study on rural connectivity in Latin America and the Caribbean, conducted jointly by IICA, the IDB and Microsoft, showed that countries such as Honduras have low levels of connectivity particularly in rural areas. The 19.2% connectivity penetration in rural areas of Honduras is almost 27 percentage points less than in urban areas of Honduras (46.2%), is equal to just over half the average rural connectivity rate in LAC (37%), and is almost 24 percentage points lower than connectivity penetration rates in rural areas of Costa Rica (43.2%).¹⁰²

22. Access to finance is also a challenge for actors in the agri-food value chains in Northern Central America.

NCA countries are characterized by access to finance rates that are significantly below the global average, as measured by a ownership of a financial account at a financial institution or with a mobile-money service provider. The penetration rates range from 33% in El Salvador to 46% in Guatemala and 49% in Honduras, compared to the global average of 72%.¹⁰³ On the borrowing side, agri-food actors in NCA also suffer from limited access to credit: for example, less than 4 percent of all bank credit in Honduras flows to agriculture¹⁰⁴ and only 10 percent of the rural population (primarily large agricultural producers and exporters) borrows from a financial institution. Key constraints include smallholders' limited financial and business planning skills, high operational costs to banks, covariant risks, and the lack of a credit history or acceptable collateral, coupled with underdeveloped value-chain finance instruments such as buyer or input-supplier credits or guarantees.

23. Even though connectivity and access to finance remain relatively low, they have been increasing rapidly in Northern Central America in recent years.

For example, the share of internet users has more than tripled in El Salvador since 2010, from 16% to 55%, almost quadrupled in Honduras (from 11% to 42%) and increased almost five-fold in Guatemala (from 11% to 50%). Similarly, the share of the population aged 15 and over with an account at a financial institution has doubled in each of the three NCA countries.¹⁰⁵ Moreover, the establishment of productive alliances has increased the confidence of participating financial institutions in providing financing to transitioning smallholder farmers, thanks to the organization of family farmers into cooperatives, the technical assistance they receive from technical support providers, and the marketing partnerships they establish with commercial partners. Continuing improvements in connectivity and access to finance indicators have the potential to both facilitate and spur important innovations in the agri-food system.

24. Adaptation to the mobility constraints imposed as a result of the COVID-19 pandemic has accelerated the adoption of digital technologies worldwide.

Businesses in NCA have made some progress in digitalizing their operations in areas ranging from pre- and post-harvest processes, logistics, sales, marketing, to payments. An assessment carried out by the IFC, confirmed that businesses in the digital sector are more productive than others. At the same time, entrepreneurship in NCA countries is characterized by significant lags in innovation and in technological adoption rates, as well as by limited capabilities to scale up. For example, in El Salvador

⁹⁹ International Telecommunication Union (ITU) (2022a).

¹⁰⁰ World Bank (2021c).

¹⁰¹ International Telecommunication Union (ITU) (2022b).

¹⁰² IICA-IDB-Microsoft (2020). This research study calculated a Significant Connectivity Index for various countries in Latin America and the Caribbean, that takes a value between 0 and 1, based on a simple average of four indicators: Internet access; equipment; broadband services, and 4G coverage technologies. This is multiplied by 100 to arrive at the percentage of connectivity penetration in the rural, urban and total population.

¹⁰³ The World Bank (2018).

¹⁰⁴ World Economic Forum (2019), The Global Competitiveness Report 2019. Geneva.

¹⁰⁵ Financial account access doubled during 2011-17 for El Salvador from 13.8% to 29.3%, in Guatemala from 22.3% to 43.5% and in Honduras from 20.5% to 42.9%, (see World Bank (2018)).

only 14 percent of formal firms report having introduced innovations in their production process in the past year, compared to a 40 percent in Costa Rica.¹⁰⁶

25. Although the focus is frequently on private capital investments when considering private sector engagement, the private sector is also critically reshaping agrologistics in Northern Central America and beyond through its standard-setting and practices. Transfers of both agronomic and agrologistic technology are often embedded within FDI, impacting production choices, input procurement, post-harvest and handling norms, timing, and modes of shipment. Although this is not always immediately apparent, the recent sea-change in the distribution phase of agrologistics since the onset of the COVID-19 pandemic, with the accelerated deployment of e-commerce and supermarket chains' remote procurement innovations vis à vis producers and suppliers, clearly illustrates this form of embedded logistics technology transfer.¹⁰⁷

26. Contract Farming (CF) in Central America exemplifies a still more formal case of vertical integration of agrologistics value chains, with FDI bundling know-how, inputs, post-harvest assistance, and other logistics support for producers who commit to those contracts. Small-scale Guatemalan horticulture producers participate widely in CF schemes, notably for broccoli, cauliflower, and snow peas. The brokers or representatives of export firms assure that all links from inputs to market flow optimally to meet strict market standards, including the significant portions certified as organic,¹⁰⁸ although for many producers and crops, CF is not a feasible or preferred option.¹⁰⁹

27. Private policies and initiatives are also driving change on cross-cutting GRID themes such as environmental and social standards. As a key value chain involving a very broad geographic and demographic base, the coffee sector has shown leadership regarding policies regarding GRID in the agrologistic chain. ANACAFE, in particular, has formally delineated policies in addition to an Environmental Guide, issued as a Decree, to ensure that coffee meets the demanding standards of global customers.¹¹⁰ Those policies, each with extensive and specific guidelines and background, include: Gender and Social Equity; Labor Policy; Climate Change and Environmental Policy, and Human Rights Policy. These policies have clear spillover potential to the agricultural sector more broadly, given the widespread locations and large number of participants in the coffee value chain.

28. In the horticultural value chain, the dominant supermarket chain has played a similar role, raising the standards for those in the agrologistic chain that choose to work within their system. Best Practices have been enunciated for agricultural producers and other segments of the value chain including handling and transport, with standards established for social inclusion, gender, and respect for labor laws.

29. Noteworthy precedents for private-sector-led improvements and innovation have emerged across the spectrum from post-harvest to distribution. They include the following:

- » Post-Harvest: There is an extensive network of private and public R&D institutions in NCA addressing production and post-harvest improvements, typically working as public-private collaborations to leverage the limited core of public genetic and knowledge resources (see Figure 3.2).¹¹¹

¹⁰⁶ See World Intellectual Property Organization (2021). The Global Innovation Index for 2021 ranks the 132 top performing countries in the world across various categories. The highest ranking countries in LAC were Chile, Mexico, Costa Rica and Brazil.

¹⁰⁷ Reardon et al. (2021).

¹⁰⁸ Méthot et al. (2018).

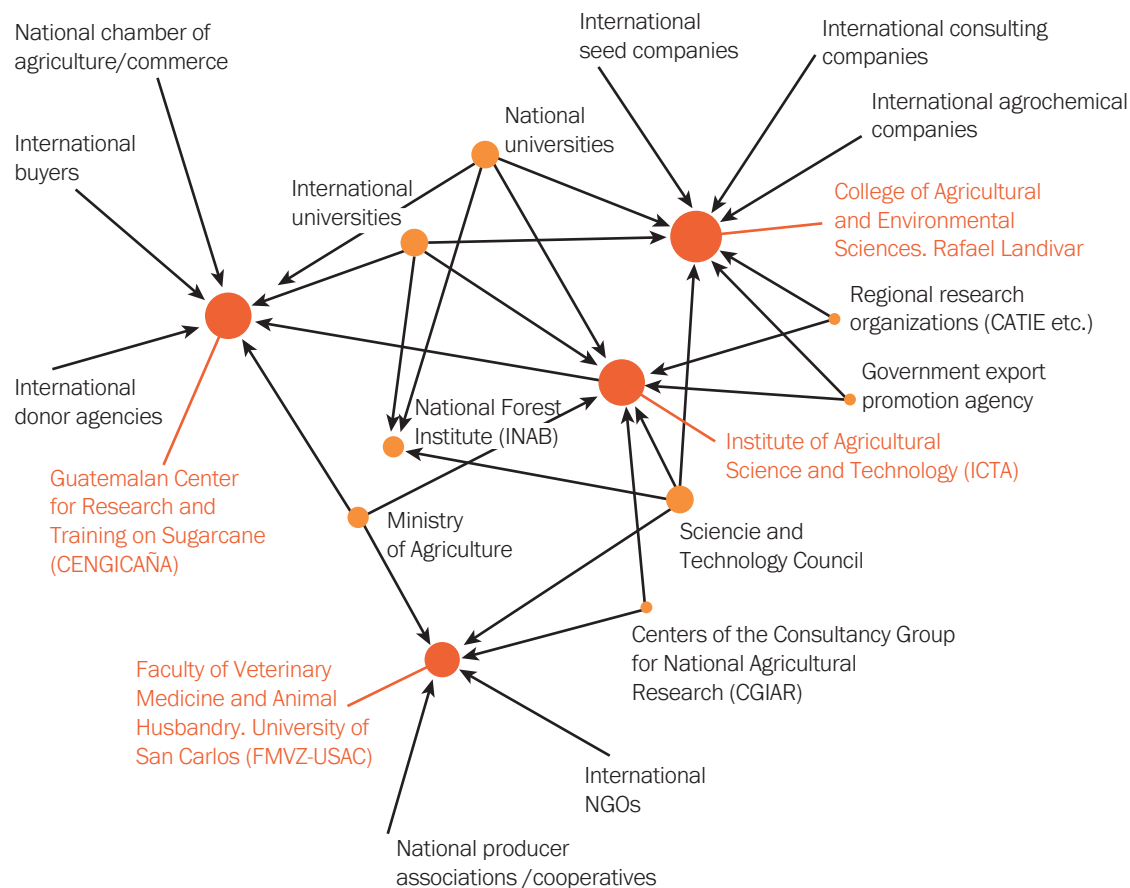
¹⁰⁹ There is a large literature on when CF is feasible and attractive to both suppliers and purchasers. In an effort to come up with a unified theory, Mugwagwa et al. (2018) propose that the analysis of transaction costs is critical.

¹¹⁰ IHCAFE has a global Coffee Policy (Política Cafetelera) and CSC has enunciated a policy for recuperation of the sector in May 2021, although it has not yet formulated its policies in detail.

¹¹¹ There are more than 90 private, public and donor institutions supporting and undertaking agricultural research in Central America. See the comprehensive institutional profile undertaken as part of the Agricultural & Scientific Technology Indicators (ASTI) initiative (Stads et al. (2008)).

- » Storage: Private laboratories are being recognized as trustworthy arbiters of the quality of stored commodities to facilitate agri-trade efficiency. The development of a trusted warehouse receipt system, certifying the grain or coffee inventory held in private storage facilities, while still underdeveloped in NCA countries, offers the potential for establishing collateral recognized by banks.
- » Processing: Solar dryers for coffee, grain and eventually for fruit offer efficiency and resilience gains. Larger-scale private food processing has begun and has considerable potential for expansion and increasing employment and domestic value added.
- » Transport: Digital and remote tracking technologies are gradually expanding, lowering transaction costs, shrinkage and spoilage, while enhancing security in transit.
- » Distribution: Supermarket chains' increased vertical coordination with producers favors the expansion of e-commerce, 3PL and other logistic service providers, and the emergence of cooperatives and mid-scale producers as direct vendors to purchasers of high-value, differentiated products, such as in the coffee and the fresh fruits and vegetables value chains.

Figure 3.2: A Broad Network of Public-Private Institutions is Promoting Innovation in Guatemala



Source: Authors, based on Stads et al., 2008.

3.4 Summary of Findings

30. This chapter has identified a range of challenges and opportunities for further advancement in the enabling environment for agrologistics value chains in Northern Central America. Although agrologistics still lacks visibility in broader national plans, at the regional level, SICA is acting as an important catalyst for strengthening and harmonizing public policies with regard to agrologistics, and its Regional Mobility and Logistics Framework Policy (PMRML) has triggered the preparation of national logistic plans (PNLOGs), although these remain at early stages of implementation. At the level of private and public investment, the most critical challenges include upgrading storage and processing facilities, cold chains, and road infrastructure. At the level of public policy, the most critical policy challenge is that customs clearance operations and certification requirements continue to present serious obstacles for importers and exporters alike at border crossings, even though the emergency conditions surrounding the COVID-19 pandemic have spurred important improvements with regard to the issuance of permits and customs clearances. More broadly, the policy environment is viewed as continuing to have important shortcomings with regard to enabling the business of agriculture. Public investment in agrologistics also remains relatively low, with El Salvador, Guatemala and Honduras taking different approaches with regard to levels of investment and to the composition of direct producer subsidies versus public investments in agri-food systems. Within the public investment domain, all three countries have emphasized publicly funded research and development as well as infrastructure development, rather than inspection, marketing or storage.

31. The Central American PNLOGs represent overarching strategic plans for each country and for Mesoamerican logistic interconnectivity rather than investment programming documents that can be tracked systematically. However, two areas of notable progress include expansion of the regional highway network and modernization of logistic process facilitating trade. Expansion in Guatemala of the Central American Highway (CA-7) connecting the Pacific and the Atlantic reduce costs and travel times for cargo originating in El Salvador and Honduras as well as Guatemala. The modernization of the regulatory framework and simplification of technological processes for logistics in Honduras represents another area of progress following the PNLOG strategic plan.¹¹²

32. Over the past two decades, the private sector has emerged not only as an important source of foreign direct investment but also as a catalyst for rapid transformation of agrologistics, notably via standards-setting and capacity-building backward linkages from supermarkets to suppliers, as well as contract farming. These standards increasingly include environmental and social standards. One area that remains to be developed in the NCA countries is enhanced ICT access and usage, especially in rural areas, in order to transform agrologistics value chains in ways that are greener, more resilient and more inclusive. A range of policy and investment options for public and private actors to strengthen agri-food systems in NCA are presented below in Chapter 5. However, first this study analyzes the state of agrologistics in Northern Central America in greater detail via a deep dive into three critical agri-food value chains in the NCA countries, namely coffee, fresh fruits and vegetables, and basic grains. The results of the deep dives are presented next in Chapter 4.

¹¹² Calatayud and Montes (2021).

Agrologistics for Key Value Chains: A Deep Dive

4.1 A Focus on Key Agri-food Value Chains in Northern Central America

1. This chapter reports the findings from deep dive assessments of agrologistics systems associated with selected value chains (VCs) in the three NCA countries of El Salvador, Guatemala, and Honduras. The analysis focuses on identifying the main characteristics of, and challenges facing, agrologistics systems from the production to retail stages in coffee, fresh fruits and vegetables, and basic grains VCs. These three value chains were selected based on their socio-economic footprint, relevance to family farms, and high potential to modernize and promote green, resilient and inclusive development of agri-food systems in NCA (Table 4.1). The aim of this chapter is to outline structural bottlenecks and missing links along the agrologistics chain, in order to identify policy options and investment opportunities to promote green, resilient, and inclusive development in the value chains under study.

2. The analysis for the deep dives in the coffee, fresh fruits and vegetables, and basic grains value chains draws on rapid appraisal interviews and on secondary data provided by public, private and foreign analysts. Rapid appraisal interviews were conducted with more than 40 representative producers, aggregators, processors, traders, industry representatives, and government officials to collect, update, and validate information on all elements of the deep dives. Secondary data agricultural production and trade were obtained from international and country-level databases, including those maintained by government ministries in the three countries, coffee federations in NCA, and the United Nation's International Trade Statistics Database (COMTRADE), FAO's FAOSTAT database, and analyses by the United States Department of Agriculture (USDA).

3. The three deep dives follow the selected VCs from the farmgate to final sale – on-farm post-harvest, storage and handling, processing, transport, and distribution marketing linkages in order to identify the impacts of agrologistics bottlenecks and inefficiencies on key performance indicators of food loss and quality, GHG emissions, costs associated with transit delays, producer/exporter margins, and consumer/export prices. Each of the three analyses has the same structure. The three deep dives systematically develop a profile of the selected value chains under the following analytical sections:

- » A profile of Production and Trade Flows for the Value Chain in the NCA Countries
- » The Industrial Structure of, and Flows along, the Value Chain
- » Key Stages in the Value Chain from Production to Distribution
- » Post-Harvest Price Margins in the Value Chain
- » Summary of Findings for the Value Chain.

Table 4.1: Coffee, Fresh Fruits & Vegetables, and Basic Grains are Three Important Value Chains in NCA

	Socio-Economic Footprint	Relevance to Family Farms	Modernization and GRID potential
Coffee	<p>Export revenues: Honduras (4th) and Guatemala (14th) rank high in share of global coffee exports; coffee accounts for about half of agriculture exports</p> <p>Inclusion: High employment of women, and opportunities for smallholders in remote mountainous areas to link to global value chains</p>	<p>Geographical spread: Nearly every department in all 3 countries produces coffee; VCs are established</p> <p>Participation by small farmers: Smallholders account for almost all coffee production in Honduras and almost half of producers in El Salvador and Guatemala; three-quarters of coffee producers in Guatemala are organized in cooperatives</p>	<p>Quality premia: Low adoption of innovations and best practices in drying, handling and processing contributes to cost inefficiencies and contamination risks</p> <p>Rural roads: High transit times are a key bottleneck to processing and distribution efficiency</p> <p>Water footprint: Innovations have significant potential for savings in water utilization</p> <p>Adaptation: Climate change is reducing viability of lower elevations</p>
Fresh fruit and vegetables (FFV)	<p>Export revenues: Fresh fruit and vegetables comprise a large share of cross-border trade and global exports to the U.S. and E.U.</p> <p>Nutrition security: Higher FFV consumption would contribute to improving diets of the poor and vulnerable</p>	<p>Income source: Small, dispersed and informally organized family farms comprise the base of relatively organized value chains (e.g. bananas, pineapples, tomatoes)</p>	<p>Supermarkets: Vertical integration with specialized suppliers is growing, to ensure frequency and quality of supply</p> <p>Value addition: FFV feature in exports of prepared foods</p> <p>Food loss: There is major potential to reduce food losses due to agrologistics gaps and inefficiencies (e.g. tomatoes), and related carbon footprints</p>
Basic Grains	<p>Food security: Basic grains are a large share of food consumption and dietary energy</p> <p>Inclusion: Basic grains are culturally significant products, especially among indigenous producers (60% of grain producers in Guatemala)</p>	<p>Subsistence: A large share of basic grains producers in remote areas are subsistence-oriented farmers</p> <p>Income source: Over 1.6 million smallholder farmers produce grains on 30% of agricultural area in El Salvador and Guatemala, 16% of area in Honduras</p>	<p>Commercialization: Higher productivity, storage, and market access can increase competitiveness relative to the large basic grains imports</p> <p>Food loss: High food loss and waste due to agrologistics gaps and inefficiencies (e.g. maize), which, if addressed, would reduce carbon footprints</p>

4.2 Agrologistics in the Coffee Value Chain

4.2.1 A Profile of Coffee Production and Trade Flows in the NCA Countries

4. The coffee value chain plays a preponderant role in Central American rural economies not only because of its contribution to exports and employment, but also because of its fundamental strategic importance for national and household resilience, environmental protection, and social inclusion. As the primary perennial crop in higher elevations, coffee cultivation performs a vital function in watershed maintenance and downstream water availability. As a no-till crop that depends on the maintenance of shade tree cover, the

large number of small-scale coffee plantations play a crucial role in environmental and biodiversity protection. It represents a countervailing force against land and water degradation, with its anti-erosive properties and its consistency with maintaining tree cover and rainforest habitat, mitigating damages from the increased incidence of severe climate events.¹¹³

5. The higher elevation and often more remote zones where coffee flourishes coincide with the areas of Northern Central America with the highest proportions of Indigenous populations and a long tradition of coffee cultivation by smallholder farmers. Moreover, in the absence of mechanized cultivation or harvesting—used for example in Brazil—women play a substantial role in coffee production and in the post-harvest labor force, as they are typically preferred for the visual selection processing for picking, which requires careful selection. In addition, around 20-30% of coffee farms are female-owned.

6. The widespread distribution of growing areas and the more flexible and robust perishability and storage profile of coffee, means that coffee provides farming households with a less volatile financial cushion. This implies greater resilience for a broad swathe of the population in mitigating the impacts of household-level shocks (e.g. to health and food security) and broader shocks (e.g. economic shocks, natural disasters, the COVID-19 pandemic).

7. Honduras is the largest coffee producer in NCA, ranking fourth in the world by global market share of exports. Honduran coffee is almost exclusively produced by smallholder farmers (95% of the country's 120,400 producers are smallholders) cultivating over 420,000 hectares of coffee in 15 out of 18 Departments in Honduras. Valued at US\$1.2 billion, coffee exports accounts for more than half of Honduras' agricultural exports in 2021. Guatemala has the largest number of coffee producers of the three NCA countries (175,000), five times more than the 36,125 producers in El Salvador. Like in Honduras, the majority of coffee farmers in Guatemala (97%) and El Salvador (83%) are categorized as smallholders. The cultivated areas and volumes of production in both countries (0.6 million bags in El Salvador and 3.4 million bags in Guatemala) are significantly lower than in Honduras (5.9 million 60kg bags in 2021). Higher quality varieties of coffee (arabica) predominate in all three countries (Tables 4.2 to 4.4).

Table 4.2: Coffee Producers are Present in Almost All Departments of the NCA Countries

Typology of Farmers	El Salvador	Guatemala	Honduras
Regions of Production	14 of 14 Depts	20 of 22 Depts	15 of 18 Depts
Farmer Families	36,125	175,100	120,400
Farm Size	83% smallholders	97% smallholders; 75% cooperative-affiliated	95% smallholders
Variety of Coffee Grown	98% arabica	96% arabica	100% arabica

Sources: CSC (2022); IHCAFE (2022); ANACAFE (2022); USDA-GAIN (2021)

Table 4.3: Honduras and Guatemala are Major Global Exporters of Coffee

Indicator	Units	El Salvador	Guatemala	Honduras
Production Volume in 2021	Millions of 60kg bags	0.6	3.4	5.9
Export Volume in 2021	Millions of 60kg bags	0.54	3.2	5.8
Export Value in 2021	US\$ million	112	657	1,165
Share of Agricultural Exports	Percent	19%	46%	54%

¹¹³ The cataclysmic impacts of Category 4 Hurricanes Eta and Iota did result in landslides in November 2020 that partially destroyed coffee plantations, although other crops proved more vulnerable to losses.

Indicator	Units	El Salvador	Guatemala	Honduras
Share of Global Coffee Exports	Percent	0.50%	3%	6%
Global Ranking by Market Share	Ranking	N/A	14th	4th

Sources: CSC (2022); IHCAFE (2022); ANACAFE (2022); USDA-GAIN (2021)

8. The highest quality beans come from a series of growing zones in the three countries that fetch a premium in the marketplace (see Table 4.4). The harvest from many prime areas has been formally recognized in recent years via Denomination of Origin (D.O.) certification systems, favoring the marketing differentiation (quasi-branding) of coffee beans according to a series of sought-after characteristics. These D.O. initiatives have been undertaken by the private sector, led by the respective coffee federations in collaboration with producer associations. ANACAFE in Guatemala pioneered the demarcation and typification of distinct coffee organoleptic and other characteristics beginning in the 2000s with support from the Inter-American Development Bank (IDB).¹¹⁴ Although the portion of quality price premia that can be attributed to Denominations of Origin has not been analyzed, it is noteworthy that Guatemala, which spearheaded this approach and has eight D.O. zones, together with other initiatives to develop quality coffees recognized in the marketplace, has the highest average export value at US\$205/60kg bag, compared with \$186 for El Salvador (with six D.O. zones) and US\$160 for Honduras (with only one D.O. zone).

Table 4.4: Honduras has the Largest Cultivated Area under Coffee in Northern Central America

Indicator	El Salvador	Guatemala	Honduras
Altitude Range (m)	500-1500	1300-2000	1100-1600
Area Planted (ha)	152,339	308,217	420,957
Prime Growing Areas	Six “Cordilleras del Café” (D.O.) Zones ¹¹⁵	Eight Denominated (D.O.) Zones ¹¹⁶	Six Distinct Subregions, plus one D.O. ¹¹⁷

Sources: CSC (2022); IHCAFE (2022); ANACAFE (2022); USDA-GAIN (2021)

9. Climate change is leading to changing cultivation patterns for coffee in the NCA countries. Currently coffee is grown at altitudes of 500-1,500 meters above sea level (masl) in El Salvador, 1,300-2,000 masl in Guatemala and 1,100-1,600 masl in Honduras (see Table 4.4). However, lower elevations in NCA are becoming less viable for coffee because of climate change, and agricultural production is shifting toward food crops in those areas. Even those zones that remain hospitable to coffee plantations require adaptations to changes in climatic conditions. Modelling the dynamics of climate change impacts on coffee, utilizing a wide array of scenarios, suggests that a considerable suite of interventions will need to be marshalled if volumes of production and exports are to be maintained.¹¹⁸ “Quality” coffee has typically been grown above 1200 masl,

¹¹⁴ The IDB’s Multilateral Investment Fund financed an early ANACAFE project beginning in 2007.

¹¹⁵ El Salvador: Apaneca – Ilamatepec; 2. El Bálsamo – Quezaltepec; 3. Tecapa – Chinameca; 4. Chichontepec; 5. Cacahuatique; 6. Alotepec – Metapán. See: <http://www.csc.gob.sv/cordilleras/>.

¹¹⁶ Guatemala: 1. Antigua, 2. Acatenango, 3. Atitlán, 4. Cobán, 5. Fraijanes, 6. Huehuetenango, 7. Nuevo Oriente, and 8. San Marcos. See: <https://www.anacafe.org/conozcanos/cafes-de-guatemala/>.

¹¹⁷ Honduras: 1. Copán, 2. Opalaca, 3. Montecillos, 4. Comayagua, 5. El Paraíso, 6. Agalta. In addition Honduras has recognized one D.O., that for Marcala, known by the brand “Honduran Western Coffees”. See: <https://www.ihcafe.hn/regiones-cafeteras/>.

¹¹⁸ See C. Bunn (2019). The CGIAR’s Climate Change, Agriculture and Food Security (CCAFS) program, in conjunction with the Centro Internacional de Agricultura Tropical (CIAT), have identified a suite of 18 intervention areas to support climate adaptation, distinguishing between those that are “incremental”, “systemic”, or “transformative”. The technical areas range from shade management, ground cover, Roya resistant varieties, soil conservation, water-harvesting, irrigation, and a variety of resilient good agricultural practices. More detailed information concerning these 18 intervention areas can be found at <http://toolbox.coffeeandclimate.org/es/>

but there are signs of coffee farms migrating to higher altitudes to sustain the quality as a consequence of warming temperatures. If this tendency becomes more widespread, it could threaten buffer zones in upper reaches of watersheds.¹¹⁹

10. The most important on-farm agronomic factor limiting coffee production in Northern Central America is the now endemic presence of the coffee-rust plant fungus (“Roya”), which is cutting production by as much as half in the worst hit areas. This has implications for the agrologistics of the coffee value chain insofar as the most effective solution is the provision by input suppliers of Roya-resistant germplasm (seed, cutting, grafting) and crop management know-how. Traditional treatments have focused on extensive chemical spraying which precludes certification as organic production and implies forfeiting the related market price premia. The agrologistic challenge for input supply is scaling up the production of roya-resistant planting material, developing an input-supply delivery system that can reach producers across the challenging terrain and remote areas of all coffee-growing areas of the NCA countries, and ensuring that smallholder farmers can access the requisite financing and technical assistance on planting or grafting best practices.

4.2.2 The Industrial Structure of, and Flows along, the Coffee Value Chain

11. Coffee value chains in NCA are characterized by tens of thousands of geographically dispersed small-scale producers who sell primarily to small-scale traders or to cooperatives in which they are members. Most coffee plantations in Guatemala, Honduras and El Salvador are located in remote highlands (over 1,000 masl) which are typically connected to wet coffee millers (“beneficios”), drying and collection centers in municipalities via anywhere from 5-20 km of tertiary dirt roads and trails. The first phase of post-harvest assembly (“acopio”) is linked to the initial processing of coffee beans by producers, or to sales by traders to larger-scale traders or beneficios. Dry parchment coffee (10-12% moisture) then travels hundreds of kilometers via paved rural roads and highways to dry milling facilities for bagging as green coffee. Cooperatives and associations, corporate and family-owned businesses play the leading role in the wet and wet/dry agroindustrial processing of coffee beans. Dry mills have in the past been located close to ports in the Atlantic or Pacific Ocean, but the greater emphasis on quality preservation in recent years has triggered dry-milling investments closer to production areas. Coffee roasting is undertaken by cooperative or private roasters for sale to local retailers, although beans are also exported by private and cooperative exporters to international roasters for sale to overseas retailers (Figure 4.1).

12. The organizational structure of coffee producers is a critical driver of their incomes. Membership of a cooperative can facilitate knowledge transfers; improved access to working capital; sharing of infrastructure such as storage and processing facilities; and better prices on inputs as well as produce. For example, the United States Department of Agriculture (USDA) reports that the average price per 100-pound parchment coffee paid in Quiche, Huehuetenango, and San Marcos to farmers belonging to a cooperative are 10-20% higher than for those operating outside of a cooperative or association (USDA (2021)), thereby capturing a larger share of the value added.

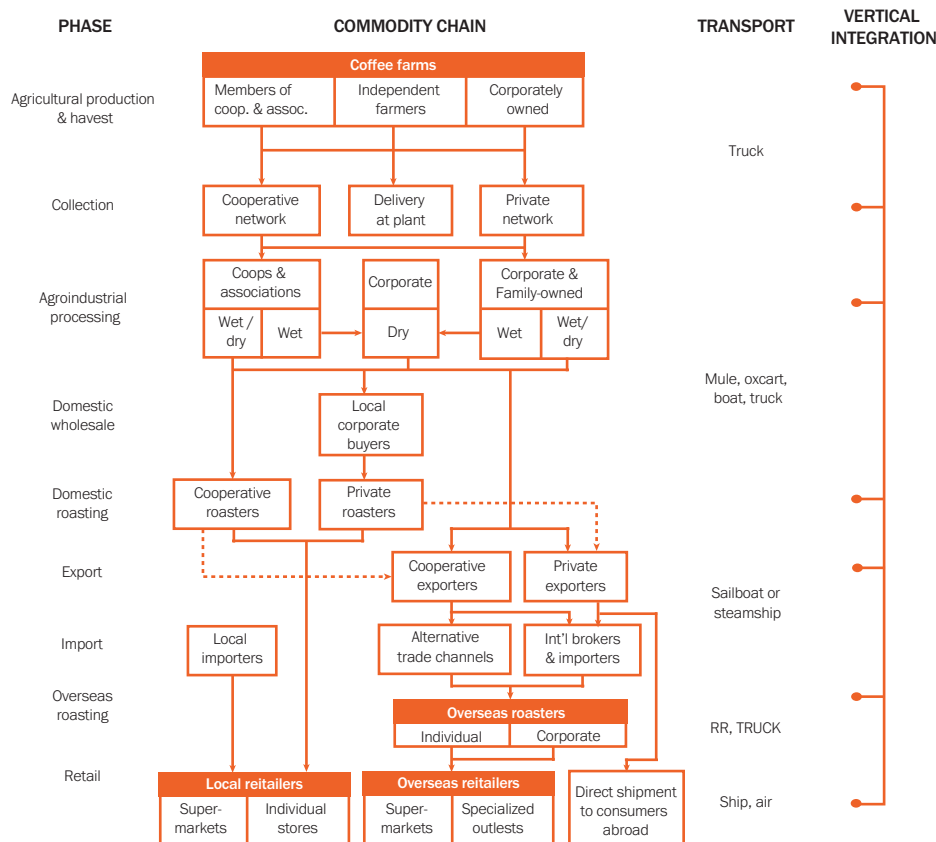
13. A second critical driver of farmers’ incomes relates to capturing market premia. This can be achieved by: (a) product and market differentiation, identifying market niches that offer price premia, and targeting them through production practices; and (b) achieving quality standards that earn price premia. In both cases, maintaining product identity from farm to consumer is an agrologistic challenge, but the substantial price premia this offers is demonstrated by Rainforest Alliance, organic, and fair-trade certifications. Participation in the Cup of Excellence, third-party curated coffee “cupping” or tasting programs in Central America, has proven to offer even more significant price advantages at auction for the very top tier of coffees, but also provide export market recognition that buoys prices more broadly for coffee from the districts where winners emerge. It is noteworthy that the winners of these “blind” taste quality comparisons are typically small-scale

¹¹⁹ See: Fromm (2022) and Blitzer (2019).

producers. When cooperatives pursue certifications such as Rainforest Alliance, Organic, Fair Trade, among others, farmgate prices can increase by an additional US\$6.50-37.50 per 100 pounds. Organic coffee has received a \$23.38 premium per 100-pound bag and additional US\$30.00 premium if Fair Trade certified.

The Federation of Cooperatives of Coffee Producers of Guatemala (FEDECOCAGUA), which comprises 148 cooperatives with around 20,000 members, reported that during the 2020/2021 harvest, their members received a positive differential of up to 5% at the farmgate for parchment coffee, relative to New York international reference prices for green coffee. Farmers associated with FEDECOCAGUA benefit from technical assistance (e.g. for plantation management, certifications, etc.), access to financing, dry-milling and export services.

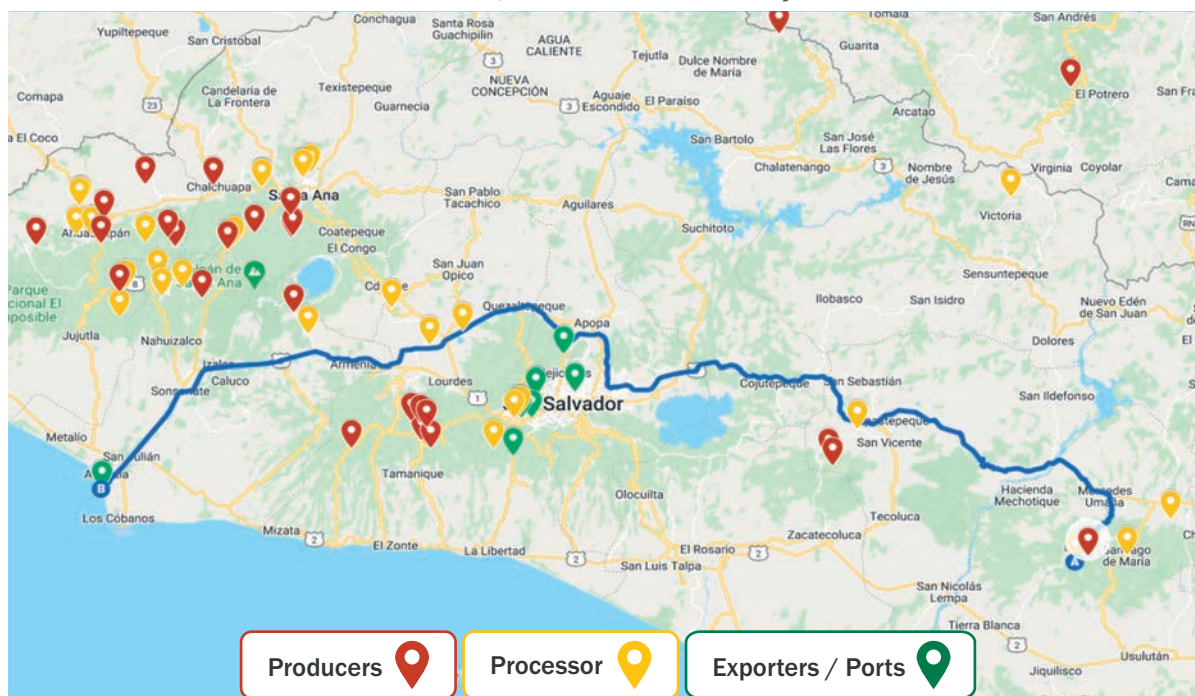
Figure 4.1: Agrologistics Value Chains for Coffee Range from Producers to National or Overseas Retailers



Source: Samper Kutschbach (2019)

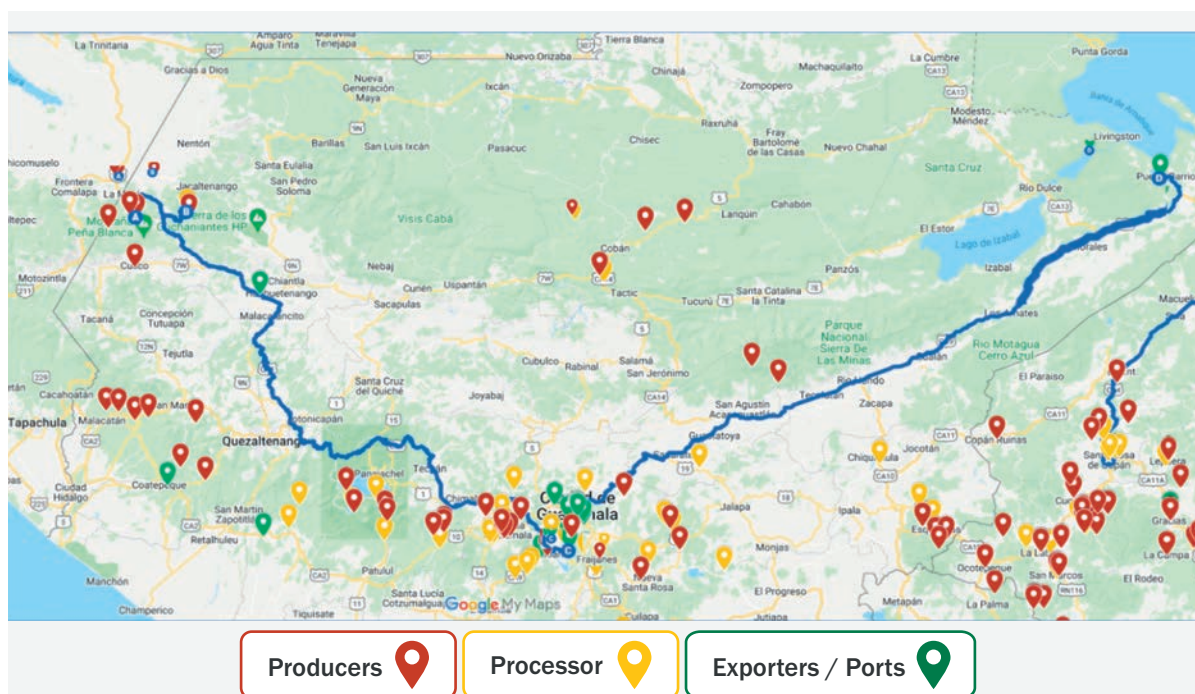
14. Due to the nature of coffee production, the agrologistic distribution of coffee value chains in the NCA countries generally begin at locations over 1,000 masl, with produce transported on tertiary roads to collection and processing centers. The following coffee export logistics maps (Figures 4.2, 4.3 and 4.4) highlight the locations of key coffee infrastructure and establishments in NCA, as well as the principal routes to ports from the coffee growing areas, in the case of El Salvador from from Berlin, Usulután to the port of Acajutla; in the case of Guatemala from El Paraiso, Huehuetanango to Santo Tomas de Castilla, Izabal; and in the case of Honduras from Copán and Intibuca to Puerto Cortes on the Atlantic coast, as well as from Comayagua to San Lorenzo, Valle on the Pacific coast. For example, in Honduras family farmers sell the parchment (hulled) coffee to intermediaries in Copán, who transport and sell it to the exporters for drying into green coffee that is then exported through Puerto Cortés.

Figure 4.2: Agrologistics Mapping of the Coffee Value Chain in El Salvador from Berlin, Usulután to the Port of Acajutla



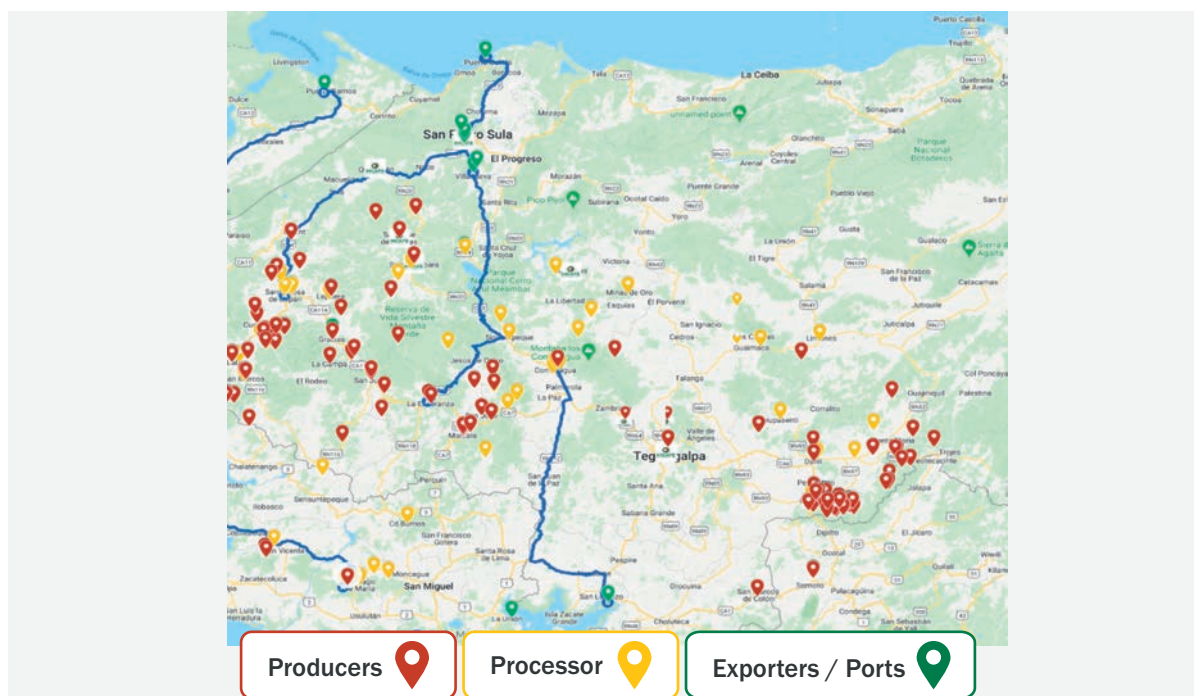
Sources: El Salvador's Consejo Nacional del Cafe; USDA-GAIN (2021); and www.google.com/maps

Figure 4.3: Agrologistics Mapping of the Coffee Value Chain in Guatemala from El Paraiso, Huehuetenango to Santo Tomas de Castilla, Izabal



Sources: USDA-GAIN (2021); and www.google.com/maps

Figure 4.4: Agrologistics Mapping of the Coffee Value Chain in Honduras, from Copan and Intibuca to Puerto Cortes (on the Atlantic coast), and from Comayagua to San Lorenzo, Valle (on the Pacific coast)



Sources: IHCAFE; INVEST-H; ADECAFEH; and www.google.com/maps

15. The Guatemalan coffee value chain that goes from the famous El Injerto coffee plantation in the best positioned D.O. region of Guatemala (the Huehuetenango highlands) to the port of Santo Tomas de Castilla on the Atlantic coast involves a 636 km, 12 hour journey by road (see Figure 4.3). Harvested coffee (cherry/wet parchment) is transported in small pick-up trucks via dirt roads to the closest town (Santo Domingo, at a distance of 9 km, or 29 minutes) for collection and drying. From there, dry parchment coffee is transported by trucks to be dry-milled into green coffee at an exporter facility either in Huehuetenango (69 km or about 2 hours away) or in Guatemala City (at a distance of 330 km or 7 hours) on a two-lane paved highway (CA-1). Green coffee is then transported in 60-69 kg bags on a four-lane highway (CA-9) to Tulumaje (at a distance of 115 km, or 2 hours and 30 minutes) and onward via a two-lane route (CA-9) to the port of Santo Tomas de Castilla (at a distance of 214 km, or 4 hours and 20 minutes) for export to US, Europe and other destinations. Similar coffee farm-to-port export logistics routes can be seen in Figure 4.2 for El Salvador (covering a total distance of 212 km or 4.5 hours) and in Figure 4.4 for the northern value chain in Honduras (covering a total distance of 248 km, or 4.5 hours).

4.2.3 Key Stages in the Coffee Value Chain from Production to Distribution

16. A range of challenges at each stage of the agrologistics value chain (on-farm post-harvest, storage and handling, processing, transport, and distribution) impede green, resilient and inclusive development of coffee in Northern Central America. The analysis is based on interviews conducted between mid-March and mid-April 2022 with key informants identified in El Salvador, Guatemala and Honduras, as well as on a range of secondary sources published by the respective governments, coffee federations and the USDA.¹²⁰ The five stages of the value chain are discussed in turn below.

¹²⁰ Interviews with the informants were guided by a questionnaire covering all links in the coffee chain and informants were assured of anonymity, notably since sensitive price information was shared for the calculation of cost margins.

17. The post-harvest issue that most constrains efficiency and risk-management arises from the predominance of traditional patio coffee drying methods. This time-consuming and labor-intensive process requires daily bagging, unbagging and movement of coffee for a week in the case of washed coffee and for two to three weeks for natural coffee.¹²¹ The process is also subject to the vagaries of weather, contamination and pest damage. Solar drying sheds or tunnels dramatically reduce these risks and the costs associated with time and labor, but even though the innovation is readily available, it is not yet widespread in NCA. This is due to multiple factors including access to finance, as well as the technical skill required to apply the technology: drying coffee too quickly, or at temperatures beyond a recommended threshold, can adversely affect the beans' retention of optimal levels of essential oils for ideal cupping characteristics, so that the calibration of the temperature and humidity in coffee drying tunnels must be managed carefully for best results.¹²²

18. The key challenge in terms of storage and handling is that, once coffee beans are dried to humidity levels that allow for stable storage (9.5-11% humidity range), those levels need to be maintained constant until the beans are processed. Storage facilities and in-storage dryers or humidity controls are particularly expensive for small farmers, who often lack access to more accessible technologies and options. While humidity stabilization and protection from pests make long-term storage feasible and provide flexibility in managing price volatility and securing the best prices, they can also imply the immobilization of a major asset for producers, namely the value of the coffee stored until the product is sold, with implications for working capital requirements. Storage is also undertaken by intermediaries, including collectors or larger farmers with linkages to local and export markets, and by actors in the next step of the value chain, namely processing.

19. The processing of coffee beans involves two main steps: the first step is wet processing and the second step is dry processing. According to the key informants interviewed for this study, wet processing is more widespread among family farmers, or is a service provided by cooperatives. Dry processing is less commonly undertaken by farmers, and is a service provided by exporters (which can include exporting cooperatives). In Honduras, farmers generally apply wet processing before selling the coffee to an intermediary who transports the wet cherries to an exporter who dries them. Guatemalan coffee growers have far higher rates of associativity via cooperatives that offer a blend of wet and dry processing, so that a larger share of Guatemalan coffee is dry processed before further shipment. Dry processing can be achieved with natural sunlight using two different techniques that can take 20 to 40 days, depending on the technique that is used. There are innovations in the form of plastic tunnels that reduce the drying times by 20 to 30 days. However, taste and quality are crucial for specialty coffees, so that innovations in this process need to be tested carefully before adoption. According to our rapid interview assessment, 40% of family farmers in NCA have drying facilities on farms. This point is important, since drying on a farm saves the cost of outsourcing this service, increases farmers' control over the timing/availability of the service, eliminates a transport link from the farm to the drying point, and reduces the total weight of coffee that must be transported to the port and, therefore, the cost of transport.

20. Coffee processing in NCA still uses excessive amounts of water and harmful practices in disposal of water effluent from the washing process, even though technologies exist that could make the process much greener. As much as 40 liters of water is required for each kilogram of washed coffee, while generating toxic effluent known as "aguas mieles". The International Coffee Organization (ICO) recognizes that one of the main problems for some regions is water pollution arising from wet processing.¹²³ Although a low-water-utilization processing technology has existed for more than two decades in South America, it is still not commonly applied in Northern Central America. Colombia's National Center for Coffee Research (CENICAFE)

¹²¹ See Griffin (2006). This was also confirmed in interviews with key informants.

¹²² One interview, conducted on April 6, 2022 with a Salvadoran coffee planter and exporter suggested that the reluctance to use patios can arise from solar drying techniques that compromise the quality of the coffee beans.

¹²³ Perfect Daily Grind (2017, August 3).

pioneered the technology in the mid-1990s, coining the term BECOLSUB,¹²⁴ which involves a fermentation and mucilage removal system (DESLIM) that reduces water usage in the processing from 40 liters to less than one.¹²⁵ Applying the BECOLSUB methodology would involve process changes requiring some training and technical support, as well as the purchase of DESLIM machinery (available for purchase for US\$10,000 or less, depending on scale), and there are models available designed specifically for small-scale producers. Thus, important innovations to promote greener and more inclusive development could usefully be introduced at the processing stage.

21. The transport link in the coffee agrologistics value chain involves significant delays, risks and inefficiencies. Rural roads and truck capacity play a significant role in agrologistics. Rural roads are key to moving cherry beans into the first processing stages for wet/dry processing. In light of the topography of the producing zones, the first transport steps on rural feeder roads involve long transit times even for short distances. For example, it generally takes an hour to transport the coffee 15-17 km in the dry season, well below global standards of 80 km per hour, whereas in the wet season transport costs soar as trucks have to carry reduced loads to cope with treacherous, often flooded roads.¹²⁶ Additional costs and risks are associated with high rates of vehicle damage and high maintenance costs, due to roadway conditions, as well as thefts and vehicle assaults. Even though the use of mobile banking has obviated the need for carrying cash, coffee cargos are still directly targeted in the NCA countries. Interviews with exporters in El Salvador mentioned one case in which there was a safe and shorter alternative 6 km rural road to the 17 km road being used, but that could not be used due to its bad condition. Using the longer road not only drove costs up because of increased distance and transport time, but also because of the need for added security, since trucks needed to be escorted, so that upgrading the shorter road could halve transport cost for producers.

22. Distribution in all three countries is fundamentally about exports, as 90% or more of the production volume in each of the three NCA countries is exported (see Table 4.3). The wholesalers, exporters, and retailers involved in distribution represent the most modern link in the coffee value chain, as their efficiency level is comparable to international benchmarks in the industry beyond NCA. Strengthening backward linkages between distributors and producers presents the greatest opportunities for agrologistic integration, efficiency, and inclusion gains. A key challenge with regard to distribution of coffee is the high cost of bringing coffee from distribution points to the ports. This stage of transportation is provided mainly by the shipping companies, with export coffee exiting the final processing points in sealed containers, and tariffs for containerized cargo freight have increased sharply over the last few years.

4.2.4 Post-Harvest Price Margins in the Coffee Value Chain

23. A breakdown of costs along the agrologistics value chain for Honduran coffee from a vertically integrated cooperative in El Paraíso shows that the farmgate price accounts for 58% of the final exporter price (Figure 4.5).¹²⁷ In contrast, the majority of coffee farmers in the region still sell their wet parchment or

¹²⁴ BECOLSUB refers to a methodology called “Beneficio del Café y Aprovechamiento de los Subproductos”, or benefitting from coffee and the utilization of by-products.

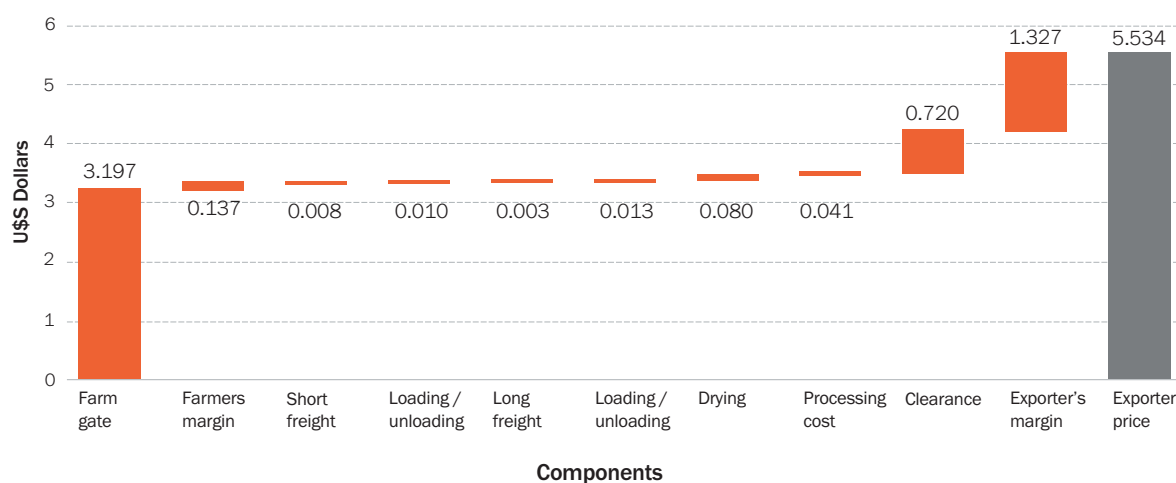
¹²⁵ DESLIM is the abbreviation for Desmucilagador Mecánico, or mechanical demucilation. Roa, G. and Oliveros J.A. et al. (2010) provides an extensive review of 14 years of work using this approach, and University of Los Andes (2011) provides a summary review of the technique.

¹²⁶ Deficiencies in road infrastructure were consistently reported as significant contributors to costs in interviews with coffee industry respondents. The owner of a coffee plantation in El Salvador located 15 km away from the beneficio Los Pirineos, Berlin, Usulután confirmed without prompting that the trip takes over an hour and advised not to be fooled by short distances, even more so during the rainy season. According to El Salvador's the the National Plan of Logistics, average transit speeds on roads is 17km per hour for the entire road network, due to topography, road quality and road congestion. Similar findings were reported in interviews for Honduras and Guatemala, (and compare with international standards of 80km per hour). For example, in Honduras, production zones that are further away from Villanueva and Puerto Cortés result in transit times of 7 to 8 hours before the cherries reach the threshing plants.

¹²⁷ As a vertically integrated cooperative, El Paraíso was selected for this value chain analysis as its agrologistics costs are likely to represent a

even wet cherry coffee to intermediaries and generally get paid 10-20% less, and at times up to 30% less, at the farmgate, according to farmers and experts interviewed. The proportion received at the farmgate by the El Paraíso cooperative is substantially higher than the farmgate price/final price ratio for fresh fruits and vegetables but lower than the farmgate price/final price ratio for basic grains (see the next two sections of this chapter on the respective value chains). The analysis below illustrates the various costs and margins along the value chain for coffee exporters from El Paraíso, based on interviews with Honduran producers. The El Paraíso production zone comprises 20,000 producers with a highly dualistic structure: while 30% of them produce 2,300 kg or more of coffee, the remaining 70% produce less than 2,300 kg per year. Wet processing is done by the producers, whereas dry processing services are provided by the local cooperative in El Paraíso to 16,500 of the 20,000 producers, before the processed beans are transported to the main Honduran export hub of Puerto Cortés. Agrologistics costs from the farm to the port include short and long freight, loading and unloading at the cooperative and at the port, and all the fees included in the category “clearance” in the figure, i.e. fees for custom clearance, border crossing, port fees and IHCAFE (National Institute of Coffee) permit and registration fees, certificates of origin, phytosanitary certificates, export permits, security costs from the cooperative to the port, and handling. Taken together, all agrologistics costs (excluding the exporter’s margin) represent 14% of the export price (15% if the drying service is included in the logistic costs, and 40% if the exporter’s margin is included, as there is 2% margin that farmers recover beyond the farmgate price).

Figure 4.5: Agrologistics Account for 40% of Export Prices for Coffee Produced by a Vertically Integrated Cooperative in El Paraíso, Honduras



Source: Authors, based on interviews.

24. It is noteworthy that these proportions are different for Guatemala: an analysis of the structure of post-harvest price margins in Guatemala indicates that only 38% of the price of coffee for export derives from on-farm production costs, while 62% relates to the costs of processing from coffee bean “cherries” to final green beans ready for roasting.¹²⁸ The proportions accruing to farmers also differ in Guatemala according to the production arrangements: data for several regions of Guatemala indicate that the three-quarters of coffee growers who are coop-affiliated receive prices that are 10% to 18% higher through their cooperatives than they would receive in local markets.¹²⁹ In this sense, association appears to be instrumental for producers to obtain

conservative lower bound for other cooperatives in the sector.

¹²⁸ United States Department of Agriculture, Global Agricultural Information Network (USDA-GAIN) (2020).

¹²⁹ Information from Guatemalan coffee growers federation (FEDECOCAGUA), as reported in USDA-GAIN (2021).

more favorable prices and conditions. Interviews in El Salvador also suggest that, while intermediaries play an important role in the coffee value chain, the costs charged by intermediaries and local millers to prepare coffee as export-ready green coffee lack transparency and oftentimes appear excessive, and that more efficient agro-logistics in the coffee value chain could significantly reduce costs for producers and value-chain actors. Several Interviewees mentioned that intermediaries will discount based on humidity, quality and sometimes a biased scale weighting concepts, with these items measured in an informal way. Figure 4.5 breaks down the cost structure and price margins for the Honduran coffee agrologistics value chain. The cost structure in this case reflects a group of organized producers, with transport and processing handled directly as a service provided by the cooperative. Consequently, this group of farmers sees two benefits: first, a higher farm gate price for a kilogram of coffee, and second, logistics cost savings of 15% of the exporters' price. Furthermore, the collector assures the quality for the target market. Less organized producers will incur higher transport and logistics costs since they must rely on intermediaries for critical steps in the value chain. Interviews indicated that these costs could increase by around 30 to 40%, due to dependence on other actors in the commercialization process.

25. Product losses result in an important cost that is not captured in the above costs and margins, which refer to produce that is actually sold for export. On average, 15% of total production does not meet export quality standards, or is lost during transportation or processing.¹³⁰ Applying this standard loss rate to the volume of coffee exported annually by El Salvador yields economic losses equivalent to US\$16.8 million attributable to agro-logistics gaps each year.

26. Environmental and climate-change related costs are also not captured in the above cost breakdown for the agrologistics of the coffee value chains. While costs associated with the carbon footprints could not be calculated, there are major costs in the post-harvest value chain associated with excessive water utilization and toxic runoffs in processing coffee cherries. While the economic value of the potential savings has not been calculated, just reducing the 15% production loss would cut wastage of water by up to 4 liters per kg of exported coffee, while the universal application of low-water-utilization technologies could eliminate the need for more than 90% of the water used in processing the 9.9 million 60 kg bags of coffee produced annually in the NCA countries, i.e., almost 360 million liters of water.

27. Over the past decade, a range of studies have attempted to quantify the GHG emissions generated and water utilized during processing by the coffee value chain. One of the most recent studies drew its data from coffee producers in Brazil, Colombia, Nicaragua, and Honduras, while using data from Finland on the distribution and consumption end of the chain.¹³¹ The study concludes that, while the values vary between countries, scale, and types of production, in general production accounts for most of the GHG impact. For example, Nicaraguan coffee plantation were found to produce an estimated 5.2 tCO₂e per hectare per year, whereas in Honduras the figure was 3.1 tCO₂e per hectare per year. The lion's share of production emissions resulted from land use changes. Comparing the magnitude of GHG attributed to the consumption side of the change presents challenges, since the units are measured in kilograms of CO₂e per liter of coffee consumed, but the study estimated that the carbon footprint varied between one-fifth and one-half of the total GHG in the coffee value chain. Water utilization was assessed in terms of its contribution to water scarcity, rather than via a volumetric estimate. In Central America, where irrigation is not common in coffee production, the impact on water was estimated at 0.02 m³ per liter of coffee, which is well below the figure for Brazil, where irrigation is common.

28. Since the study focused on medium-scale Central American coffee plantations, the Central American GHG emissions, while low by South American standards, would be even lower for smallholder farmers. This is because land use impacts are greater for producers who apply higher average amounts of fertilizer, yet the

¹³⁰ This loss rate of 15% is based on interviews with key informants in El Salvador

¹³¹ Usua et al. (2020).

smallest producers have low levels of fertilizer application as well as low utilization of irrigation. Producers who qualify as organic, pesticide-free, and shade tree coffee producers reduce their emissions even further. The study,¹³² and others like it, explicitly exclude estimates of the amount of water utilized in coffee milling, which is precisely where the greatest potential gains in terms of water conservation and effluent reduction lie, and which should be targeted to increase green production.

29. Additional research will be required to estimate realistic levels of adoption of water-saving techniques across the NCA countries and to project the volume of water that can be saved. One NGO financed by the IDB in Nicaragua conducted “Blue Harvest” trials using water recycling technologies in six locations. These trials demonstrated average water-use savings of 70%, with results reaching up to 92% savings in the best case and brought net water utilization down to less than one liter per kilogram of coffee milled.¹³³ Incorporating the BECOLSUB technologies previously described would further increase water savings significantly and reduce the coffee value chain’s contribution to water scarcity.

4.3 Agrologistics for Fresh Fruits and Vegetables

4.3.1 A Profile of Fresh Fruits and Vegetables Production and Trade Flows in the NCA Countries

30. The horticulture value chains in Northern Central America have significant potential to contribute to the development of a greener, more resilient, and more equitable agri-food system. Key products in the fruits and vegetables value chains include bananas, melons, pineapples, oranges, tomatoes, avocados, coconuts and mangos, as well as a range of fresh vegetables, including peppers and cabbages.¹³⁴ Although production volumes, areas planted and numbers of farmers in fresh fruits and vegetables (FFV) value chains are significantly smaller than the corresponding numbers for maize and beans value chains (see the deep dive on the basic grains value chains below), the FFV value chains are of great importance not only for domestic diets but also in the cases of Guatemala and Honduras, for export revenues. At the same time, production is dominated by smallholder farmers with low levels of technology and associativity, which has hampered improvements in both the quantity and quality of FFV production.

Table 4.5: Guatemala is the Largest Producer of Fresh Fruits and Vegetables in Northern Central America

	Units	El Salvador	Guatemala	Honduras
Horticulture Production in 2020	tons	483,264	7,962,691	1,913,780
Gross Production Value in 2020	current US\$’000	146,834,000	N/A	368,512,000
Extension of Production	hectares	32,775	288,344	60,723

Sources: FAOSTAT (2020) for volumes and FAOSTAT (2018) for estimated production values

31. All three NCA countries have experienced increases in productivity in FFV value chains over the past decade, which could point to advances in green development, although for both El Salvador and Honduras this has been the result of production volumes declining less rapidly than areas cultivated.¹³⁵ In 2020, 483,264 tons of fresh fruits and vegetables were produced in El Salvador on 32,775 ha of land, representing a decline of 14% in production and a 17% decline in area planted over the past decade (Table 4.5). In the case

¹³² Usua et al. (2020).

¹³³ Catholic Relief Services (2018).

¹³⁴ This deep dive considers fruits and vegetables as the main horticulture crops. Beans and maize, which are included in the deep dive for basic grains value chains below, are excluded from consideration in this review.

¹³⁵ The data on production and areas cultivated are drawn from FAOSTAT (2010) and FAOSTAT (2020).

of Honduras, 1,913,780 tons of FFV were produced on 60,723 ha of land, corresponding to a 9% decline in production and a 31% decline in area planted over the past decade. The increased productivity is attributable in part to a change in the mix of FFV produced, most likely due to the loss of competitive advantages in some products (e.g., tomatoes, bananas, and mangoes), forcing producers to switch to other fruits and vegetables (including melons, pumpkins, lemons, and peppers). The situation is very different for Guatemala, where the area cultivated has risen over the past decade to 288,344 ha while production has risen three times faster (by 53%) to 7,962,691 tons in 2020.

32. Guatemala is the dominant producer of fresh fruits and vegetables in Northern Central America.

The main fruit and vegetables produced in 2020 were bananas (4,476,680 tons), melons (655,712 tons), pineapples (360,964 tons), tomatoes (337,875 tons), fresh vegetables (154,328 tons), and avocados (137,024 tons). Most of its production is in the north-west, north, and center part of the country, the latter region, and especially the departments of Chimaltenango, Sololá, and Sacatepéquez are the main producing areas of vegetables for exports such as French beans, peas, broccoli, mini carrots and zucchini, among others. Honduras is the second largest producer of FFV among the three NCA countries. The main fresh fruits and vegetables produced include bananas (585,929 tons), melons (308,788 tons), oranges (267,360 tons), cabbages (84,742 tons), and tomatoes (81,580 tons), which are produced in the departments of Choluteca, Comayagua, Olancho, Francisco Morazán, Ocotepeque, Copán, El Paraíso, La Paz, and Santa Bárbara. In the case of El Salvador, Coconut (76,501 tons), mangoes (50,357 tons), and watermelons (49,077 tons) are the main fruits produced, followed by avocados (40,992 tons) and fresh vegetables (30,169 tons), with production mainly in the departments of Chalatenango, La Libertad, and La Paz (see Table 4.6 and Figure 4.6).

Table 4.6: Fresh Fruits and Vegetables Production in NCA is Dominated by Smallholder Farmers

	El Salvador	Guatemala	Honduras
Regions of Production	14 of 14 Depts, mainly in the departments of Chalatenango, La Libertad, and La Paz ¹³⁶	Chimaltenango, Sacatepequez, and Sololá ¹³⁷	Choluteca, Comayagua, Olancho, Francisco Morazán, Ocotepeque, Copán, El Paraíso, La Paz, and Santa Bárbara
Farmer Families	According to the 2007 census, there were 395,588 agricultural producers, although the number producing horticulture is unclear	According to the 2004 census, there were 822,188 agricultural producers, although the number producing horticulture is unclear	According to an independent study, there were 18,000 families dedicated to horticulture in 2019. ¹³⁸
Type	18% commercial 82% subsistence	Accurate data not available, but predominantly subsistence	72% semi-subsistence farmers ¹³⁹

Source: Gobierno de El Salvador (2007); Gobierno de Guatemala (2004); Honduras: Secretaría de Agricultura (2022)

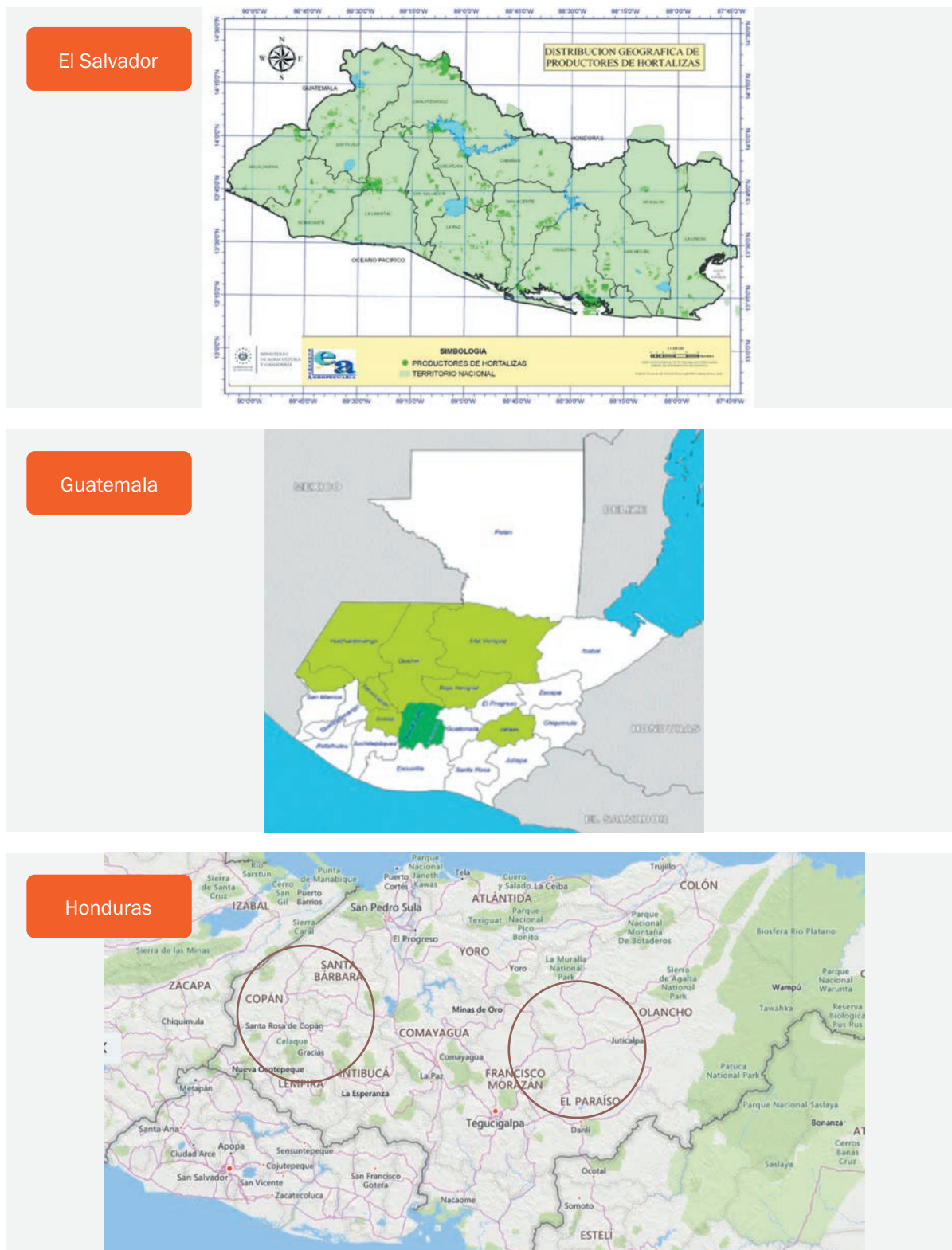
¹³⁶ Gobierno de El Salvador (2007).

¹³⁷ These areas have become a sort of Cluster of the vegetable VC, given appropriate climate and soil conditions, the existence of infrastructure and transportation, and proximity to the main shipping ports, whether by air or sea.

¹³⁸ The last National Agriculture Census was in 1993.

¹³⁹ World Bank (2019b).

Figure 4.6: A Mapping of Key Horticulture Production Areas in Northern Central America



Sources: El Salvador: Ministry of Agriculture (2021); Guatemala: MINECO (2015); Honduras: Secretaria de Agricultura (2022)

33. Whereas El Salvador is a major importer of fresh fruits and vegetables, Guatemala and Honduras are major exporters of FFV. In 2020, FFV exports in El Salvador amounted to just 0.5% of production and 0.2% of total agriculture exports.¹⁴⁰ The volume and value of FFV exports decreased by 63% and 7%, respectively, over the past 5 years, with fresh vegetables, chillies and exports constituting the primary FFV exports, typically with some level of value added, with the USA, Guatemala and Honduras as the key overseas markets.¹⁴¹ At the same time, Salvadoran imports of FFV greatly exceed domestic production in 2020 (by 32%, see Table 4.7). That year El Salvador imported 116,871 tons of fruits and vegetables from Honduras and 393,534 tones from Guatemala, amounting, respectively, to 18% and almost 62% of the country's total fruit and vegetable imports. By contrast, Guatemala exported almost half of the volume of fresh fruits and vegetables produced in 2020, with these exports representing 46% of Guatemala's total exports that year.¹⁴² The FFV export volume in 2020 was 19% higher than in 2015, although the value decreased by 23%. Key exports by volume included bananas, melon, plantain, watermelon, fresh or chilled green peas and French beans, with the USA, El Salvador and the Netherlands as important markets. Guatemala also exports horticultural products within CAFTA with some level of value added, including preparations for soups, stews and sauces. Guatemalan imports of FFV were negligible in 2020 relative to domestic production (1.4%). In the case of Honduras, FFV exports were equivalent to 45% of total agricultural exports and 59% of domestic production in 2020.¹⁴³ While the volume of FFV exports has declined by 3% over the past 5 years, the value has increased by almost 45% (Table 4.7). Important FFV exports include fresh or chilled vegetables and bell peppers, with the USA, El Salvador, and Canada as key destinations. FFV imports in Honduras in 2020 were equivalent to less than 10% of the volume of domestic production, sourced primarily from Guatemala (47,546 tons, equal to 25% of total FFV imports).

Table 4.7: Guatemala and Honduras are Major Exporters of Fresh Fruits and Vegetables

Country	Units	El Salvador	Guatemala	Honduras
Horticulture Production in 2020	tons	483,264	7,962,691	1,913,780
Export Volume in 2020	tons	2,402	3,794,204	1,131,876
Export Value in 2020	US\$'000	\$5,234	\$1,467,952	\$595,321
Export variation 2015-2020	tons	-62.3%	19.0%	-3.0%
Exports / Production by Volume	Percent	0.5%	47.6%	59.1%
Imports Volume in 2020	tons	635,802	111,487	186,620
Imports Value in 2020	US\$'000	\$149,392	\$72,508	\$78,523
Imports variation 2015-2020	tons	14.5%	43.4%	46.6%
Imports / Production by Volume	Percent	131.6%	1.4%	9.8%
Representative value of each country in total fruit and vegetable exports worldwide.	Percent	0.005%	1.30%	0.53%

Source: Authors, based on FAOSTAT, 2020.

4.3.2 The Industrial Structure of, and Flows along, Fresh Fruits and Vegetables Value Chains

34. The market structure of FFV value chains in NCA countries is characterized by a large number of atomized, informal and undercapitalized family farms, and by a limited number of companies that provide post-harvest storage and handling, processing, transformation and packaging. Although participation in cooperatives can make a major difference for producers (see Box 4.1 on the success of the 4Pinos Cooperative in Guatemala), only a relatively small share of smallholder producers are associated in cooperatives or have

¹⁴⁰ FAOSTAT (2020).

¹⁴¹ FAO (2021b).

¹⁴² FAOSTAT (2020).

¹⁴³ FAOSTAT (2020).

direct sales linkages to specific retailers or exporters (along the lines of more mature economies where key agents such as supermarkets ensure strong interlinkages from production and processing to distribution). The majority of FFV-producing family farms in the NCA countries sell their produce to intermediaries who pay them for the harvest of the day.¹⁴⁴

Box 4.1: The 4 Pinos Cooperative: A Success Story in the Horticulture Value Chain in Guatemala

The Integral Agricultural Cooperative “Unión de 4 Pinos” R. L. was founded in 1979 with the main purpose of supporting productive activities and social development for small producers in the country’s highlands. Its objective is to increase the economic incomes of peasant families through a process of agricultural reconversion, i.e. changing from traditional subsistence agriculture to high-value agriculture with intensive use of labor.

After 30 years of work, the Cuatro Pinos Cooperative is recognized nationally and internationally for its achievements in improving the quality of life of its producers and collaborators. Its membership currently reaches 560 associate-owners, all Mayan-Kakchikel and 4,200 producers organized in more than 120 groups distributed in 14 departments across the country. The company has a total of 1,200 employees, of whom 90% are women.

Originally, the Integral Agricultural Cooperative “Unión de 4 Pinos” R. L. was founded by male farmers and women did not participate officially as members of the cooperative. However, in 2002 a group of 35 female farmers, who were already supplying the men’s COOPERATIVA 4 PINOS with baby vegetables,¹⁴⁵ decided to join the cooperative. However, right from the start they encountered difficulties with the men’s cooperative, which imposed an admissions policy that accepted only female relatives of male members (spouses, daughters, or granddaughters) as providers. Therefore, in 2010 the women decided to create their own cooperative to gain more independence and autonomy. This is how the “Cooperativa Integral Agrícola Mujeres 4 Pinos” was created.

The Women Cooperative 4 Pinos is the first organization in Guatemala that has reached export levels of quality and production as a women’s agricultural cooperative. It is in the municipality of Santiago, in Sacatepéquez, and is made up of 525 members and 35 non-member suppliers and generates around 150 jobs for women. The Cooperative includes a processing and packaging plant, an irrigation project, training, agricultural technology, certification, commercial promotion at international fairs, as well as health programs, education (primary and secondary education, as well as diplomas in gender), and nutrition programs (including weight control and supplements for feeding boys and girls).

Additionally, in 2011 the cooperative joined AGEXPORT’s Business Linkage Programme (BLP).¹⁴⁶ Through the BLP they support access to markets for groups of micro, small, and medium scale producers in different regions of the country.

¹⁴⁴ Sanders, A. (2019). There is a trend towards increasing vertical integration between supermarkets and specialized suppliers of horticulture products, designed to ensure a regular supply of quality produce. This integration is mostly via formal contracts between agribusinesses and local smallholder producers or producer organizations who receive training in agriculture practices to ensure quality standards are met.

¹⁴⁵ French bean, yellow bean, blue lake bean, mini carrot, Chinese pea, sweet pea, creole pea, green zucchini, yellow patty pan, green patty pan, corn, and radicchio.

¹⁴⁶ AGEXPORT is the biggest association of exporters in Guatemala and one of the main implementing partners of the AL INVEST IV programme in Central America.

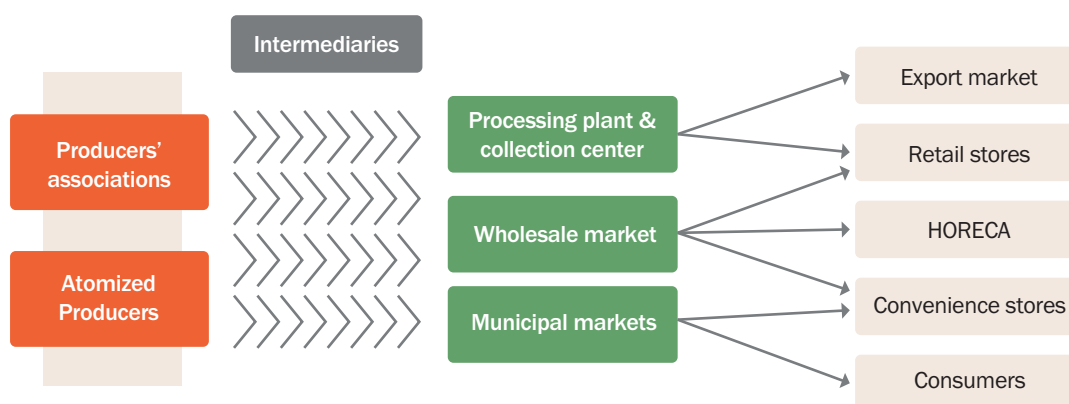
The aim is to create long-term alliances between small entrepreneurs and producers on the one hand with national and international buyers on the other.

The lives of the cooperative's members have changed significantly. Their incomes have increased substantially. This in turn has triggered other changes, such as their empowerment as farmers and as individuals (with increased awareness of women's rights). The cooperative has contributed to the welfare of the women members, their families and their communities in different fields, such as education, health, nutrition and hygiene. It has also prevented emigration and has helped to keep families together. Finally, it has had an impact on literacy, as one of the requirements to join the cooperative is to engage in their literacy programme. Moreover, literacy is essential to develop the daily tasks in this new context, including written controls for chemical applications, management, among others.

35. Intermediaries play a key role in grouping, gathering and shipping produce to wholesale markets, processing plants (e.g. in Chimaltenango and Sacatepequez in Guatemala) or to larger retailers (e.g. supermarket chains) in urban centers (Figure 4.7). The central markets in NCA generally offer services such as washing, packing, and grading, and limited cold chain storage for FFV. Although these services provide opportunities for price differentiation due to better quality, they also imply an additional cost for producers. Therefore, their use is limited to more commercially oriented producers, who sell their products to local retailers, convenience stores, the HORECA sector (hotels, restaurants, and catering), and/or neighboring countries. For imported FFV, major importers process imports through the main ports (by air or sea) and channel them to large retailers (supermarkets) and wholesalers for distribution to retailers.

At the retail end of the value chain, commercialization is still relatively atomized: although supermarkets are becoming more important players, they still supply less than 30% of consumers in the NCA countries, notably those in urban areas with higher incomes.

Figure 4.7: Common Market Structures for Horticulture in NCA Countries



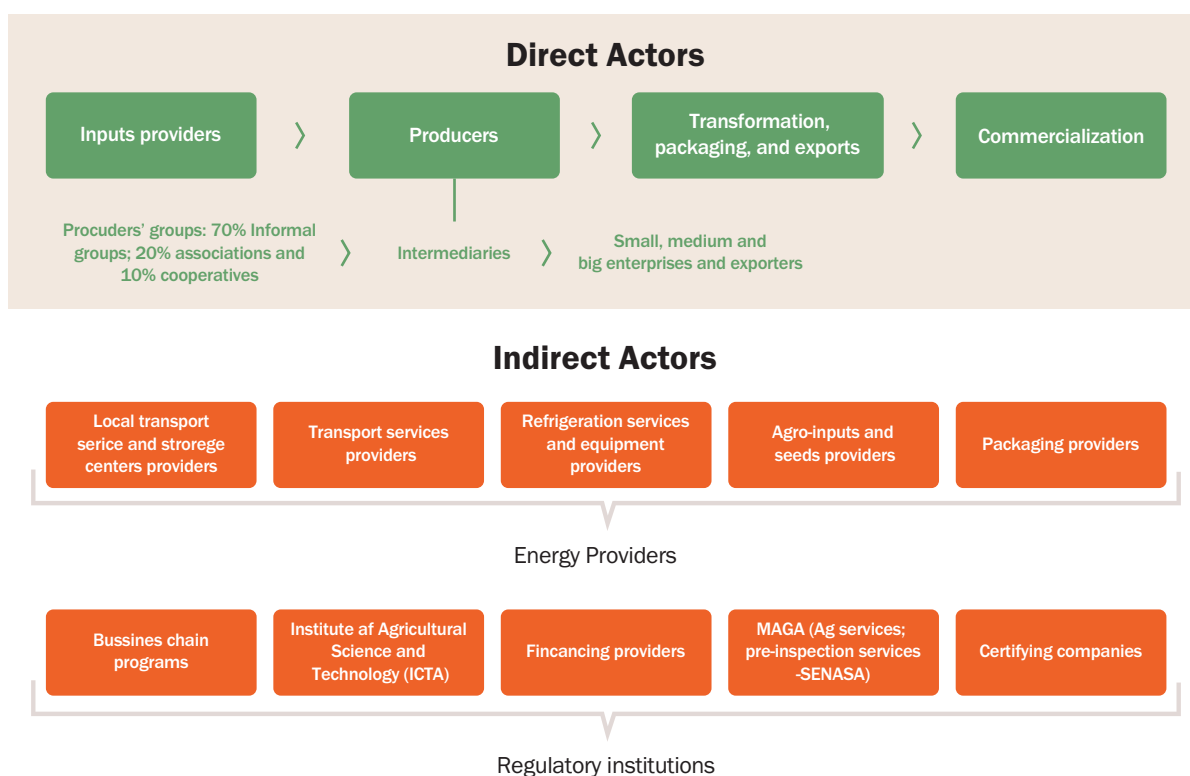
Source: Authors.

36. A more detailed value chain analysis for Guatemala shows the full range of actors directly and indirectly involved in fresh fruits and vegetables value chains. The direct value chain extends from input providers to producers to processing, transformation and packaging links before commercialization. Where associativity is

higher among small producers and there is no processing, linkages can be established through intermediaries or directly to various sizes of retailers and exporters at the distribution stage of the value chain. These linkages are underpinned by research and extension agencies, regulatory agencies, standards setters (of quality and phytosanitary standards), financiers, as well as by energy suppliers that support transportation, refrigeration and other service providers that in turn support the value chain (see Figure 4.8 below).

37. Fresh fruit and vegetable value chains often extend beyond international borders. For example, a large volume of tomatoes produced in Guatemala are commercialized in the central markets of San Salvador. In 2020, tomatoes represented 16% of total horticulture production in Guatemala with 337,875 tons produced on a total harvested area of 8,523 hectares.¹⁴⁷ That year, 15% of the total (51,831 tons) was exported to El Salvador, at a value of more than US\$ 8 million, (12% of horticulture exports by value).¹⁴⁸ As shown in Figure 4.9 below, tomatoes are transported by road from the main production areas in the Baja Verapaz and Juitapa departments of Guatemala to the central market of Guatemala City (CENMA) and on to the central market of San Salvador (*La Tiendona*).¹⁴⁹ Every day of the year, an average of 48 three-ton trucks transport tomatoes from the central market in Guatemala to the central market in San Salvador.

Figure 4.8: Horticulture value chain actors in Guatemala¹⁵⁰



(MAGA - CONADEA; Guatemalan Chamber of Industry, Chamber of Commerce, AGEXPORT; MICECO; USDA/FDA/GLOBAL G.A.P - Normas and regulations for the entry of vegetables to the export destination countries).

Source: Ministerio de Economía (MINECO).

¹⁴⁷ Data from FAOSTAT (2020).

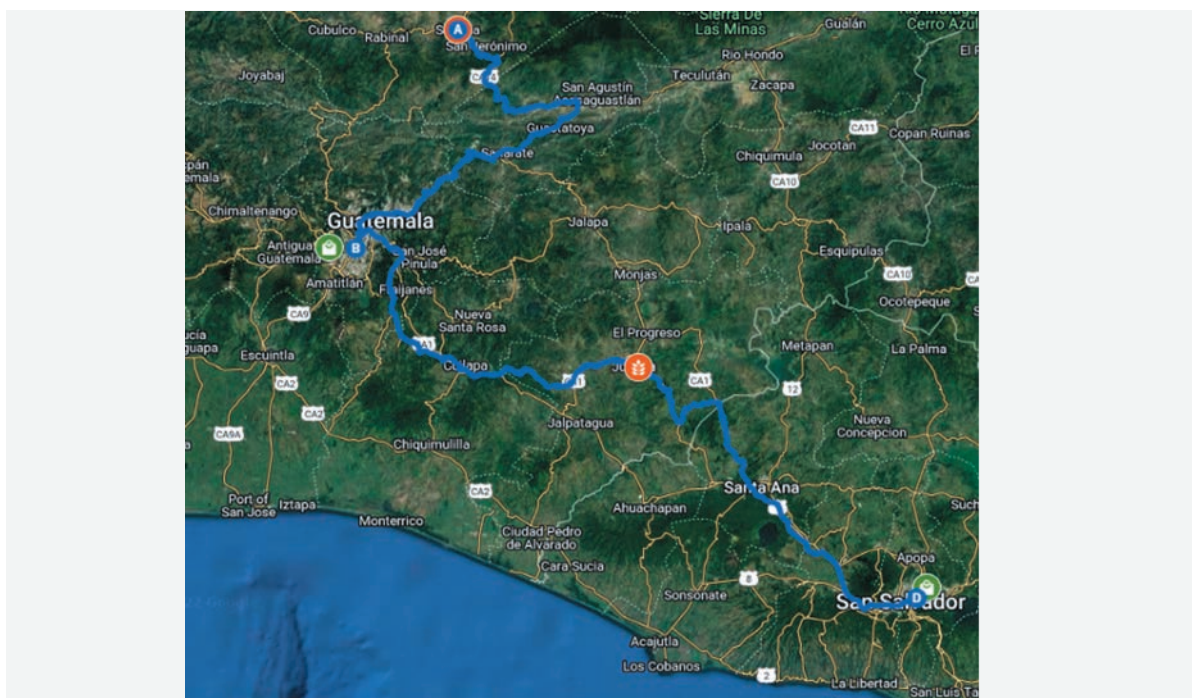
¹⁴⁸ Data from SIECA (2022).

¹⁴⁹ Data from interviews.

¹⁵⁰ Note: MAGA-CONADEA: Ministerio de Agricultura y Ganadería - Consejo Nacional de Desarrollo Agropecuario; AGEXPORT: Asociación de Exportadores de Guatemala; USDA: US Department of Agriculture; FDA: Food and Drug Administration; GLOBALG.A.P.: Good Agricultural Practices Set of Standards.

38. A distinguishing feature of fresh fruits and vegetables value chains is the critical role that the cold chain can play in ensuring quality and extending the shelf life of produce. However, on-farm access to cold chain equipment is limited, due to poor electrification and high purchase and operating costs. In addition, the limited availability of cold chain transportation means that family farmers generally harvest and load their produce early in the morning to ensure a lower temperature during transportation to their destination (collection center, wholesaler, processor or retailer). This in turn implies that average distances to these destinations need to be short. However, worsening road conditions and road congestion have increased transport delays over time, and the lack of adequate cold chain logistics has led to food losses and waste, as well as challenges in meeting the quality requirements of buyers of high-value products in domestic and export markets (e.g. supermarkets, export companies). The problem of food loss is aggravated by the fact that in the NCA countries, FFV are generally transported in bulk on (frequently overloaded) trucks to the first gathering and processing unit (e.g. collection center, wholesaler, municipal market or major central market), instead of being routinely boxed and palletized at the farm level and transported on trucks observing prudent loads, which would help to reduce food loss and waste.¹⁵¹ This is a major constraint for “green” development.

Figure 4.9: Production of tomatoes and flow to main markets in Guatemala and El Salvador



Source: Authors, based on production data and interviews with CENMA.

39. Cold chain transport is more commonly available and accessible for produce destined for export markets, and is frequently used from processing plants to market outlets (notably supermarkets, the HORECA sector, or to borders, ports or airports for export). Total cubic meters of cold chain capacity in Guatemala and El Salvador is far below the capacity in benchmark countries like Chile or Mexico (Table 4.8). El Salvador has 2,000 cubic meters (m³) of capacity and Guatemala has 125,000 m³, whereas Chile has over 2 million m³ of capacity and Mexico has 15 million m³ (there are no data for Honduras). Increasing cold chain

¹⁵¹ Palletization is the process of loading produce onto pallets for easier shipping and handling.

capacity is essential in light of the limited feasible transport and storage times for horticulture (Table 4.9). The limited and dualistic access to cold chain services has adverse implications for both green and inclusive development.

Table 4.8: Cold Chain Capacity is Extremely Limited in the NCA Countries

Country	El Salvador	Guatemala	Honduras	Chile	México
Total (Million m ³)	0.002	0.125	N/A	2.165	15.0
M ³ per urban citizen	0.005	0.014	N/A	0.133	0.152

Source: Global Cold Chain Alliance (2018). Note: El Salvador values are for 2016.

Table 4.9: Feasible Transport and Storage Times for Perishable Horticulture Products are Very Limited

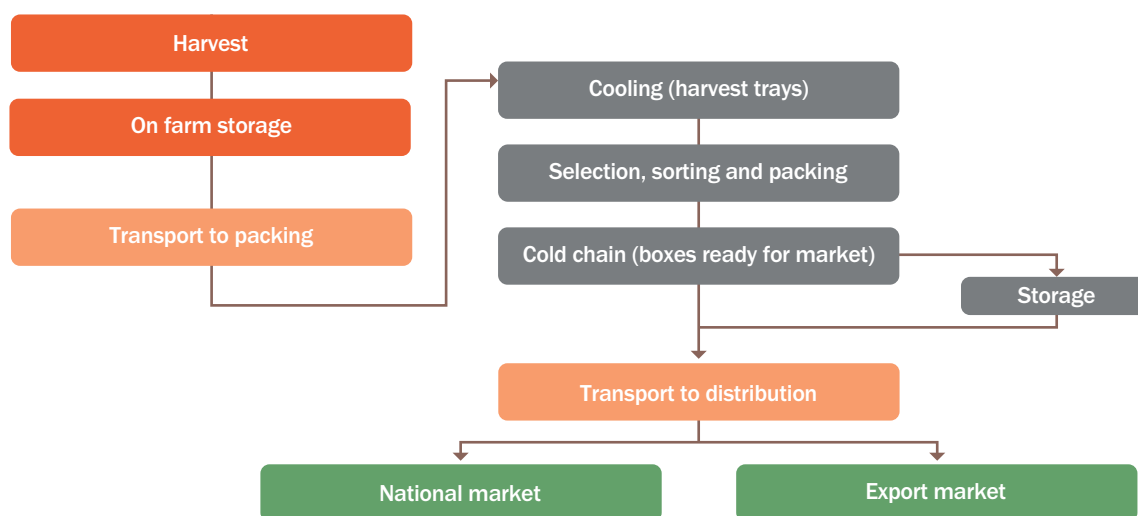
Products	Maximum Transport Time	Maximum Storage Time
Tomatoes	10 days	4-5 days
Peppers	10 days	4-5 days
Avocado	14 days	7 days

Source: FAO & EBRD (2020).

4.3.3 Key Stages in Fresh Fruits and Vegetables Value Chains from Production to Distribution

40. Key stages in the agrologistics value chains for FFV are on-farm post harvest, storage and handling, processing, transportation and distribution. Figure 4.10 displays the agro-logistics links for horticulture produce in Northern Central America: stages that occur on-farm are shaded in blue; transport links are shaded in yellow; off-farm storage and handling, as well as processing stages are shaded in grey; and distribution in domestic and export markets is shaded in green. This section discusses each stage in turn, including the implications for green, resilient and inclusive development.

Figure 4.10: Key Stages of the Value Chain from On-Farm Post Harvest to Distribution



Source: GUATEMALA: FAO/World Bank Cooperative Programme - Responding to COVID-19: Modern and Resilient Agri-food Value Chains.

41. Post-harvest treatment of fresh fruits and vegetables is critical to maintain the shelf life and quality of fresh horticultural produce. At this stage, FFV is gathered, in some cases washed, and prepared for transportation, generally in bulk. Family farms are generally obliged to sell on-farm, resulting in lower prices for their produce. For example, interviews for this study suggest that in Guatemala a kilogram (kg) of tomatoes sells for US\$0.29, compared to US\$0.33 on local markets and up to US\$1.43 on export markets. Small farms lack access to resources for on-farm storage at a controlled temperature, or for value addition through product transformation into pulp, tomato sauce, or canned products. There is also insufficient quality grading and sorting, which could contribute to improved pricing.

42. Storage and handling plays a key role in ensuring quality and a longer shelf life for FFV. In the NCA countries, storage is provided primarily by municipal markets, processing and exporting plants, and/or wholesalers. Zonal markets do not have cool rooms, and vegetables are normally kept at room temperature. Bigger wholesale markets may have limited space for cold chain storage, to sell to supermarkets or to regional export markets. This is the case of CENMA, the Center Wholesale Market of Guatemala. However, the La Tiendona wholesale market in El Salvador does not have a cool room, nor do Honduras' central markets in Tegucigalpa or San Pedro Sula. Handling during loading and unloading of transport from the farm to the storage and handling centers in the three countries is generally undertaken by intermediaries. Improper storage and handling is a significant contributor to food loss and waste (see the section on post-harvest price margins below).

43. Processing is the key step at which fresh horticulture is cleaned, sorted and packed. Where there is associativity among producers, cooperatives can play an important role in sorting, grading, washing, and packing services through a single processing plant that gathers and sells the produce to the main clients (enterprises that transform produce, retailers, the HORECA sector or exporters). In the case of exports, the exporting firms often integrate these services in a chain that extends back to selected producers. At the same time, smallholders' access to modern processing systems still remains limited, acting as a limitation on green, inclusive development.

44. The transportation of FFV, which occurs both from producers to processors and from processors to distributors, is marked by major shortcomings that exacerbate food loss and waste. Average transit times for FFV transports on Guatemalan roads are about 17 km per hour, thereby converting even short distances into long journeys.¹⁵² Furthermore, interviews revealed that the transit times from horticulture production areas to the main market in Guatemala City (CENMA) have increased significantly, due to the poor state of the road network (both main roads and feeder roads), especially in remoter areas, as well as increasing road congestion. Additional transport problems include the overloading of vehicles; loading of produce with improper packaging, i.e. bulk loading or loading in cartons that fail to prevent losses and damage during transport; and insufficient cold chain transportation. The exceptions in this regard are concentrated in produce destined for more distant export markets, for which refrigerated vehicles are often provided by the shipping company to bring FFV to the ports/airports. While transport quality is on average better from processors to distributors than from farmgate to processors, products may be delivered to smaller retail outlets by pick-ups or even by motorcycles.

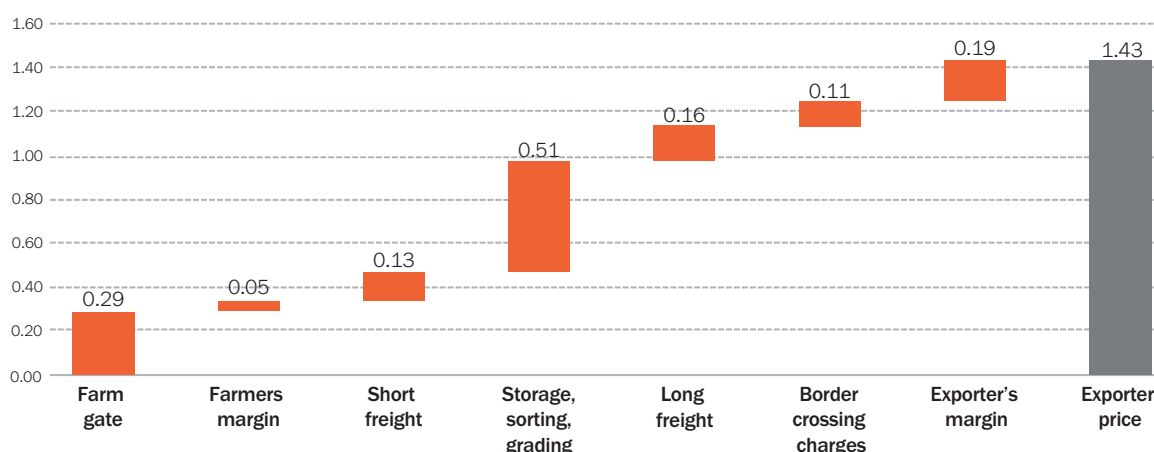
45. The quality of distribution is highly uneven and depends on the intended market. Whereas supermarkets often have refrigerated displays for perishable products, smaller retail outlets typically display fruit and vegetables at room temperature. The distribution system for FFV is dualistic, with larger producers and exporters participating in better integrated distribution channels than do smallholder farmers, ensuring better application of food quality and phytosanitary standards, and enjoying better price premia. This duality represents a further challenge for inclusive development.

¹⁵² Gobierno de Guatemala & IDB (2016).

4.3.4 Post-Harvest Price Margins in the Fresh Fruits and Vegetables Value Chains

46. Agrologistics account for a far larger share of final prices in FFV value chains than in basic grains value chains, and the lack of efficient agro-logistics in FFV value chains results in significant food losses and waste, higher consumer prices, and reduced international competitiveness. In the case of the tomatoes value chain from production areas in Guatemala to the central market in El Salvador, the farmgate price (US\$0.29 per kg) is only 20% of the final exporter price (US\$1.43 per kg), with post-farm agrologistics accounting for the remaining 80% (Figure 4.11). Farmers' gains are therefore very limited. Logistics costs associated just with short and long freight are equal to the farmgate price (US\$0.29 per kg), while the margin for storage, sorting and grading (US\$0.51 per kg) greatly exceeds the farmgate price. In addition, border crossing charges (US\$0.11 per kg) increase the price to final consumers in El Salvador by almost 7%, while gains for exporters (US\$0.19 per kg) amount to 13% of the final price. This means that consumers in El Salvador could pay a substantially lower price for FFV if agrologistics challenges were reduced, with important repercussions for their livelihoods and resilience in terms of food and nutrition security.

Figure 4.11: Guatemalan Farmers Receive only 20% of Final Price of Tomatoes Exported to El Salvador



Source: Authors based on interviews and market prices.

47. Product losses in FFV value chains in Northern Central America are very large, reaching as much as 54% of total production in the case of the value chain for tomatoes produced in Guatemala.¹⁵³ Agrologistics account for almost half of the losses in the tomato value chain: 5.4% of losses occur during transport, handling and storage; 10.8% at the processing stage, and 6.5% at the wholesale and retail stages, for a total of 22.7% of losses attributable to agrologistics.¹⁵⁴ Considering the 337,875 tons of tomatoes produced in 2021 and the average price of tomatoes, a total value of US\$36.5 million was lost in 2021 due to agrologistics challenges.¹⁵⁵ Delays are major contributors to food loss and waste: increasing transit time from farms to wholesale markets by 50% significantly reduces the shelf life of FFV products. In the case of tomatoes, this is equivalent to an additional cost of US\$0.01 per kilogram in wholesale markets, so that in 2021, delays would have represented an additional cost of US\$3.4 million.¹⁵⁶ Moreover, the burden of poor roads and costly land transport services is shared unevenly, as a 2012 World Bank agrologistics analysis found that transporting tomatoes from the farm

¹⁵³ World Bank (2020).

¹⁵⁴ Op. Cit.

¹⁵⁵ FAO Value of production 2019 divided total production gave a price average of 0.475 \$/kg of tomatoes.

¹⁵⁶ The total useful life of a tomato (including maximum transport and storage times) is 120 hours. With tomato prices at the CENMA market of US\$0.72 per kg, the useful life yields a cost of US\$0.01 per hour of delay. To arrive at the final figure for delays, the analysis drew on interviews and on data on the volumes delivered to CENMA.

to the border accounted for 23% of the sales price for small producers, more than 3 times the corresponding metric for larger producers.¹⁵⁷

48. A further major loss associated with FFV value chains in NCA countries, with important implications for resilient development, is the carbon footprint associated with these value chains. Estimates for the value chain for tomatoes produced in Guatemala suggest that improvements in agrologistics could reduce greenhouse emissions by 50,594 tCO₂e per year, based on food losses and waste associated with agrologistics equivalent to 22.7% of 2021 production. In economic terms, the carbon footprint is equal to US\$3.2 million per year.¹⁵⁸ While the added energy involved in the increased use of cold chain technology would offset a portion of these gains to the extent that they are not renewable, it is likely that in rural areas a significant portion of the energy will be off-grid from renewable sources, and that in the case of the tomatoes value chain, it is therefore very likely that the benefits from reduced food loss and waste of almost one-quarter of annual production (22.7%) through improved agrologistics in the value chain would exceed the added tCO₂e from incremental use of cold chain technology.

4.4 Agrologistics and Basic Grains Value Chains

4.4.1 A Profile of Basic Grains Production and Trade Flows in Northern Central America

49. The basic grains sector is crucial for the region, both for its cultural significance and for its critical contribution to food security. Maize and beans are an indispensable part of the diets of Central Americans, especially for those in rural areas with scarce economic resources, providing 37% of food energy per person, with maize accounting for almost one-third of this total and beans providing around 20% of total daily protein consumption.¹⁵⁹ All three countries are both producers and importers of grains, with almost half (47%) of domestic production of maize, beans and sorghum destined to on-farm consumption and the surplus dedicated to domestic markets and regional trade.¹⁶⁰ Grains processed for flour (except for nixtamalized corn flour), concentrates for feed, and grains for the beverage industry are mostly imported.

50. There are over 1.6 million producers of basic grains (including corn, beans, rice and sorghum) in the region, most of whom are subsistence farmers living below the poverty line (see Table 4.10).¹⁶¹ Basic grains producers account for 52% of the rural population in the region and include large indigenous populations (60% of producers in Guatemala), as well as vulnerable smallholder farmers in the Dry Corridor.¹⁶² The average planted area/producer in El Salvador and Honduras is 1.3 ha, while in Guatemala it is 1.2 ha.¹⁶³ The number of basic grains producers in Guatemala (close to 1 million) has doubled during the last 35 years, while the number of producers has risen much more slowly in El Salvador (20%) and Honduras (2%).¹⁶⁴ There are three maize production systems in Northern Central America, distinguished by the level of technology used: traditional subsistence agriculture systems (around 50% of maize produced); a modern commercial system (42% of maize produced), and a transitional sector of family farms that are seeking to improve market linkages and adopt modern technologies (8% of total maize produced). Greater commercialization of basic grains could significantly increase incomes, living conditions and employment opportunities for smallholder farming households, and reduce incentives for outmigration.

¹⁵⁷ World Bank (2012).

¹⁵⁸ This calculation assumes agrologistics losses are reduced to zero, and is based on an average price for GHG of US\$63/tCO₂e (the mid-point between the low price of US\$42/tCO₂e and the high price of US\$84/tCO₂e for 2022 specified in World Bank's guidance on the shadow price of carbon in economic analysis (World Bank (2017)).

¹⁵⁹ FAOSTAT (2020).

¹⁶⁰ FAO - RUTA (2010). Also see: IICA (2014).

¹⁶¹ *ibid.* The proportion of subsistence farmers ranges from 63% in El Salvador to 96% in Guatemala. According to FAO (2021), around 80% of small-scale producers in the Dry Corridor live below the poverty line and 30% live in extreme poverty.

¹⁶² Sources: FAO (2021) and Federico Fraga (2020).

¹⁶³ FAO - RUTA (2010).

¹⁶⁴ *ibid.*

Table 4.10: Family Farms are the Backbone of Basic Grains Value Chains in the NCA Countries

Description	El Salvador	Guatemala	Honduras
Regions of production	Maize: Produced in 196 out of 262 departments	Maize: Petén (22%), Alta Verapaz (15%), Quiché (14%), Huehuetenango (10%), Jutiapa & San Marcos (5%), Chiquimula & Quetzaltenango (4%), and remaining departments (23%). Beans: Petén is the main bean producer, followed by Jutiapa, Chiquimula, Santa Rosa and Jalapa	Maize: Atlántida, Cortés, Yoro, Comayagua, Choluteca, Valle, El Paraíso, Olancho, Copán.
Number of farmers	325,000 (157,000 bean producers)	941,800. Beans production generates equivalent of 54,162 permanent jobs	385,100
Farm sizes	63% subsistence farmers, 27% commercial farmers	96% subsistence farmers, including 37% infra-subsistence	92% of farms are less than 7 hectares

Sources: MAGA-UIPI (2002); Institute of Agricultural Science and Technology (ICTA) (2022); El Salvador Superintendency of Competitiveness (2014); FAOSTAT (2010); Guatemala: MINECO (2015); Fioravanti et al. (2019).

51. Northern Central America accounts for most of the basic grains production in Central America. On average, 16% of agriculture land in Central America is dedicated to the production of maize and beans whereas in El Salvador and Guatemala the proportion rises to more than 30% (see Table 4.11). Of the three countries in Northern Central America, Guatemala has the highest yields in the production of beans (with an average yield of 1,002 kg/ha), while El Salvador has the highest maize yields (with an average yield of 2,963 kg/ha, 45% above than the average for Central America).

Table 4.11: The NCA Countries Account for Most of the Basic Grains Production in Central America

Area/Production/Yields	El Salvador	Guatemala	Honduras	Total Central America
Maize				
Area harvested (ha)	299,047	870,724	360,957	1,893,292
Area harvested as a % of agriculture land	25%	23%	10%	11%
Production (tonnes)	886,000	1,910,000	666,798	3,981,242
Yield (kg/ha)	2,963	2,194	1,847	2,079
Beans (dried)				
Area harvested (ha)	108,500	268,673	158,677	797,854
Area harvested as a % of agriculture land	9%	7%	5%	5%
Production (tonnes)	105,937	269,221	127,733	723,820
Yield (kg/ha)	976	1,002	805	785

Source: FAOSTAT (2020). Note: Total for Central America includes data for El Salvador, Honduras, Guatemala, Nicaragua, Costa Rica and Panama. Yield data for Central America total represents average yield for the region.

52. Although all three NCA countries are relatively large producers of basic grains in Central America, they also rely heavily on imports of basic grains. Indeed, imports are almost equal to domestic production in El Salvador and exceed domestic production by 8% in Honduras and by almost 60% in Guatemala (Table 4.12). By contrast, exports (even at the intraregional level) are marginal both in quantity and value, with less than 1% of domestic basic grains production exported. It is important to point out that grains are imported not only

for human consumption but also for animal and fish/seafood feed, including for the expansion of shrimp and tilapia production in Honduras and for poultry feed in El Salvador. Most basic grain imports come from the USA, due to the sub-region's proximity to grain export terminals in the USA, with Brazil, Mexico and Guatemala constituting other important sources of imported grains. On the export side, the limited maize exports by NCA countries are primarily intra-regional, whereas export markets for beans are concentrated in North America and in selected European countries (Table 4.13).

Table 4.12: Northern Central America is Highly Dependent on Imports of Basic Grains

Country	Units	El Salvador	Guatemala	Honduras
Production Volume	tons '000	1,131	2,031	723
Export Volume	tons '000	5.8	2.1	6.3
Imports Volume	tons '000	1,100	2,200	1,150
Export Value	US\$ '000	2,978	1,632	4,808
Imports Value	US\$ '000	284,599	489,168	270,578
Exports as Share of Imports (by volume)	Percent	0.5%	0.1%	0.5%
Exports as Share of Production (by volume)	Percent	0.5%	0.1%	0.9%
Imports as Share of Production (by volume)	Percent	97.3%	108.3%	159.1%
Imports: Country of Origin	Maize (HS4 1005)	USA (72%), Brazil (19%), Mexico (8%)	USA (79%), Brazil (16%), Mexico (5%)	USA (92%), Mexico (2%), Argentina (2%)

Source: Authors, based on United Nations (2022), FAO GIEWS (2021), and Harvard University Growth Lab (2019).

Table 4.13: Main Origin of Imports and Destination of Exports of Basic Grains in NCA Countries

Main Origins of imports	El Salvador	Guatemala	Honduras
Maize (HS4 1005)	United States (72%), Brazil (19%) and Mexico (8%)	United States (79%), Brazil (16%) and Mexico (5%)	United States (95%), Mexico (2%) and Brazil (1%)
Beans (HS6 070820)	Guatemala (100%)	United States (100%)	Guatemala (76%), United States (23%), Canada (1%)
Main Destinations of Exports	El Salvador	Guatemala	Honduras
Maize (HS4 1005)	Honduras (45%), Guatemala (22%) and Nicaragua (18%)	El Salvador (36%), Honduras (33%) and Costa Rica (14%)	Colombia (63%), undeclared (36%), Guatemala (0.7%)
Beans (HS6 070820)	United States (100%)	United States (74%), Canada (11.6%) and United Kingdom (7.4%)	Spain (58%), United States (24%) and Canada (18%)

Source: Harvard University Growth Lab (2019).

53. This high dependence of basic grain imports translates into an increasing vulnerability and exposure to external shocks in international markets that could risk Central American countries' food sovereignty and worsen current levels of food and nutritional insecurity. Mobility restrictions implemented during the Covid-19 pandemic created intra-regional disruptions in food exports and in domestic supply from production to consumption areas, threatening the livelihoods of the rural poor and smallholder producers. Temporary export bans on red beans were put in place by the Governments of El Salvador and Honduras, with the aim to ensure adequate domestic supplies.

54. The production of basic grains in Northern Central America faces several major challenges for green, resilient and inclusive development. These include:

- » **Lagging productivity and low average yields:** Maize is mostly produced on low-productivity lands by subsistence farmers with limited access to resources and technological innovation. The average yield is very low in all three countries (e.g. 2,194 kg/ha in Guatemala, cf. Table 4.11) compared to countries such as the United States (9,339 kg/ha), Argentina (6,700kg/ha) or China (5,090 kg/ha).¹⁶⁵ Addressing the technological, knowledge and financing challenges is key to ensuring more inclusive development.
- » **Atomized and dispersed production:** Production is unorganized, with limited associativity among producers, leading to lower value added and higher marketing and input purchase costs for producers.
- » **Poor infrastructure and a weak agricultural innovation system:** family farms face challenges related to poor road infrastructure, limited access to financial services, a lack of innovative technologies such as improved maize varieties, and limited capacity building on climate-smart agricultural practices or on improved post-harvest handling and value-adding practices.
- » **Limited storage capacity:** Most grains stocks are held in storage silos pertaining to the food and feed industries. The government of Guatemala has roughly 70,000 MT of storage capacity (a fraction of annual production, cf. Table 4.12) but this is devoted exclusively to emergency food relief.¹⁶⁶ Similarly, the Honduran Agricultural Marketing Institute (IHMA) has only 35,000 MT of storage capacity for maize and 10,000 MT for beans, with strategic storage for food security equivalent to 12,000 MT for maize and beans jointly.¹⁶⁷ Limited storage capacity affects farmers' ability to manage risks associated with volatility in production and prices, and ensure green, resilient development with reduced food losses.
- » **Drought and climate vulnerability:** Climate events have contributed to high levels of food insecurity in the Dry Corridor. For example, the drought conditions associated with the El Niño phenomenon in 2015 resulted in crop losses of 60% of maize production in El Salvador, 60% of maize and 80% of beans production in Honduras, as well as around 200,000 tonnes of maize and beans in Guatemala.¹⁶⁸ At the same time, climate change are expected to increase pest infestations in crops and heighten the frequency and severity of hurricanes, as already evidenced by tropical storms Eta and Iota, which affected 72% of the cropped area in Honduras in 2020. By 2050, average temperatures in Honduras are projected to increase by 1.0–2.5 °C, whereas annual rainfall is projected to decrease by 9–14%, which would intensify droughts and could reduce yields of key staples such as beans by 32%. Adaptation to climate change and managing natural disaster risks more effectively is crucial for resilient development.

4.4.2 The Industrial Structure of, and Flows along, the Basic Grains Value Chains

55. The key actors in the maize and beans value chains are producers, collectors, transporters, brokers, wholesalers and retailers, as well as exporter, importers, and producers in the human and animal food industries. While production is atomized and there are many retailers, there are a limited number of collection centers (acopios), brokers, wholesalers, importers and industrial processors. Grains flow from producers to wholesalers, often via collectors/transporters, and then on to retailers, processors or exporters before reaching domestic or foreign consumers. Grains brokers and importers also, respectively, channel domestic and imported basic grains to industrial producers who sell processed goods to consumers (see Figure 4.12). Figure 4.13 shows the geographical flows of maize, starting from external sources and from surplus areas in Central America (in green, and largely in NCA) to major basic grains deficit areas (in brown) and minor deficit areas (in yellow). Figures 4.14, 4.15 and 4.16 provide detailed logistics mappings of flows of basic grains from producers via collection centers to key markets for the red beans value chain in El Salvador and for white maize value chains in Guatemala and Honduras.

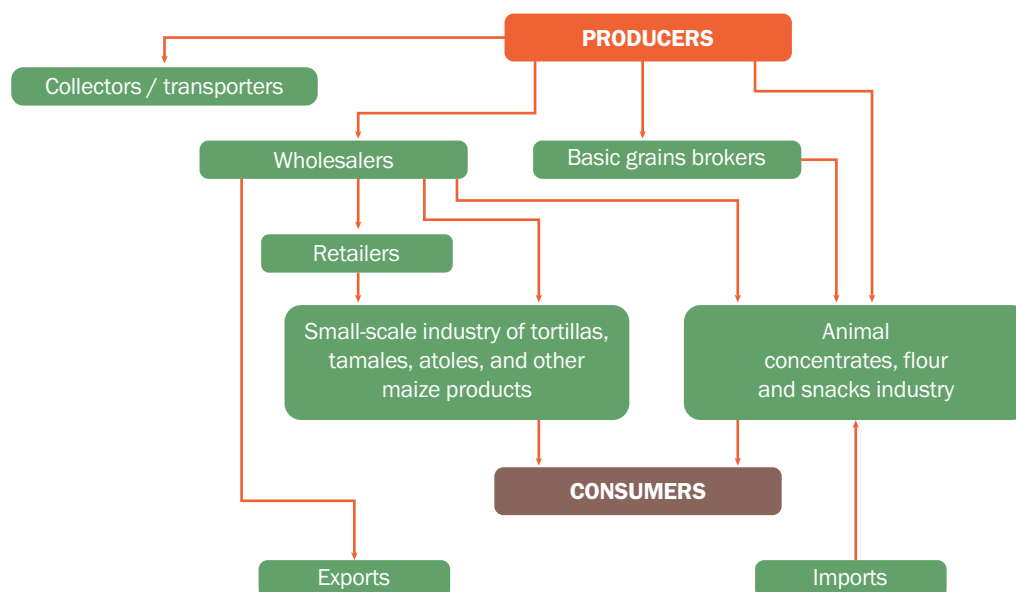
¹⁶⁵ Asociación Maíz y Sorgo Argentino (MAIZAR) (2010).

¹⁶⁶ USDA GAIN (2021).

¹⁶⁷ Data from interview with IHMA.

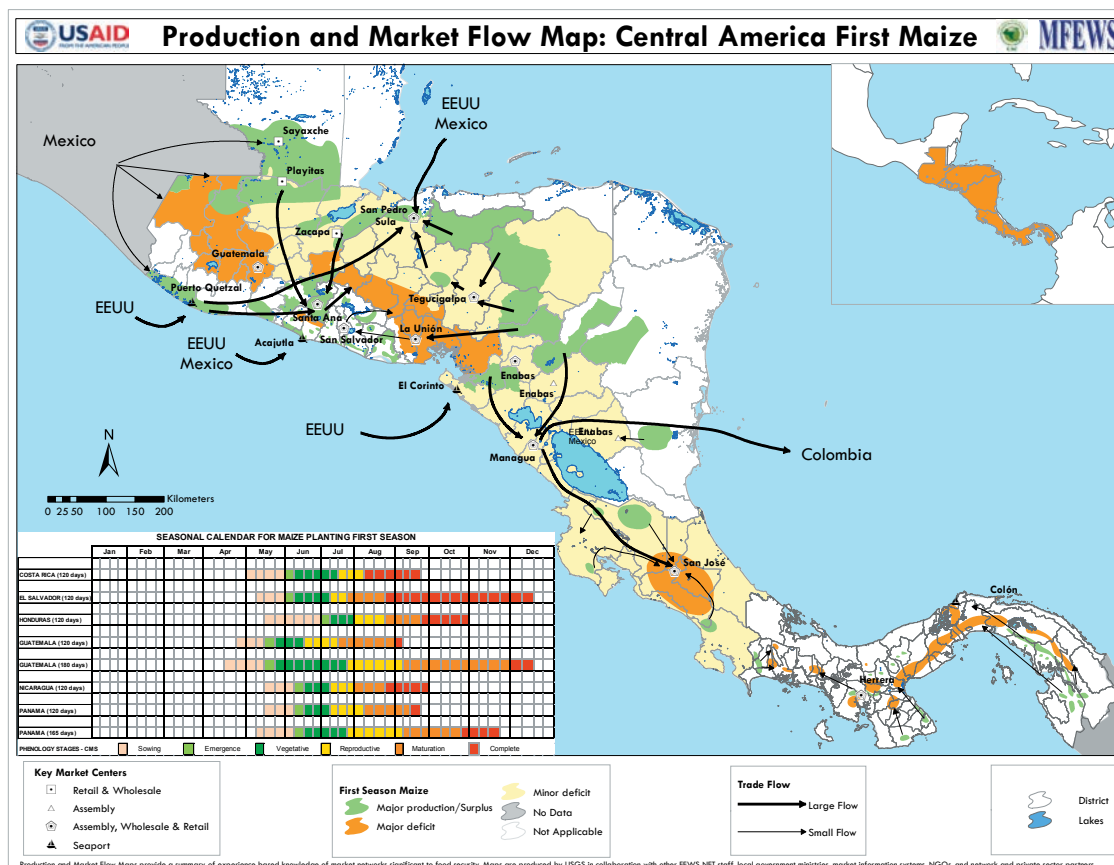
¹⁶⁸ FAO (2021).

Figure 4.12: The Basic Grains Value Chain



Source: Authors, based on Reyes Hernandez (2013).

Figure 4.13: Basic Grains Flow from Surplus Areas and from Imports to Deficit Areas in Central America

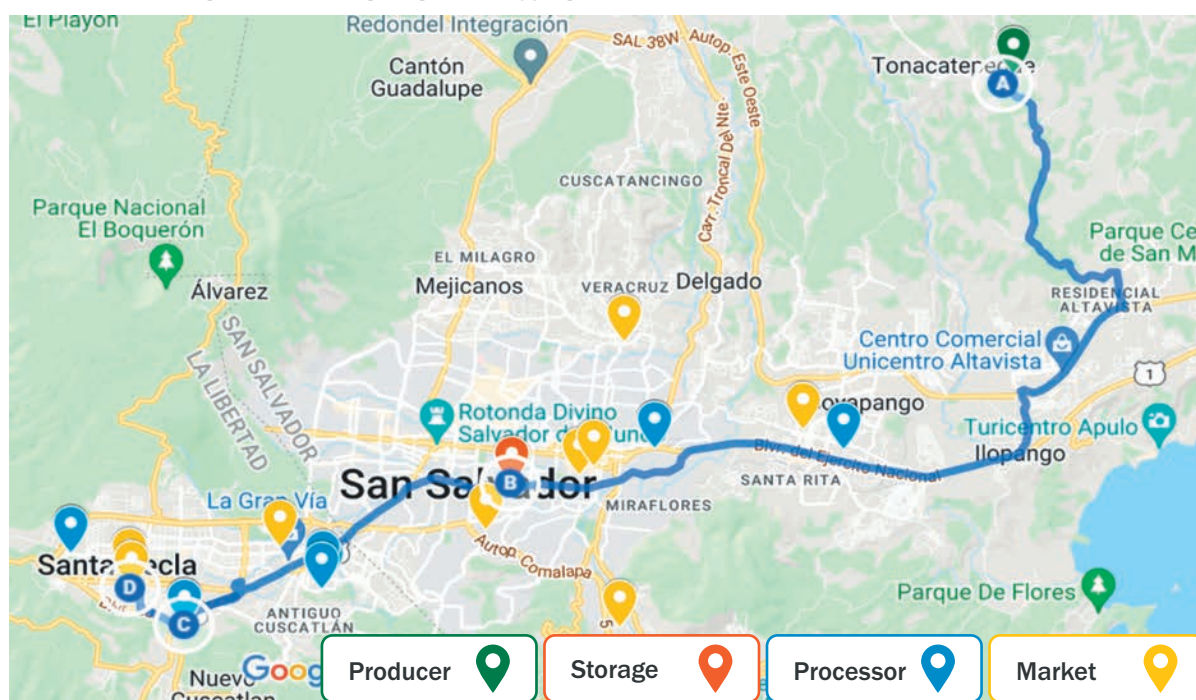


Source: FEWS NET (2022).

56. Although El Salvador produces less basic grains than Guatemala or Honduras, it has important market connections to regional producers and buyers. Maize, beans and sorghum are collected and transported from producing regions to key markets in the country. The main market for these grains is Gerardo Barrios in San Salvador, which even influences prices at the Central American level.¹ El Salvador also has important zonal assembly markets for domestically produced maize and beans in San Miguel, Usulután and San Vicente. Although flows of domestically produced basic grains are low relative to Guatemala and Honduras, the country has regional markets with trade connections to neighboring countries, notably Santa Ana and Ahuachapán in the West, with connections to Guatemala, and La Unión in the East, with connection to Honduras and Nicaragua. Figure 4.14 shows the agrologistics route for red beans from the Tonacatepeque production site, to a storage facility in San Salvador and on to a refried bean processing plant in Santa Tecla, before reaching the Municipal Market in Santa Tecla.

57. Guatemala's main centers for human consumption of basic grains are in Guatemala City, where the largest markets are, as well as in Chimaltenango, Chichicastenango, Zacapa, Cobán, Todos Santos and Ayutia.¹⁶⁹ Figure 4.15 below shows the flow of white maize produced west of Guatemala City in Mazatenango to a storage facility in Escuintla, and then to a corn snacks processing plant in Guatemala City, where it is transformed into puffed snacks that are sold at Guatemala City's Central Market.

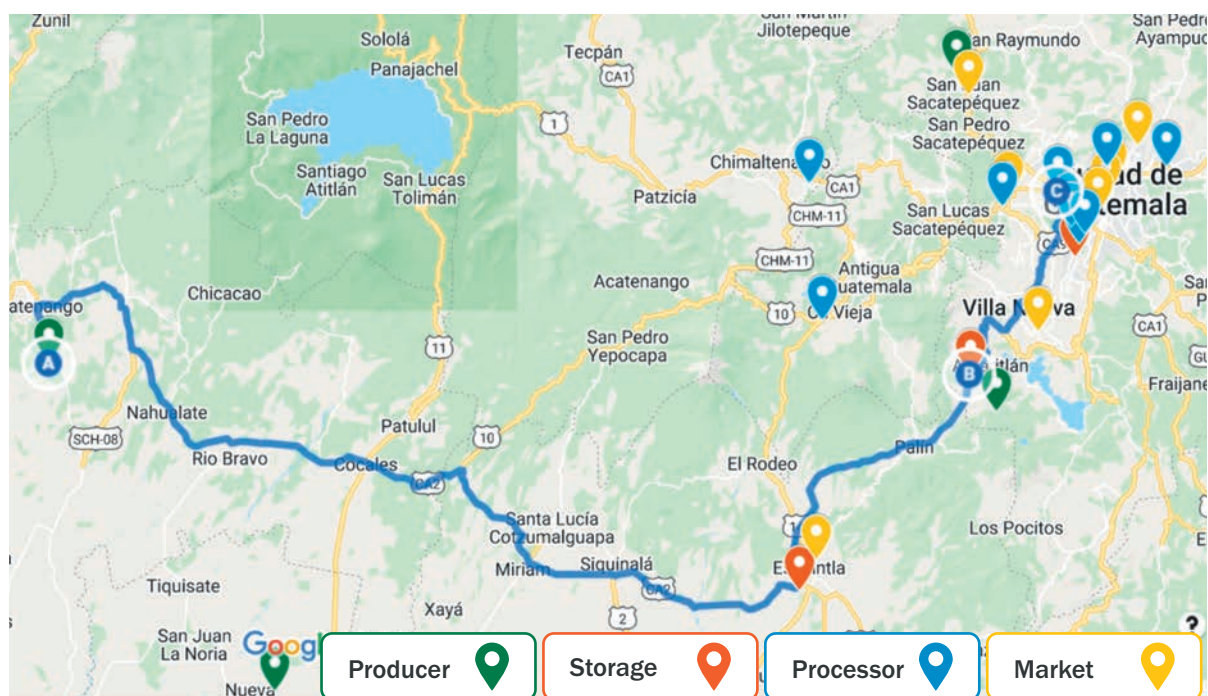
Figure 4.14: An Agrologistics Mapping of the Red Beans Value Chain in El Salvador



Sources: Authors' review of production, storage, processing and market data; and www.google.com/maps

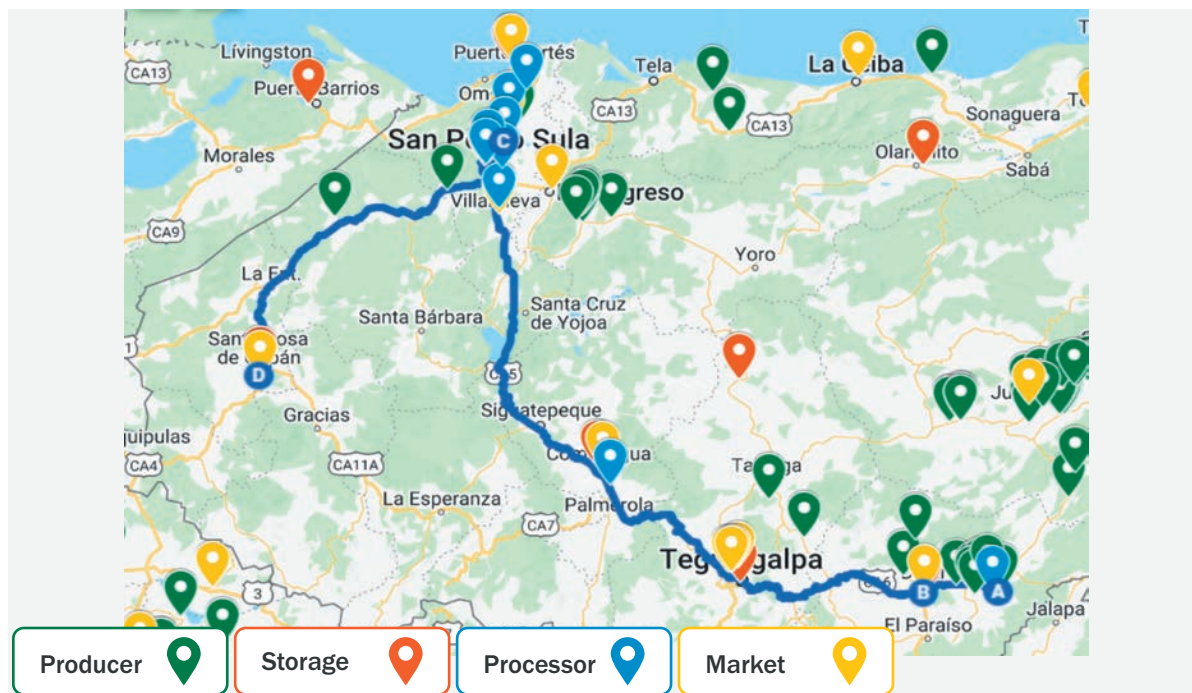
¹⁶⁹ FEWS NET (2022)

Figure 4.15: White Maize Value Chain Agrologistical Map for Corn Snacks Production in Guatemala



Sources: Authors' review of production, storage, processing and market data; and www.google.com/maps

Figure 4.16: Agrologistical Map of the White Maize Value Chain for Tortilla Flour Production in Honduras



Sources: Authors' review of production, storage, processing and market data; and www.google.com/maps

58. Honduras' Agricultural Marketing Institute (IHMA) has established assembly markets in production areas in northern and central/eastern parts of the country to facilitate logistics for the basic grains value chain. In northern Honduras, locally produced maize is transported to San Pedro Sula and its surroundings, while imported grains arrive at the grain terminal of Puerto Cortés and are sent to San Pedro Sula. There are collection and processing centers for corn flour and concentrates along the key CA5 route. In the center and eastern parts of the country, basic grains flow production hubs in Choluteca, El Paraíso, Danlí, Catacamas and el Porvenir to Tegucigalpa, while production in Marcala and la Esperanza is sourced via an IHMA collection center in Comayagua. Figure 4.16 shows the flow of basic grains from production and storage areas in the Jamastran Valley (marked in green), to a nixtamalized corn flour processing Plant in Cortes to a key consumption center in Western Honduras (Copán).

4.4.3 Key Stages in the Basic Grains Value Chain from Production to Distribution

59. The agrologistics of basic grains have particular features related to the nature of basic grains cargos. In particular, basic grains are transported in bulk, whether by sea (imported grains) or by trucks (internally), and therefore require appropriate collection centers, adequate transport for bulk and high tonnage cargo, and access to ports, collection centers, roads, loading and unloading facilities. Moreover, unlike fruits and vegetables, basic grains can be stored for extended periods of time without cold storage, if humidity is managed properly. There are five key stages in the basic grains value chain: on-farm post-harvest; storage and handling; processing; transport and distribution. These are examined briefly in turn.

60. The key challenges in on-farm post-harvest handling of basic grains are proper humidity management and pest management. Proper handling post-harvest allows farmers to maintain the stocks of basic grains that they produce so as to sell when prices are most favorable, and therefore to manage price volatility better. It also allows farmers to manage production risks better, notably to maintain reserves for subsequent seasons in the event of bad harvests. A major challenge, notably for small farmers with limited capital assets and technology, is ensuring proper humidity management and isolation of grains from rodents, so as to be able to store basic grains for human and animal feed for the longest possible time. The limited associativity of small farmer producers also limits their ability to manage post-harvest handling more efficiently via cooperative approaches, representing challenges in terms of both green development, in light of food losses and waste, and for resilient and inclusive development.

61. Storage and handling of basic grains is undertaken via two key modalities, namely silo bags or silos. Silo bags are a special type of large bag that can maintain the quality of basic grains, while silos are typically metal structures and can be on-farm or third-party silos. A key difference from an investment perspective is that metal silos can typically be used for 15-20 years whereas silo-bags are for single use.¹⁷⁰ Hermetic bag technology has been developed for on-farm storage of maize and other grains by small farmers, but there is significant scope for expanding its use in NCA.¹⁷¹ In light of the investment costs involved in on-farm silos, small farmers generally rely on third-party silos and on the warehouses of informal intermediaries. In general, the warehouses in which grains such as beans and maize are stored are basic facilities that informal intermediaries use to weigh and dry the grains before distributing them along the value chain, and where fertilizers are also stored. The warehouses work without significant controls or municipal authorizations, so that the quality of their these services is not assured. This problem is compounded by the lack of appropriate traceability systems, which is a major logistic challenge for bulk products. According to key-informant interviews in Honduras, an important lesson from the COVID-19 pandemic is that there is a need for significant additional storage capacity in third-party silos, and for competitive collection, drying and warehouse centers, due to a large gap between existing storage capacity and the grain storage capacity that would ensure adequate food

¹⁷⁰ Dirección de Ciencia y Tecnología Agropecuaria de Honduras (Accessed 2022, May).

¹⁷¹ Quezada, M.Y.; Moreno, J.; et al. (2006).

security. Moreover, underinvestment in maintenance to keep silos operating properly is a further key challenge. Shortcomings in storage and handling represent a major challenge for resilient development of the basic grains value chain, (as will be seen in the next section).

62. Processing of basic grains involves three main areas: maize for human consumption (either fresh or as corn flour for food products); maize for animal feed; and beans for local consumption, processing and/or exports in canned or dry packaged formats. Larger processors in the major cities in the NCA countries receive the locally produced grains via wholesalers and grains brokers that aggregate stocks for transportation to them, whereas smaller-scale processors typically purchase smaller stocks of grains via wholesalers and retailers. The supply chains for processors who export processed grains, such as processed beans, generally have better organized supply chains with linkages to exporters and final foreign clients. A key challenge in processing is ensuring a steady supply of quality basic grains. More informal processors engaged in intermediate transformation of basic grains face challenges associated with inappropriate storage and product losses.

63. Bulk transportation of basic grains faces significant challenges in light of the poor quality of road networks and inefficiencies in NCA ports. In light of the minimal rail infrastructure in these countries, the main transport mode for locally produced grains is by road. However, both travel times and costs are substantially affected by the poor condition of the road network, which results in road freight in NCA having a very high modal share (see the section on post-harvest price margins below).¹⁷² The problems are compounded in rural areas by the lack of adequate all-weather feeder roads. Moreover, the NCA countries are lagging in terms of the application of digital technologies in tracing transported produce. Ports also represent significant congestion points in the transportation of basic grains imports and exports. The main grain terminals are located in Ajacutla port in El Salvador, Puerto Cortés in Honduras, and Puerto Quetzal in Guatemala, and all three ports are prepared to handle grains, although, as indicated in Chapter 2 and documented in the National Plans of Cargo of SICA member countries, inefficiencies in loading and unloading and port exit times add significantly to costs (also see the next section on post-harvest price margins).

64. The distribution system for basic grains is essentially dualistic, with better integrated distribution channels for larger producers and for exporters than for the distribution systems accessed by small farmers, representing a challenge for inclusive development. Small-medium scale family farmers' distribution systems in the three countries remain predominantly organized as traditional economies, relying on many dispersed producers, or associations of producers with varying levels of organization, to reach urban area central markets concentrated in the capital cities of the countries. As supermarkets are playing an increasing role in the distribution of products, relative to small retailers (see Chapter 2), they are extending the application of standards in terms of processing and packaging. Producers for exports are linked to foreign purchasers with greater availability of financing and stronger delivery and quality standards. Moreover, the SIRSS system's harmonized system of sanitary and phyto-zoo-sanitary norms is gradually facilitating regional market integration at lower costs for ensuring safety standards.¹⁷³ E-commerce, including business-to-consumer (B2C) and business-to-business (B2B) e-commerce platforms, while growing exponentially in other value chains, have not features significantly yet in value chains for basic grains in NCA.

4.4.4 Post-Harvest Price Margins in the Basic Grains Value Chains

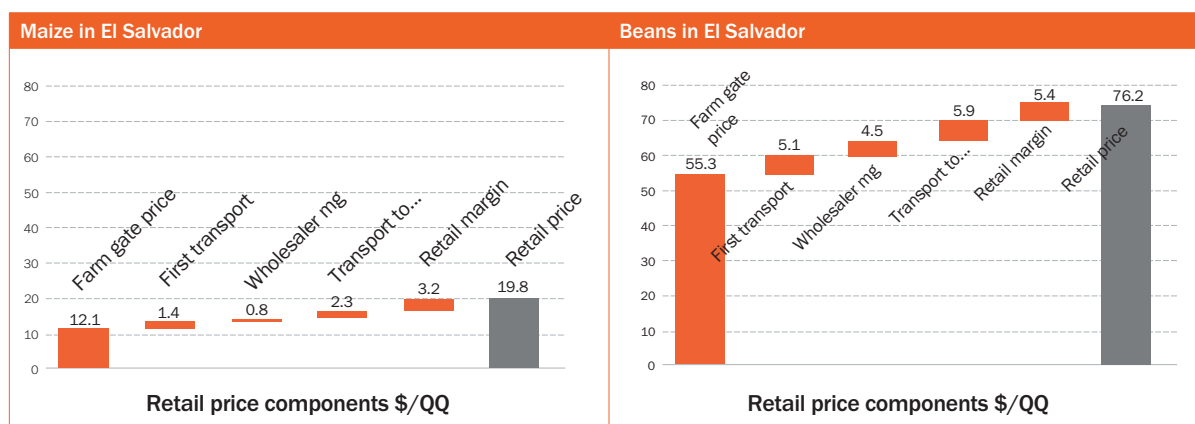
65. Agrologistics can represent between 25% to 40% of the final price of basic grains products, and containing these costs can greatly increase incomes for farmers and reduce food prices for consumers. In an analysis of the maize and beans value chains in El Salvador—drawing on data from the Ministry of Agriculture—farmers were found to gain 61% of the retail price in terms of farmgate prices for the maize value chain, and

¹⁷² Modal share is the cost of the final product accounted for by transport: maritime, waterways, roads or railways.

¹⁷³ SIECA announced the initiative in 2016 and with financial support from USAID and WB, the system is now in the early phases of operation. See: <https://www.sirrs.sieca.int/>.

almost 73% of the retail price via farmgate prices for beans (Figure 4.17). However, transportation costs from farmgates to wholesalers and from wholesalers to retailers play a significant role in driving up the final retail price. In particular, for maize, transport costs represent 19% of the final retail price on domestic markets, while for beans transportation represents 14% of the retail price. Logistics bottlenecks associated with poor rural roads, congestion, flooding, overloaded vehicles, and inefficient loading or unloading at the farm, wholesale or retail levels contribute to higher times to reach markets and drive up transport costs. For grains imports, an important delay is related to the port of entry. For instance, each year the Port of Acajutla in El Salvador is estimated to be inactive for 18% of its total hours of operation. While inactivity is due to inclement weather in almost half of all cases (48%), other reasons for inactivity are related to agrologistics delays: delays by users who must receive merchandise (27% of cases), customs, maritime and port authority delays (21%), and vessel delays (4%). Bulk carriers that transport grains suffer the longest delays because they tend to have the lowest level of priority after passenger ships, ferries and container ships. This means that final consumer prices could be reduced by a significant amount if these transport challenges were attenuated. Other components of the agrologistics costs include margins for wholesalers and retailers, as well as handling and packaging/processing links in the value chain, for which no readily accessible data are available.

Figure 4.17: Agrologistics Account for 25-40% of Retail Prices for Maize and Beans in El Salvador



Source: Authors, based on IICA (Accessed 2022, May 22), and IICA, CENTA and MAG (Accessed 2022, May 22).

66. A critical loss not captured in the above breakdown of the agrologistics cost structure is food losses and waste (FLW). Calculations for Guatemala suggest that maize losses amount to 34% of total production. Post-harvest losses at the warehouse and processor levels are caused by poor handling by laborers, inappropriate storage techniques, as well as pests and rodents. Agrologistics losses along the value chain beyond the farmgate, i.e. at the handling and storage, transportation, processing and distribution stages, add up to 9% of total production.¹⁷⁴ In terms of value, that represents annual losses for Guatemala of US\$32.1 million due to agrologistics challenges.¹⁷⁵ In the case of beans, total losses represent 26% of production, with agro-logistics-related losses beyond the farmgate adding up to 6% of total production.¹⁷⁶ Intuitively, these product losses have a direct and serious impact from the point of view of countries' food security and grains availability, and a critical bearing on achieving green and resilient development. To the extent that losses are greater for small farmers with less ability to reduce FLW, they also have an important bearing on inclusive development.

¹⁷⁴ World Bank (2020).

¹⁷⁵ Taking into account the 2019 maize production in value, times 9%.

¹⁷⁶ World Bank (2020).

67. Another critical loss not captured in the above breakdown of the agrologistics cost structure is the carbon footprint. Considering that agrologistics are responsible for the loss of 9% of total maize produced in Guatemala, improvements in agrologistics could reduce greenhouse gas emissions in Guatemala by up to 530,947 tCO₂eq. This would be equivalent to savings of US\$33.4 million per year.¹⁷⁷ For beans, taking into account that agrologistics are responsible for the loss of 6% of the total annual production in Guatemala, agrologistics improvements could reduce GHG emissions in the country by up to 2,655 tCO₂e per year, yielding annual savings of up to US\$167,283.¹⁷⁸

4.5 Summary of Findings for the Three Value Chain Deep Dives

68. The coffee industry has several promising inherent characteristics from the point of view of green, resilient and inclusive development. In terms of green and resilient development, coffee cultivation performs a vital function in watershed management, environmental and biodiversity protection and avoidance of land degradation. It also provides opportunities for inclusive development through employment opportunities for women, and income opportunities for rural communities living in remoter, more mountainous areas to engage in value chains linked to global markets. Honduras and Guatemala are both important actors in global coffee export markets and all three countries have production zones with Denominations of Origin that contribute to premium prices for coffee produced in those areas. Where smallholder producers are organized into cooperatives, and where they obtain organic, fair-trade, rainforest protection or Cup of Excellence certifications and recognitions, they also command (at times significantly) better prices for their products.

69. However, coffee value chains in NCA face a range of challenges at each stage of the agrologistics value chain that impede more green, resilient and inclusive development. These challenges include limited on-farm adoption of innovations in post-harvest drying of coffee; inadequate storage facilities for humidity controls post-harvest; excessive water use and toxic effluents in processing coffee; costly, inefficient and risky transport logistics, both on rural roads from producers to collection/processing centers, and in terms of high container freight tariffs in transporting from distributors to port. Improvements in agrologistics, including solar drying, water management, rural roads, and quality certifications, could significantly increase incomes for the smallholder coffee producers who account for most of the production in the NCA countries, and contribute to greener, more resilient and more inclusive development (see the specific policy and investment options identified in Chapter 5).

70. There is significant potential for strengthening fresh fruits and vegetables value chains to boost green, resilient and inclusive development in Northern Central America. Green development requires the adoption of innovative solutions at the production and on-farm post-harvest stages, with enhanced knowledge and capacity to strengthen production quality, grading and on-farm handling, as well as increased associativity and financing for essential on-farm controlled temperature storage to boost farmers' incomes and reduce food loss and waste. Reducing food loss and waste associated with post-farm food loss and waste, notably during the transport, storage and handling stages of the value chain, especially via improved cold chain management, would reduce carbon footprints and increase resilient development. Interviews suggest that cold rooms are a more important impediment than refrigerated transportation, as there are organized transport firms that can provide cold transportation, while for exporters the final inland transport is generally provided directly by the maritime company. Finally, better integrated value chains can enhance inclusive development: when small farmers are obliged to sell on-farm to intermediaries or to local markets, the prices they receive are lower than the prices they could obtain selling directly to retail chains or to exporters, and could increase capacity building to ensure improved product standards and reduced food losses and waste, so that strengthening linkages with

¹⁷⁷ This calculation is based on an average price for GHG of US\$63/tCO₂e (the mid-point between the low price of US\$42/tCO₂e and the high price of US\$84/tCO₂e for 2022 specified in World Bank's guidance on the shadow price of carbon in economic analysis (World Bank (2017)).

¹⁷⁸ Using the same average value GHG, \$42, \$84 / tCO₂e, as a starting point in 2017 price.

high premium markets could increase family farmers' incomes. Improved services via collection centers and wholesale markets that provide more efficient and comprehensive aggregation services including cold rooms, washing, drying, and sorting, would also enhance GRID development.

71. Basic grains are of critical importance for cultural and food security reasons in Northern Central America, but the three countries face major challenges in achieving green, resilient and inclusive agrologistics for these value chains. Over 1.6 million farmers, the vast majority of whom are subsistence farmers, are engaged in producing basic grains, but face a range of challenges not just in production but also at all five stages of the agrologistics of delivering from farms to final clients, namely post-harvest on-farm management, storage and handling, transport, processing and distribution. Transportation costs feature heavily in the agrologistics challenges for the value chain, while significant food losses and waste at both the production and agrologistics stages have important implications for food security, farmers' incomes and consumer prices; contribute to substantial imports of grains; and result in significant carbon footprints. Improving agrologistics can contribute significantly to boosting green, resilient and inclusive development via the basic grains value chains in the NCA countries.

72. For all the value chains included in the deep dive, improving agrologistics will have substantial effects on value-chain efficiency, profit margins for family farmers, and food accessibility for consumers. Some back-of-the-envelope calculations using estimates from the deep dives in this chapter provide telling examples of the monetary value of these effects. Previous World Bank studies in Latin America estimated that an improvement of logistics due to efficiency gains in ports, road transport, customs clearance and border crossings, better inventory practices, and more capacity and better use of storage and warehousing could reduce logistics costs by 20 to 50 percent.¹⁷⁹ Applying the lower-bound estimate of a 20% cost reduction to the agrologistics costs of US\$0.91 per kg estimated in this chapter for tomatoes, and considering the volume of tomatoes exported by Guatemala to the rest of the world it can be inferred that improving agrologistics would have implied a cumulative annual cost saving of up to US\$11.30 million for Guatemalan producers along the tomato value chain.¹⁸⁰ Similarly, considering that inland logistics costs for maize in El Salvador are equivalent to US\$0.08 per kg, a 20% cost reduction would have been equivalent to savings of US\$18.1 million in 2021, considering a total forecasted production of 1.13 million tons.¹⁸¹ Finally, for the case of coffee in Honduras, the cost breakdown in this chapter showed a logistics cost up to export ports of US\$0.82 per kg for an integrated value chain, and of US\$1.11 per kg for independent producers. Taking a simple average of these two estimates, and considering that total exports of coffee of Honduras in 2021 were 5.8 million 60-kg bags, an average of US\$67 million could have been saved in 2021 if logistics costs could have been reduced by 20%.¹⁸²

¹⁷⁹ World Bank (2009), Logistics, Transport and Food Prices in LAC: Policy Guidance for Improving Efficiency and Reducing Costs.

¹⁸⁰ In 2020, a total of 62,104 tons were exported from Guatemala to the rest of the World (FAOStat data).

¹⁸¹ Production forecast from FAO GIEWS (2021).

¹⁸² ANACAFE (2022).

Options for Efficient, Green, Resilient and Inclusive Agrologistics in Northern Central America

5.1 Policy Priorities for Making Agrologistics Efficient, Green, Resilient and Inclusive

1. Policy recommendations for promoting efficient pro-GRID agrologistics systems in NCA countries involve a decisive revamping of public support directed at the provision of public goods and services.

Evidence from within Latin America as well as other regions of the world suggests that the composition of public expenditure on agriculture affects its effectiveness in promoting agricultural development.¹⁸³ While total government expenditure on the farm sector positively impacts agriculture's performance, increasing the share of expenditures committed to public goods and services is less distortionary and more effective than subsidizing the provision of private goods and services or market price support.

2. A first, essential step to support this agenda would be the systematic collection of sectoral data. In line with the absence of defined agrologistics strategies, data on agrologistics challenges and opportunities in NCA countries are particularly scarce, especially in a context where sectoral censuses and surveys tend to be outdated and infrequently collected. In Guatemala, the last Agriculture Census dates back to the year 2003, and no census of manufacturing and services has been collected to date. In Honduras, the latest Agriculture Census was collected in 1993, and a recent effort to revive it in 2019 has not presently come to fruition. In El Salvador, the Agriculture Census was last published in 2008. In terms of representative surveys, the Guatemalan Living Standards Survey (ENCOVI), which allows to link sectoral issues with livelihoods, was last collected in 2014, and did not include an agriculture module; on the other hand, the National Agricultural Survey has recently moved to only gathering information on maize, beans, and rice. Similarly, in Honduras the National Agriculture Survey was last collected in 2008, and the Household Survey (EPHPM), while collected on a yearly basis, does not include information on agriculture. While El Salvador recently published an updated Agriculture Survey in 2020, most information pertains to primary production and trade, with no specific attention to key bottlenecks along the agriculture value chain. The same applies to Enterprise Surveys which are being collected somehow more systematically in the three countries. Accounting of agrologistics goods and services would eventually provide a stronger base and rationale for more integrated decision-making among sectors that impact GRID in agriculture.

3. As a general principle, in the short run, existing private support should be refocused on pursuing proactive incentives for adoption of sustainable, energy-efficient, and natural-resource-conserving equipment and technologies by family farmers. As energy-efficient technologies proliferate and become more affordable worldwide, the opportunities for feasible financial packages to acquire them are increasingly within reach. Dissemination and promotion of these technologies by sector authorities in collaboration with private input suppliers would accelerate adoption, reduce costs, and expand resilience and environmental sustainability. Similarly, as chronic and acute water shortages increase, especially in the region's Dry Corridor and beyond, the urgency for water resource management is compelling. For instance, the adoption of water recycling and water-conservation techniques, notably in the widespread water-intensive and environmentally contaminating wet-milling of coffee, would convert a liability into an asset. Support can be directed to family farmers to compensate for the potentially high costs of adopting such equipment and technologies, in the form of subsidies, dedicated credit lines and other programs, including payments for mitigation or ecosystem services. An example in this sense is the recent strategic engagement of Honduras' Agricultural Marketing Institute (IHMA) to promote sustainability and climate change resilience in the corn and beans value chains,

¹⁸³ Anríquez et al. (2016), López et al. (2007) and López et al. (2017).

through payment of a premium to farmers adopting organic production practices and the offer of controlled-temperature warehouses and silo services that can extend storage time without lowering the quality standards of basic grains for small producers.

4. In the medium term, in order to efficiently promote green, resilient, and inclusive development through the agrologistics sector, agricultural support should be repurposed from private towards public goods and services, in particular agricultural innovation, efficient inspection, and essential infrastructure. Public support should focus especially on pro-GRID R&D, innovation of green technologies, plant and animal inspection services, agricultural extension and information systems, and climate-resilient infrastructure.

5. Strengthened agricultural extension services will ensure that adequate training and technical assistance reach family farmers and vulnerable producers at a grassroots level. GRID objectives should become explicit key pillars of the public institutions in charge of the services of generation and transfer of agricultural technology, such as the Directorate of Agricultural Science and Technology (DICTA) in Honduras, the Rural Extension Directorate (DICORER) in Guatemala, and the National Center for Agricultural and Forestry Technology (CENTA) in El Salvador: this could be achieved by systematically integrating climate aspects in the diagnostic and planning of their programs, introducing specific climate-related indicators in their results framework, building the capacity of agricultural extension service providers, and leveraging technology and digitalization for broader inclusion and information dissemination among producers and other value-chain actors. The R&D functions of these institutions should also be better coordinated and streamlined with those of other actors involved in agriculture innovation in each country, such as the Honduran Foundation for Agricultural Research (FHIA), the National Central School for Agriculture (ENC) and the Institute of Agriculture Science and Technology (ICTA) in Guatemala. In addition, gaps in local R&D capacity could be addressed through international collaborations with leading research centers, strengthening linkages with regional actors such as the Tropical Agricultural Research and Higher Education Center (CATIE) in Costa Rica, the International Center for Tropical Agriculture (CIAT) in Colombia, and the International Maize and Wheat Improvement Center (CIMMYT) in Mexico.

6. At the same time, assuring expanded access to and quality of laboratories and third-party quality verification mechanisms would render agrologistic chains more efficient and reliable, improving product safety and access to markets for smallholder farmers.¹⁸⁴ In Guatemala, for example, the food quality testing and certification functions are weak and fragmented over a variety of actors and ministries, including the National Quality System (SNC) and the Directorate for the Attention and Assistance to the Consumer (DIACO) under the Ministry of Economy for export products, the Ministry of Agriculture for unprocessed agriculture produce, and the Ministry of Public Health for processed food. Providing better articulation, timeliness, and quality of these services, including strengthening the country's overall lab capacity, would greatly improve process efficiency and reliability especially for small producers: for instance, the ENC school is increasingly adopting an agroindustrial, competitiveness-oriented focus, and its lab capacity could be strengthened so as to provide streamlined certification services. At the regional level, streamlining controls and inspection of agricultural products that cross borders between Central American countries would be critical to increasing the efficiency of logistic flows, facilitating sourcing products from various countries and favoring regional integration. In this sense, a harmonized system of sanitary and phyto-zoo-sanitary norms is being deployed as the On-line System for Mutual Recognition of Sanitary Records ("Sistema Informática de Reconocimiento Mutuo de Registros Sanitarios", SIRRS) under the auspices of SIECA, and this process should be supported and brought to full operation.¹⁸⁵

7. This strategy will also entail redoubling intersectoral policy dialogue, including at the regional level. As highlighted consistently throughout this report, significant national investments and regional coordination are required in customs harmonization, transport, and ICT networks. Some virtuous examples along these lines are starting to be deployed in the region, like the establishment of a reciprocal recognition of Customs

¹⁸⁴ Laboratory verification includes humidity, percentage of broken grain or beans, and the presence or absence of contamination, such as pest damage, mould, or aflatoxins in grain.

¹⁸⁵ SIECA announced the initiative in 2016 and with financial support from USAID and the World Bank, the system is now in the early phases of operation. See: <https://www.sirrs.sieca.int/>.

Declarations between Guatemala and Honduras in 2021: with the implementation of fast-track procedures for non-quarantine listed produce and foods, and advance customs declaration with the Single Central American Invoice and Declaration (FYDUCA), the flow of container trucks at Corinto customs between Guatemala and Honduras increased by 25% between 2020 and 2021, while clearance time was reduced to 10 min. There remains, however, scope for improvement of national policies and processes, in particular to ensure a synergistic interplay between efficiency and equity. In Guatemala, the Single Window for Foreign Trade (VUCE), launched in 2020, offers one-stop-shop online services and information to plan and carry out foreign trade transactions, building on a history of previous national experiences with single windows for exports and imports. While this innovation has proven effective at consistently simplifying import and export requirements for producers, the price of the various processes and documents remains based on a flat fee-for-service mechanism, which results in prohibitive costs by small and medium producers of value-added produce who tend to trade in smaller volumes: finding the right balance between creating high-value export opportunities and avoiding firm-size distortions will require a coordinated effort involving temporary support to SMEs and incentives towards aggregation and association.

8. Coordination efforts should also be revamped as regards the interface between value-chain logistics and transport, and the economic evaluation and prioritization of road and port infrastructure upgrades under national PNLOGs. Ministries of Agriculture and other agriculture institutions can play a key role in promoting and supporting initiatives for connectivity and penetration, also in close coordination with other sector stakeholders. For instance, El Salvador is currently implementing a National Freight Logistics Plan 2018-2032, which, among other activities, is converting the coastal Pacific Corridor road into a four-lane highway from the agricultural commercial center of Zacatecoluca, located at the center of the country, towards La Unión port at the very east end of the country: for agriculture producers along the route, this expansion would open up the possibility of exporting through La Unión rather than Acajutla (in the west), enabling sizeable time and cost savings.¹⁸⁶ In Guatemala, the current construction of the first Central American multimodal cargo airport connected to a port and free zone in Escuintla, on the Pacific coast, has the potential to generate employment and increase the levels of investment and exports of the country. In Honduras, planned investments in road infrastructure promise to improve the resilience of the country's agriculture productive system and generate thousands of jobs throughout the country (see Box 5.1).

9. Importantly, the impact of public policy can be boosted through public-private partnership (PPP). In light of low overall levels of public support to agriculture, systematically encouraging public-private partnerships can compensate for constraints in public expenditure capacity (cf. Box 5.2). For instance, while public R&D and extension remain the mainstay in the region, private, university, and non-profit institutions play a significant role as researchers and technical service providers that could be strengthened. Leveraging the core public research capacity with strategic public-private R&D partnerships with value-chain actors can multiply the impacts of innovation, targeting the priority concerns of the respective value chains: an example in this sense is the strong role played by the three national coffee federations in Northern Central America (Guatemala's "Asociación Nacional de Café", ANACAFE, Honduras' "Instituto Hondureño de Café", IHCAFE, and El Salvador's "Consejo Salvadoreño de Café", CSC), which provide access to knowledge and programs along the whole agrologistics value chain.¹⁸⁷ PPPs are also being used in the region for streamlining custom procedures. In Honduras, in 2021 the Animal, Plant and Food Safety authority (SENASA), the Food and Drug Regulatory Agency (ARSA), and the Customs Administration have partnered with PROYESA, a private Logistic Operator Hub near Puerto Cortes,

¹⁸⁶ For coffee producers in Usulután, for example, exporting through La Unión instead of Acajutla would mean covering a distance which is 115 km shorter, entailing a 66% reduction in road travel time (from 4.5 to 1.5 hours).

¹⁸⁷ ANACAFE sets a high benchmark identifying and disseminating Best Practices in the production and processing of coffee from an environmentally sustainable perspective. Its Environmental Guide, formally approved by the Ministry of Environment and Natural Resources, provides detailed guidance on every aspect of the logistics chain from agro-forestry coffee production, to wet and dry milling, to roasting and environmentally sound disposal of liquid and solid by-products.

to provide food import and export clearance and storage services: this PPP model is relieving pressure from Puerto Cortes' Container Terminal Operator, while increasing refrigerated and frozen food storage capacity in the country. A similar strategy is being developed under the El Salvador PNLOG, whereby the La Unión port is expected to be endowed with a Logistical Operations Hub to be operated via concession, with bidding process to start in late 2022.

Box 5.1: Improving the Resilience of Roads Infrastructure in Honduras

While the transportation system in Honduras is dominated by road travel, the road network is concentrated in the western, northern and southern parts of the country. In contrast, the eastern part of the country is poorly linked to the road network and is often covered by dirt roads and tracks that are not weather-resistant. Apart from the unequal development of the road network throughout Honduras, the country's road connectivity is characterized by irregular terrain, vulnerability to climate disasters, and scarce maintenance.

The challenges with Honduras' road network contribute to inefficiencies in the transport sector and limit the mobility of people and products, constraining national and international trade. More than 60% of the transport network is exposed to natural disasters, with floods being the main source of exposure and resulting in severe impacts in terms of connectivity and accessibility via rural areas. Since roads are often built on the slopes of hills and mountains, they are vulnerable to landslides. As an example, to travel the 400 km from San Lorenzo to Puerto Cortés via the CA-5, the best highway in the country, takes nearly 7 hours (i.e., an average speed of less than 60 km/hour).

Poor road conditions and frequent climate shocks have a significant impact on socio-economic and rural development in Honduras. Disruption of road infrastructure due to climate shocks translate into estimated annual economic losses to firms and businesses equivalent to 1.8% of GDP. For example, improvements in road infrastructure in the Olancho department would generate about US\$17 million in additional income from the sale of agriculture products due to additional market access during the rainy season. Increased investments in infrastructure resilience would thus contribute to stabilizing economic growth and reduce the cyclical and volatility in growth that has characterized Honduras for more than 30 years.

Local economic development is hampered by the climate vulnerabilities of the rural transport network. In the case of agriculture production in the Dry Corridor, which is better connected to markets, approximately 68% of total agriculture products can reach a local market within 60 minutes. However, due to climate impacts, about 4% of the total agricultural production (US\$50 million) currently suffers from increased delays relative to this one-hour-timeframe to reach markets, and the proportion of production affected by delays is expected to increase in future. Moreover, at this time, US\$34 million of agricultural production has no access to local markets under favorable weather conditions, and this number nearly doubles when damage to roads due to climate shocks are considered.

Resilient infrastructure investments were recognized by the Government of Honduras as a strategic priority in its 2021 Sustainable Development and Reconstruction Plan. Estimated investment requirements for climate adaptation of the road sector range from US\$0.95-3.1 billion over the next 20 years, equivalent to an annual investment of approximately 0.2-0.6% of GDP. These investments would not only improve public infrastructure but also generate between 10,000 and 40,000 jobs in the construction sector and between 500 to 2,000 jobs annually for maintenance.

Climate adaptation investment in the road sector has the potential to generate thousands of inclusive jobs, including labor-intensive work, outside and within the agriculture sector for local communities and women. While construction may require high-skilled labor, maintenance and rehabilitation jobs can be undertaken by local small- and medium-scale enterprises and can generate labor-intensive work by people from local communities, including youth, women, and members of indigenous and Afro-descendent communities. Therefore, investment in strategic resilient infrastructure will not only generate higher incomes for farmers via improved access for agriculture products to main markets but also improve employment opportunities for families in lagging regions.

Source: World Bank, 2022. Transport sector deep dive of the World Bank Country Climate and Development Report for Honduras. Transport Global Practice. Washington, DC: The World Bank.

10. Similarly, private commercial financing can be leveraged to promote the adoption of profitable pro-GRID technologies among family farmers. A particular example of public-private partnership that has been used across Latin America and the Caribbean to improve smallholders' access to technology, markets, and finance is the productive alliances approach.¹⁸⁸ The model broadly consists of an agreement between organizations of smallholder producers, buyers, private financial institutions, and technical service providers, which revolves around the implementation of a business plan proposed by producers. Productive investments, technical assistance, and business development are financed through public grants, which are matched by producers' contributions (which could be in-kind) and, especially in the case of transitioning smallholders and commercial producers, by buyers and participating private financial institutions.

Box 5.2: Examples of Efficient, Pro-GRID Agrologistics Public-Private Alliances in Central America

In **Guatemala**, the Ministry of Economy along with other government agencies provided support in the form of technical assistance and equipment to maize farmers (organized in cooperatives) and processors while the private sector provided loans. The activities involved physical investment in post-harvesting infrastructure, such as solar dryers, maize sorting machines and silos, and organizing farmers and processors in the form of a business to access markets.

In **Nicaragua**, the government along with the International Fund for Agriculture Development (IFAD) coordinated the connection between farmers, cooperatives, and the private sector, and co-financed the repair of 1100 km of rural roads, while the private sector invested in technical assistance and post-harvest infrastructure in multiple value chains including coffee, honey and dairy.

In **Honduras**, the Rural Competitiveness program (COMRURAL), a flagship initiative of the Government of Honduras supported by the World Bank, promoted improved adoption among farmers of processing practices such as solar-powered dryers for coffee beans and grains, the use of cold storage rooms and vehicles to transport vegetable and fruit produce, which reduced post-harvest losses and led to increased productivity.

Sources: FAO (2013) and World Bank (2022).

¹⁸⁸ The Productive Alliance approach has been used extensively in multiple countries in Latin America and Caribbean, including Argentina, Belize, Brazil, Colombia, Grenada, Guatemala, Honduras, Mexico, Panama, Paraguay, and Peru.

11. The healthy involvement of the private sector requires actions to strengthen the agribusiness and innovation enabling environment. Private actors, from input suppliers, to storage, processing, shipping, and distribution, all operate within the framework of the broader enabling environment. The legal and regulatory framework, in particular, has been found to be of primary importance, as it governs competition and fair practices in agricultural value chains; on the opposite, regulatory uncertainty, unpredictable policy regimes, and cumbersome regulatory processes create a risky environment and raise major barriers for farmers, traders, exporters, and other value chain actors, impacting their investment decisions and the success of agro-enterprises. Moreover, producers cannot take full advantage of improvements along the agrologistic chain without expanded access to financial services, including risk-management tools, and recognition of their stored inventory as collateral: assuring that public policies and the legal framework are adequate for operation and oversight of competitive microcredit and insurance markets, including functioning of the warehouse receipt system would also represent an important step forward in advancing the inclusiveness of agrologistics solutions.

5.2 Investment Priorities for GRID Agrologistics in Northern Central America

12. Targeted investments can operationalize this agenda at each level of the agrologistics value chain. These include the following:

- » At the **post-harvest** stage, improving family farmers' access to green, climate-smart, and resource-efficient post-harvest and handling know-how will help reduce product losses, improve produce quality and safety, and increase resilience. Streamlining the delivery of extension services will be key in this sense, together with measures to facilitate adoption of technologies and practices on the part of small producers (fiscal incentives, matching grants, broadened financial inclusion).
- » At the **storage** stage, the establishment of a network of off-farm storage facilities appears as a low-hanging fruit to address the lack of storage capacity from family farmers, while contributing to ensuring compliance with produce quality and safety standards. This solution would rely on a system of reliable warehouse receipts to enable tracing and accounting for lots from a large number of producers: to the extent that the network of storage facilities expands, warehouse receipts could also be leveraged as bona fide collateral, contributing to expanding access to credit among otherwise unbankable producers. For fresh produce, considering the high levels of losses in perishable products, investing in cold chain storage will have particularly large payoffs in terms of market access, nutrition security, and climate mitigation. These investments could be accompanied by efforts to deploy practical and affordable on-farm cold-storage options among small producers in rural areas without electrification (see Box 5.2 below).
- » At the **processing** stage, significant opportunities exist to add value to agricultural production as well as to stabilize and store food for household consumption. Fruit or vegetable drying and other processing such as canning hold particular potential in the context of family farming and nutrition, including to manage pre-harvest periods when families chronically suffer nutritional deficits as stocks and financial reserves run low. While larger-scale grain milling and food and beverage processing (including brewing) exist in each NCA country, their procurement systems rely on imported grain rather than being articulated with the local grain production chain. A potential method to develop local agro-processing capacity is to develop lead firm–SME linkages, which are relationships between large companies (lead firms) and SMEs with agro-processing capacity: the lead firm develops mutually beneficial agreements with multiple SMEs, on one hand improving access to finance and enhanced skills for SMEs, and on the other cutting its own procurement, production,

and distribution costs.¹⁸⁹ In this spirit, investment by a major foreign food processor in Guatemala is allowing the country and the Central America region to become suppliers of dehydrated vegetables for prepared food (soups and broths), and is establishing upstream links with local family farmers.

- » At the **transport** stage, it is paramount to upgrade the road and mobility network, operationalizing the national PNLOGs and the regional PMRML under the SICA framework. Correct maintenance of the primary and secondary road network will facilitate connection with processing plants and main market outlets (domestic and export), whereas the rehabilitation and maintenance of rural roads in the main production areas will improve access to markets and lower dependence on intermediaries for family farmers, while contributing to preserving product quality and reducing food loss (see Box 5.3 below for the case of Honduras). Refrigerated transport vehicles for perishable products will similarly extend product life and quality, and improve access to higher-value market. Enhancing cargo tracking capacity and security surveillance, including by leveraging digital technologies, will also contribute to lowering transport costs along value chains.
- » At the **distribution** stage, infrastructural upgrade is needed in both urban and rural wholesale markets to provide them with cold rooms, collection centers, cross-docking platforms,¹⁹⁰ vehicle accessibility facilities, and functioning traceability systems. Similarly, ports and airports require cargo and refrigeration facilities, as well as dedicated logistics zones facilitating more efficient loading and unloading. Improving road transit will in turn reduce congestion to reach wholesale markets, ports and airports, and land borders. At the retail level, efforts to integrate family farmers with supermarkets (for instance through contract farming) will improve access to high-value markets especially for fresh produce. The expansion of B2C and B2B e-commerce for agricultural and food products will further boost market opportunities for family farmers, provided ICT connectivity and access are expanded and integrated solutions such as third-party logistics (“3PL”)¹⁹¹ for agricultural produce are encouraged to organize shipping of fresh products from farmers to direct consumers.

Box 5.3: The POSTCOSECHA project: An Example of Effective Investment in Storage Infrastructure

An example of a project investing in storage infrastructure is the POSTCOSECHA project financed by Swiss Development Corporation. This project financed the technical design and training in the use of silos for maize and bean storage in El Salvador, Guatemala, Honduras and Nicaragua, and resulted in savings of approximately 336,000 tons of grain over 26 years of implementation. Silos enabled farmer to safely store their produce for longer periods without the use of fumigants and to sell produce when prices are above average. An evaluation undertaken five years after the project closed found that approximately 415,000 staple grain producers had adopted the silos, with the highest adoption rate in Guatemala. The study also found increased periods of food security for farmers who were storing the grain and increased incomes due to being able to sell maize when prices were higher. Rough estimates suggest, however, that (as of 2015) these silos only provided capacity for storage of 10% of basic grains production in the four countries, pointing to significant additional scope for further uptake of safe storage technology.

Source: Fischer et al. (2011).

¹⁸⁹ World Bank (2020b).

¹⁹⁰ Cross-docking is an operational procedure whereby products are directly transferred from incoming to outbound transport, which reduces inventory and operation costs and increasing fulfillment speed by eliminating unnecessary handling and storage. Products going to the same destination can also be consolidated into fewer transport vehicles.

¹⁹¹ Third-party logistics is an organization's use of third-party businesses to outsource elements of its distribution, warehousing, and fulfillment services. 3PL providers typically specialize in integrated operations of warehousing and transportation services that can be scaled and customized to meet the demands and delivery service requirements for customers' products.

13. Building upon this broad prioritization, specific investment opportunities can be identified at the value chain level. Table 5.1 lists some examples for the coffee, fresh fruit and vegetables, and basic grains value chains, based on the diagnostic of agrologistics opportunities and challenges in the previous chapters. Given heterogeneity of geographies, productive systems, and vulnerabilities across the region and within countries, operationalizing these principles will require a spatial territorial development lens, accounting for regional and national specificities. The investment options in Table 5.1 below are classified into Tier-1 and Tier-2 priority levels, with the prioritization of Tier 1 versus Tier 2 driven by the respective options' expected impact in terms of green, resilient and inclusive development.

Table 5.1: There are a Range of Investment Opportunities at Each Stage of the Agrologistics Value Chain

Stage of Value Chain	Coffee	Fresh Fruits and Vegetables	Basic Grains
Post-harvest	<ul style="list-style-type: none"> » Roya-resistant varieties » Solar dryers » Reduce transport and labor costs » Bundle input-supply » Know-how 	<ul style="list-style-type: none"> » Mainstream on-farm storage and handling technologies, including cold storage » Improved packaging to prevent damage during transport 	<ul style="list-style-type: none"> » Mainstream the use of on-farm storage and handling technologies
Storage	<ul style="list-style-type: none"> » Hermetic bag storage systems » Smart devices » Certified warehouse receipts as collateral 	<ul style="list-style-type: none"> » Expand cold storage for perishable products » Improve handling practices to reduce damage 	<ul style="list-style-type: none"> » Ensure grains warehouses comply with quality standards » Silo bags for producers' organizations » Solar dryers
Processing	<ul style="list-style-type: none"> » Coffee washing water recycling systems » Solar-powered pumps » Reduce impact of coffee-washing water effluent 	<ul style="list-style-type: none"> » Set up processing plants in production areas for value-addition activities (sorting, grading, washing, packaging) » Cold rooms 	<ul style="list-style-type: none"> » Increase capacity near main production areas for value-addition activities (ex: flour and concentrates)
Transport	<ul style="list-style-type: none"> » Upgrade rural road segments » Boost tracking and remote surveillance » Evaluate costs of trucking bagged coffee 	<ul style="list-style-type: none"> » Develop appropriate loading/unloading practices » Improve road maintenance and links with urban areas 	<ul style="list-style-type: none"> » Develop appropriate loading/unloading practices » Upgrade rural road segments and improve maintenance
Distribution	<ul style="list-style-type: none"> » Custom-purchasing opportunities » Traceability of specialty coffees » Own labels for price premia 	<ul style="list-style-type: none"> » Cold rooms » Traceability » Vehicle accessibility and cross-docking platforms 	<ul style="list-style-type: none"> » Reduce delays and losses » Improve transit on urban and rural roads » Improve loading and unloading at port of exit

Source: Authors. Note: A more intense shading marks options with higher priority and GRID potential at each stage of the value chain.

5.3 Technology and Process Agrologistic Innovations for GRID

14. Each of the investment priorities identified for the various links of the agrologistics value chain can be supported by leveraging emerging innovations in agrologistics technologies and processes. In particular, digital technologies are allowing for a shift toward highly optimized, real-time data-driven practices, while engineering and agronomic innovations are driving technical breakthroughs that can substantially increase value-chain efficiency and sustainability. Table 5.2 below presents a select list of innovations that promise to propel agrologistics development in NCA countries while advancing GRID outcomes for family farmers. As such, innovations in the table were selected based on their potential to be adopted by family farmers and to be ascribable to at least one of the following categories:

- » **Green innovations:** smart technologies and practices that utilize water, energy, and other resources more efficiently, while contributing to reducing GHG emissions. This includes technologies and practices to convert agricultural waste or underutilized resources into value-added inputs.
- » **Resilient innovations:** technologies and practices that favor recovery from downturns and exogenous shocks, either at the macro or at the producer or highly local level.
- » **Inclusive innovations:** measures that favor the fuller participation of broader segments of the rural society, for instance from a gender and ethnic perspective, and support market integration of producers from more remote areas.

Table 5.2: There are Several Promising Innovations for Green, Resilient and Inclusive Development at all Stages of Agri-food Value Chains

INNOVATION	Description	GRID POTENTIAL			Rationale
		GREEN	RESILIENCE	INCLUSION	
A. Post-Harvest					
Postharvest treatment technologies	Have advanced over the past 50 years with the science of postharvest plant physiology, entomology, and bio-tech. The breakthroughs focus on reducing perishability across a broad spectrum of temperate and tropical fruits, horticulture, and grain, extending shelf life, and diminishing often substantial losses. Can include fabrication by local skilled or semi-skilled workers utilizing local materials. Innovation Labs can accelerate the adoption of technologies and best practices.	M	H	H	Reduce losses and extend shelf-life. Opportunity for employment creation, income generation, and added value in rural areas. Innovation Labs can extend post-harvest benefits to a wide public. ¹⁹²
Solar Coffee and Grain Drying	In contrast to sun drying, where the food is exposed directly to the sun, the solar drying method uses indirect solar radiation. Solar energy is collected by heating up the air volume in solar collectors and conducting the hot air from the collector to an attached enclosure where the products to be dried are laid out.	H	H	M	Save energy, save labor costs, reduce contamination and postharvest loss. Shield from changes in rainfall and humidity patterns, obviate the need for combustion powered dryers. The tasks to move drying racks and collect produce once dried are compatible with participation of women performing other household or child rearing duties.

¹⁹² The Postharvest Innovation Lab, funded in 2010 by the Feed the Future Initiative (FFI) under the aegis of USAID, provides know-how to developing economies worldwide, including both horticulture and grains, and includes Guatemala and Honduras as two of the focus countries. The “Fab-Lab” of the Inter-American Institute for Cooperation on Agriculture (IICA) in Costa Rica develops and transfers know-how remotely, including postharvest technologies and practices relevant to other segments of the value chain. Central American countries have also benefited from the “Postcosecha” Program of the Swiss Agency for Development and Cooperation (SDC), which focused on grain storage construction and post-harvest management.

INNOVATION	Description	GRID POTENTIAL			Rationale
		GREEN	RESILIENCE	INCLUSION	
Certification of agricultural products	Certification of agricultural products requires a joint effort between private or non-governmental accreditation entities and grower groups. In the case of horticultural products subject to foreign import agricultural inspection and clearance requirements, the certification process may include additional hardware and postharvest protocols.	H	M	H	Assure the integrity of the green chain to consumers, promote access to niche markets and price premia.
B. Storage and Handling					
Improved storage and handling facilities	Construction of facilities such as grain storage bins, coffee warehouses, or produce packing houses, introducing energy-efficient cold storage and increased incorporation of smart technologies in the controller mechanisms for storage and handling, such as temperature and humidity devices.	H	H	M	Extend product life, drop losses, improved energy and water use.
Quality testing labs and third-party verification	Reliable and impartial laboratory analysis of produce, leveraging technological advances in testing, detection of mycotoxins and chemical residues, and applications of agricultural biogenetics.	M	L	M	Improve SPS and quality standards, facilitate access to high-quality markets.
Warehouse receipts certification	A fundamental tool in agricultural finance throughout much of Latin America ¹⁹³ with underutilized potential in Central America. Predicated on independently verified bonded warehouse receipts, producers can use the receipts as collateral for secured loans.	L	H	H	Opens broad access to credit, financial cushion.

¹⁹³ The Brazilian “cedula” is a key financing component, particularly for grain and coffee producers, while the equivalent used routinely in other large grain producing LAC countries are “recibos de almacenamiento” or “recibos de depósito”.

INNOVATION	Description	GRID POTENTIAL			Rationale
		GREEN	RESILIENCE	INCLUSION	
Solar-powered cold storage	Plug and play modular, solar-powered walk-in cold room, for off-grid storage and preservation of perishable foods. Offer off-grid rural producers the opportunity to assemble mixed batches from dispersed farms to meet commercially viable lots for shipment. Farmers pay a daily flat fee for each crate of food they store. ¹⁹⁴	H	H	M	Benefit to horticulture shelf-live, loss reduction, clean energy. Accessible to smallholders.
Modern inter-modal packing crates and lug boxes	Containers that can be used across different modes of transport with no need for unloading and reloading.	L	M	M	Simple accessible measures to reduce shrinkage loss from field and in transit, even for small-scale producers.
C. Processing					
Fruit or produce solar drying technologies	The same passive solar energy drying systems designed for post-harvest treatment of coffee or grain can be utilized in conjunction with complementary simple equipment to dry fruits or vegetables. Could be free-standing or part of coffee solar drying systems during the off-season.	H	H	H	Value addition, opportunities to scale up for sale to urban areas. Climate-smart, clean technology accessible to all. Nutritional cushion in areas that suffer from seasonal food shortages.
Grain milling	Small-scale milling technology through mechanical separators or biotechnology, use of renewable energy sources.	M	M	M	Value addition, improved energy use, food availability. More advanced innovations more suitable for producer associations or cooperatives.
Coffee processing	Increased use of renewable energy sources, utilization of coffee mill by-products such as coffee hull parchment or wastewater (aguas mieles) as energy sources, either using biodigesters or in the production of briquets.	H	H	H	Reduction in effluent and in water and energy use, improved income opportunities.

¹⁹⁴ See information on ColdHubs for a successful example in West Africa (<https://www.coldhubs.com/>).

Innovation	Description	Grid Potential			Rationale
		Green	Resilience	Inclusion	
D. Transport					
Radio Frequency Identification (RFID) tracking systems + Traceability apps + Remote imaging technology	A way of automating the management and locating process of physical assets, which works by loading an RFID tag with data (name, condition, amount, location) and attaching it to a relevant asset. The RFID tag repeatedly pulsates the data through radio waves, allowing for efficient monitoring and tracking. The system can in turn mesh with traceability apps that can embed an ever-broader range of information regarding product provenance, characteristics, and quality, as well as with drone-based and other remote imaging technologies to improve in-country farmgate to port surveillance.	M	M	M	Reduce product losses, reduce transport time and cost, improve transport safety. Boon to certifications throughout the value chain, improved market access.
Controlled atmosphere	Controlled atmosphere shipping containers utilize a blend of inert gases to slow plant physiology and perishability in reefers with long transit times. More recent innovations include solid-state ethylene monitoring, breathable patches on packages, 1-MCP ethylene binding, and dynamic controlled atmosphere storage.	M	M	M	Reduce product losses, improve income opportunities.

Innovation	Description	Grid Potential			Rationale
		Green	Resilience	Inclusion	
E. Distribution					
E-commerce retailing + Third-party logistics (3PL)	3PL firms act as e-commerce fulfillment companies, providing producers with all the services needed to outsource logistics operations. 3PL firms are located typically on the outskirts of urban areas with warehouse and cold-storage space and facilities for cold-chain items, and facilitate linking wholesale and retail customers with items sourced from dispersed producers.	M	H	H	Market access, improved food distribution.
Real-time visibility + Bar-codes and traceability systems + Apps connecting to buyer procurement systems	Real-time visibility leverages GPS-tracking and software to allow buyers to track and trace, in real-time, the movement of goods from the producers, providing information on shipping details, the exact status of the order, and the occurrence of any issues. Bar-codes and traceability systems, typically connected by apps to buyer procurement systems, further help improve knowledge on product origin and production practices. ¹⁹⁵	H	M	H	Broaden high-value horticultural options, enhance market access, improve food safety, improve environmental standards.
Preferred Supplier Networks	Rather than relying on spot market purchases of local produce, supermarket chain buyers develop Preferred Supplier Networks where producers can establish a track record of reliability and fulfillment of quality requirements. These relations are not as formalized as contracts and the provision of inputs, but they do provide market opportunity and payment arrangements to facilitate cashflow.	M	H	H	Market security for more producers meeting standards.

¹⁹⁵ See information on Farmforce for an example of application used by Guatemalan pea producers (<https://bigdata.cgiar.org/digital-intervention/farmforce/>).

INNOVATION	Description	GRID POTENTIAL			Rationale
		GREEN	RESILIENCE	INCLUSION	
Contract Farming	A formalized pre-harvest commitment between buyers and smallholders, in which farmers agree to supply specified quantities of a product, based on the quality standards and delivery requirements of the purchaser, whereas the buyer agrees to buy the product, often at a price that is established in advance. The company often also provides additional support through supply of inputs, technical assistance, transport services.	M	H	H	Market access and security, access to financing and inputs, improved quality and environmental standards.

Source: Authors. Note: L=Low impact; M=Moderate impact; H=High impact.

5.4 Conclusions

15. This report has analyzed how agrologistics can be more efficient, green, resilient, and inclusive in agricultural value chains in Northern Central America. In light of the duality of Central American agri-food systems, where highly sophisticated large exporters coexist with a more vulnerable yet potentially dynamic family farming sector, the analysis has focused on the extent to which agrologistics can support family farmers in their transition towards modern, commercial agriculture. As agriculture in Central America is confronted with major trends and disruptions at the domestic and international level, such as urbanization, trade interconnectedness, digitalization, and the disruption of global supply chains, among others, it is crucial that smallholder producers who make up the vast majority of agri-food actors in these countries can be resilient to challenges and are able to seize opportunities for economic recovery and job creation.

16. The study has highlighted important bottlenecks at all links of agrologistics value chains and their impacts on family farmers. Widespread inefficiencies and unsustainable practices at the post-harvest, storage, processing, transport, and distribution stages stifle productivity, hamper the environment, and leave small producers vulnerable to climatic and economic shocks, while keeping them excluded from high-value markets and income generation opportunities. These challenges are compounded by policy gaps, low levels of public investment, and insufficient intersectoral coordination, despite efforts to streamline agriculture and logistics frameworks at the regional level.

17. Recommendations for overcoming these barriers and promoting environmental sustainability, resilience, and inclusion involve a mix of well-crafted policies and robust investments. Policy priorities for making agrologistics more efficient, green, resilient and inclusive revolve around a redirection of public support towards the provision of public goods and services for agri-food systems. Public direct subsidies to private agricultural enterprises can usefully be redirected to: (a) encourage the private provision of agrologistics goods, such as on-farm or collective investments in cold chains and upgraded storage; and (b) finance essential public goods and services that are in short supply, especially for increased agricultural knowledge and innovation systems, improved inspection processes, and more and better rural infrastructure and port systems. Private engagements should, moreover, emphasize producing positive environmental and social externalities. In light of the importance of regional trade, and of leveraging opportunities for regional coordination to strengthen integration into global markets, advancing a regional agenda in the context of the Central American Integration System (SICA) is highly warranted, including on issues such as regional mobility and logistics, integrated SPS systems, harmonized border procedures, and trade negotiations. In some cases, synergies may be leveraged with the private sector, through public-private partnerships especially for R&D, e.g. on cost-effective storage and processing systems that increase value added. Investment options include actions in each link of the agrologistics value chain, from post-harvest, storage, and processing, to transport and distribution. Targeted solutions and innovations can be tailored to the reality of specific agriculture value chains.

18. While several of the identified investments priorities will ultimately rely on private adoption and investment, environmental and social externalities justify complementary action by the public sector. This would include for example technical assistance, matching grants programs, and actions to promote financial inclusion in rural areas, to ensure adequate adoption of climate-smart, efficiency-enhancing agrologistics technologies on the part of family farmers. In any case, the use of public financing to provide private goods should follow three overarching principles: (i) be economically viable; (ii) be temporary; and (iii) be designed to crowd in private sector development in the market.

19. The public sector can also play a critical role in facilitating agrologistics development through regulatory or legislative reforms to strengthen the agribusiness and innovation enabling environment. Improving the predictability and agility of policy regimes and regulatory processes, notably for sanitary and phytosanitary controls, cross-border clearances and trade regimes, as well as for ensuring expanded access to financial services, will reduce costs and risks, and will favorably impact investment and innovation decisions by family farmers and private actors along agri-food value chains.

References

- » Abuelafia, E.; Astudillo, J. A.; Barrios, J. J.; Coj-Sam, J.; Del Carmen, G.; Díaz, A. K.; Escobar, J.; Filippo, A.; Garcimartín, C.; Lagarda, G.; Linares, J.; López, A.; Fritscher, A.M.; Mejía, A.; Prat, J.; Solórzano, J.D.; Torrentes García, A.L.; Vargas, F., and Zentner, J. (2019). Country Infrastructure Briefs: Central America, Mexico, Panama and the Dominican Republic. Inter-American Development Bank. Washington, D.C.
- » Aker, J. C. (2010). Information from markets near and far: Mobile phones and agricultural markets in Niger. *American Economic Journal: Applied Economics*, 2(3), 46-59.
- » Almeida, Eduardo Marques; Prat, Jordi et al. (ed.). 2019. Honduras: A territorial Approach to Development. IDB and IDB Invest. Available online at: <https://publications.iadb.org/en/honduras-territorial-approach-development>.
- » ANACAFE. (2021). Annual Report for 2019-2020. Available online at: <https://www.anacafe.org/conozcanos/cafes-de-guatemala/>.
- » Anríquez, G.; Foster, W.; Ortega, J.; Falconi, C., and De Salvo, C.P. (2016). Public Expenditure and the Performance of Latin American and Caribbean Agriculture. Working Paper 722, Inter-American Development Bank, Washington, DC.
- » Augustin, Maria; Acero, Jose Luis; Aguilera, Ana I., and Garcia Lozano, Marisa. (2017). Central America Urbanization Review: Making Cities Work for Central America. Directions in Development - Countries and Regions. Washington, DC: World Bank. Available online at: <https://openknowledge.worldbank.org/handle/10986/26271>. License: CC BY 3.0 IGO.
- » Beaudry, R.M. (2010, October). Future trends in innovations in controlled atmosphere storage and modified atmosphere packaging technologies. *Acta Horticulturae*. Available online at: https://www.actahort.org/books/876/876_1.htm.
- » Bermeo, S. and Leblang, D. (2021). Honduras Migration: Climate Change, Violence, & Assistance. Duke Sanford Center for International Development. Available online at: <https://dcid.sanford.duke.edu/wp-content/uploads/sites/7/2021/03/Honduras-Migration-Policy-Brief-Final.pdf>.
- » Blitzer, J. (2019, April 3). How climate change is fuelling the U.S. border crisis. *New Yorker*. Available online at: <https://www.newyorker.com/news/dispatch/how-climate-change-is-fuelling-the-us-border-crisis>.
- » Borja, I.; Carpio, C.; Castillo, M.J.; García, M.; Palma, M.; Peguero, F.; Ribera, L.; Sánchez, M.; Sandoval, L.A., and Zapata, S.D. (2020). Impacto del COVID-19 en la cadena agroalimentaria de Latinoamérica. Technical Report. Texas A&M. <https://doi.org/10.13140/RG.2.2.34409.11365>.
- » Bourguignon, F., & Pleskovic, B. (Eds.). (2008). Rethinking infrastructure for development (Vol. 2). World Bank Publications.
- » Bro, A. S.; Clay, D. C.; Ortega, D. L., & Lopez, M. C. (2019). Determinants of adoption of sustainable production practices among smallholder coffee producers in Nicaragua. *Environment, Development and Sustainability*, 21(2), 895-915.
- » Bunn, C. (2019). Achieving climate-smart coffee in Central America. International Center for Tropical Agriculture (CIAT). Cali, Colombia.
- » Calatayud, A. and Montes, L. (editors). (2021). Logistics in Latin America and the Caribbean: Opportunities, Challenges, and Courses of Action. IDB Transport Division. The May 2021 “Moviblog” provides a summary at the time of the document launch: <https://blogs.iadb.org/transporte/es/sistemas-logisticos-en-mesoamerica-la-columna-vertebral-de-las-cadenas-de-valor/>
- » Catholic Relief Services. (2018). Saving water with new ecological wet mill designs. Available online at: <https://coffeelands.crs.org/2018/03/saving-water-with-new-ecological-wet-mill-designs/>.

- » CGIAR. (2022). Farmforce: Digital Management of Smallholders to Enable Sustainable Agricultural Sourcing. Available online at: <https://bigdata.cgiar.org/digital-intervention/farmforce/>.
- » Chopra, S.; Mueller, N., and Beaudry, R. (2022). Off-grid, clean energy cooling for affordable storage of perishables for bottom-of-the-pyramid farmers. Project 7-360. Available online at: https://sites.nationalacademies.org/PGA/PEER/PEERscience/PGA_189103.
- » Commission for the Defense and Promotion of Competition of Honduras. (2012). Study on the Supermarket Sector in Honduras. Supermarkets in Honduras: Central District and San Pedro Sula.
- » Congressional Research Service. (2022). Central American Migration: Root Causes and U.S. Policy. IF11151, VERSION 6.
- » Consejo Salvadoreño de Café (CSC). (2022). Mapa de producción. Available online at: <http://www.csc.gob.sv/cordilleras/>.
- » Crippa, M.; Solazzo, E.; Guizzardi, D.; Monforti-Ferrario, F.; Tubiello, F., and Leip, A. (2021). Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*, Volume 2, pages 198–209. Available online at: <https://doi.org/10.1038/s43016-021-00225-9>.
- » Delgado, L.; Nakasone, E., and Torero, M. (2021). Impacts of market-based contractual arrangements with farmers in Guatemala and Honduras. International Food Policy Research Institute.
- » Delgado, L.; Schuster, M., and Torero, M. (2021). On the origins of food loss. *Applied Economic Perspectives and Policy*, 43(2), 750-780.
- » Díaz-Bonilla, E.; Saini, E.; Henry, G.; Creamer, B., and Trigo, E. (2014). Global Strategic Trends and Agricultural Research and Development in Latin America and the Caribbean: A Framework for Analysis. Cali, Colombia: International Center for Tropical Agriculture. Dirección de Ciencia y Tecnología Agropecuaria de Honduras. (Accessed 2022, May). Uso y manejo del silo metálico. Available online at: <https://dicta.gob.hn/files/2015,-Uso-y-manejo-del-silo-metalico,-G.pdf>.
- » Dorosh, P.; Wang, H. G.; You, L., and Schmidt, E. (2012). Road connectivity, population, and crop production in Sub Saharan Africa. *Agricultural Economics*, 43(1), 89-103.cs, 152, 102686.
- » Draper, Kathleen. (2018, October). The Potential for Biochar to Improve Sustainability in Coffee Cultivation and Processing: A White Paper. Ithaka Institute for Carbon Intelligence. Available online at: <https://www.biochar-journal.org/en/ct/95>.
- » Ebata, A.; Velasco Pacheco, P. A., & von Cramon Taubadel, S. (2017). The influence of proximity to market on bean producer prices in Nicaragua. *Agricultural Economics*, 48(4), 459-467.
- » Ebata, A., & Huettel, S. (2019). The effect of value chain interventions for staple crops: evidence from small-scale farmers in Nicaragua. *The Journal of Development Studies*, 55(4), 581-596.
- » Eckstein, D., Künzel, V. and Schäfer, L. (2021). Global Climate Risk Index 2021: Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2019 and 2000-2019. Germanwatch. Available online at: https://www.germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf.
- » ECLAC. (2016). Foreign Direct Investment in Latin America and the Caribbean 2016. Available online at: <https://www.cepal.org/en/publications/40214-foreign-direct-investment-latin-america-and-caribbean-2016>.
- » ECLAC. (2017). Foreign Direct Investment in Latin America and the Caribbean 2017. Available online at: <https://www.cepal.org/en/publications/42024-foreign-direct-investment-latin-america-and-caribbean-2017>.
- » ECLAC. (2018). Foreign Direct Investment in Latin America and the Caribbean 2018. Available online at: <https://www.cepal.org/en/publications/43690-foreign-direct-investment-latin-america-and-caribbean-2018>.
- » ECLAC. (2019). Foreign Direct Investment in Latin America and the Caribbean 2019. Available online at: <https://www.cepal.org/en/publications/44698-foreign-direct-investment-latin-america-and-caribbean-2019>.

- » ECLAC. (2020). Foreign Direct Investment in Latin America and the Caribbean 2020. Available online at: https://repositorio.cepal.org/bitstream/handle/11362/47209/1/ECLAC-FAO21-22_en.pdf.
- » ECLAC. (2021). The Outlook for Agriculture and Rural Development in the Americas: A Perspective on Latin America and the Caribbean 2021-2022. Available online at: https://repositorio.cepal.org/bitstream/handle/11362/47209/1/ECLAC-FAO21-22_en.pdf.
- » ECLAC and FAO (2020). Food systems and COVID-19 in Latin America and the Caribbean. The opportunity for digital transformation. Available online at: <https://repositorio.cepal.org/handle/11362/45723>.
- » Egas Yerovi, J.J., & De Salvo, Carmine Paolo. (2018, May). Agricultural Support Policies in Latin America and the Caribbean: 2018 Review. Inter-American Development Bank. Washington, D.C.
- » Ehrbeck, T., & Stein, P. (2014). Acceso a las finanzas para pequeños productores agropecuarios. International Finance Corporation. Washington D.C.
- » El Salvador - Superintendency of Competitiveness (2014).
- » El Salvador, Gobierno de. (2007). IV Censo Agropecuario 2007-2008: Resumen de Resultados. Available online at: <https://www.mag.gob.sv/wp-content/uploads/2021/06/iv-censo-agropecuario-resumen-nacional.pdf>.
- » El Salvador, Gobierno de. (2021). Plan Maestro de Rescate Agropecuario: Hacia una agricultura sostenible y sustentable. Available online at: <https://www.transparencia.gob.sv/institutions/mag/documents/417721/download>.
- » European Commission. (2020). Farm to Fork strategy for a fair, healthy and environmentally-friendly food system. Document 52020DC0381. Available online at: https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en#Strategy.
- » European Commission. (2022). EU trade relations with Central America. Facts, figures and latest developments. Available online at: https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/central-america_en.
- » Fair Trade America (2021). Coffee Impact Report 2020. Available online at: <https://www.fairtradeamerica.org/why-fairtrade/global-impact/reports-trends/coffee-impact-report-2020/>.
- » Falagan, N., & Terry, L. (2018). Recent advances in controlled and modified atmosphere of fresh produce. Johnson Matthey Technology Review, 2018, Vol 62. Available online at: <https://doi.org/10.1595/205651318X696684>.
- » FAO. (2013). Alianzas público-privadas para el desarrollo de agronegocios – Informe de país: Guatemala. Estudios de casos de países – América Latina. Roma.
- » FAO. (2015). Logistics in the horticulture supply chain in Latin America and the Caribbean. Available online at: <https://www.fao.org/3/i4792e/i4792e.pdf>.
- » FAO. (2021). Dry Corridor in El Salvador, Guatemala and Honduras: Land of opportunities. Available online at: https://www.fao.org/fileadmin/user_upload/rlc/docs/DryCorridor.pdf.
- » FAO. (2021b). Analysis of the exportable supply of agricultural products from the region of the Central American Integration System (SICA): Identifying opportunities. Rome: FAO.
- » FAO. (2022). Food Loss and Waste Database. Online food loss calculator. Available online at: <https://www.fao.org/platform-food-loss-waste/flw-data/en/>.
- » FAOSTAT. (2010). Food and Agriculture Data for 2010. Rome: FAO. Available online at: <https://www.fao.org/faostat/en/#home>.
- » FAOSTAT. (2018). Food and Agriculture Data for 2018. Rome: FAO. Available online at: <https://www.fao.org/faostat/en/#home>.
- » FAOSTAT. (2019). Food and Agriculture Data for 2019. Rome: FAO. Available online at: <https://www.fao.org/faostat/en/#home>.

- » FAOSTAT. (2020). Food and Agriculture Data for 2020. Rome: FAO. Available online at: <https://www.fao.org/faostat/en/#home>.
- » FAO & EBRD. (2020). Export logistics of agricultural products to the countries of Central and Eastern Europe: challenges and opportunities for Morocco. Rome: FAO.
- » FAO & Regional Unit for Technical Assistance (RUTA) (2010). Small producers of basic grains of basic grains in Central in Central America: Quantification, characterization, income level, poverty, demographic, socioeconomic and occupational profiles. Rome: FAO.
- » FAO Global Information and Early Warning System (GIEWS). (2021c). Country Profiles for El Salvador, Guatemala and Honduras. Available online at: <https://www.fao.org/giews/countrybrief/index.jsp>.
- » Feed the Future Innovation Lab for Horticulture. (2011). Demonstrating Low-Cost Cooling Technology in Uganda, Honduras and India. Available at: <https://horticulture.ucdavis.edu/project/demonstrating-low-cost-cooling-technology-uganda-honduras-and-india>.
- » Famine Early Warning Systems Network (FEWS NET). (2002). Guatemala Price Bulletin February 2022. Available online at: https://fews.net/sites/default/files/documents/reports/PB_GT_202202_EN.pdf.
- » FEWS NET. (2021). Food security Outlook Central America and the Caribbean, November 2021. Available online at: <https://fews.net/central-america-and-caribbean/food-security-outlook/november-2021>.
- » FEWS NET. (2022). Production and Market Flow Map: Central America First Maize. Available at: https://fews.net/sites/default/files/documents/reports/Central_America_maize_fullmap_primera_en.pdf.
- » Fioravanti, R.; Uechi, L.; Granada, I.; Rendón, J.R.; Benitez, C.; Martínez Rivas, M., and Venot, C.S. (2019). Plan Nacional de Logística de Cargas PNLOG El Salvador 2018-2032. Washington, D.C.: IDB. Available at: https://publications.iadb.org/publications/spanish/document/Plan_Nacional_de_Log%C3%ADstica_de_Cargas_PNLOG_El_Salvador_2018-2032_es.pdf.
- » Fischer et al. (2011). 5 Year Ex-Post Impact Study POSTCOSECHA Programme Central America. Swiss Agency for Development and Cooperation SDC. Available at: https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/phm_ic_postcosecha_impact_study.pdf.
- » The Food Systems Dashboard, Global Alliance for Improved Nutrition (GAIN) and Johns Hopkins University. (2020). Data for Central America. Geneva, Switzerland. Available online at: <https://foodsystemsdashboard.org>. DOI: <https://doi.org/10.36072/db>.
- » Fraga, Federico. (2020). Central American dry corridor: An exploration of the potential of a job creation strategy for Guatemala and Honduras. International Labour Organization Working Paper No. 23 - 2020. Available online at: https://papyrus.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_744900.pdf.
- » Fromm, Ingrid. (2022). Building Resilient Value Chains After the Impact of the COVID-19 Disruption: Challenges for the Coffee Sector in Central America. Available online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2021.775716/full>.
- » Global Cold Chain Alliance. (2018). Global Cold Storage Capacity Report. Available online at: <https://www.gcca.org/sites/default/files/2018%20GCCA%20Cold%20Storage%20Capacity%20Report%20final.pdf>.
- » Grashuis, J., & Su, Y. (2019). A review of the empirical literature on farmer cooperatives: Performance, ownership and governance, finance, and member attitude. *Annals of Public and Cooperative Economics*, 90(1), 77-102.
- » Griffin, Michael. (2006). Coffee Drying. Coffee Research Institute. Available online at: <http://www.coffeeresearch.org/agriculture/drying.htm>.
- » Guatemala - Ministerio de Agricultura, Ganadería y Alimentación (MAGA-UI). (2002).
- » Guatemala - Ministerio de Economía y Comercio (MINECO). (2015).

- » Guatemala, Gobierno de. (2004). Características generales de las fincas censales y de productoras y productores agropecuarios (Resultados definitivos). Available online at: <https://www.ine.gob.gt/sistema/uploads/2014/01/16/cv9H2R2CyhS1n0c1XfKqXVf4pLxONTg.pdf>.
- » Guatemala, Gobierno de, & IDB. (2016). Plan Estratégico Nacional de Logística de Cargas – PENLOG Guatemala, 2015-2030. Available online at: <https://www.caminos.gob.gt/files/Plan-estrategico-Nacional-Logistica-Cargas.pdf>.
- » Harvard University Growth Lab. (2019). Atlas of Economic Complexity. Available online at: <https://atlas.cid.harvard.edu>.
- » ICTA. (2022). Programa de Maíz. Instituto de Ciencia y Tecnología Agrícolas - Investigación para el Desarrollo Agropecuario. Available online at: <https://www.icta.gob.gt/maiz#:~:text=El%2062.3%25%20de%20la%20superficie,2015%3B%20MAGA%2C%202018>.
- » IDB. (2021, December). The Infrastructure Gap in Latin America and the Caribbean: Investment Needed Through 2030 to Meet the Sustainable Development Goals. Washington D.C.: IDB.
- » IDB Agrimonitor (2021). Product Support Estimates Agricultural Policy Monitoring System. Available online at: <https://mydata.iadb.org/Agriculture-and-Rural-Development/IDB-Agrimonitor-PSE-Agricultural-Policy-Monitoring/2dqw-u35p>.
- » IICA. (2014). Regional Assessment - LA: Maize situation in Latin America: Outlook and investment opportunities. Available online at: <https://repositorio.iica.int/handle/11324/6465>.
- » IICA. (2019). Agricultural policy for the SICA region 2019-2030. Central American Agricultural Council, Central American Integration System.
- » IICA. (2020). Rural Connectivity in Latin America and the Caribbean: A Bridge to Sustainable Development During a Pandemic. Available online at: <https://www.iica.int/en/press/news/least-77-million-rural-inhabitants-latin-america-and-caribbean-have-no-access-high>.
- » IICA. (Accessed 2022, May 22). Caracterización de la cadena de maíz blanco en El Salvador. Available online at: <http://simag.mag.gob.sv/uploads/pdf/Presentaciones201381915825.pdf>.
- » IICA, CENTA and Ministerio de Agricultura y Ganadería de El Salvador (MAG). (Accessed 2022, May 22). Caracterización de la cadena productiva de frijol rojo en El Salvador. Available online at: <http://repiica.iica.int/docs/B4151e/B4151e.pdf>.
- » Ijanu, E.M.; Kamaruddin, M.A., & Norashiddin, F.A. (2020). Coffee processing wastewater treatment: a critical review on current treatment technologies with a proposed alternative. *Applied Water Science* (2020), Vol 10:11. Available online at: <https://doi.org/10.1007/s13201-019-1091-9>.
- » Ikegwuono, Nnaemeka C. (2018, November 20). ColdHubs: Addressing the crucial problem of food loss in Nigeria with solar-powered refrigeration. International Food Policy Research Institute. Available online at: <https://www.ifpri.org/blog/coldhubs-addressing-crucial-problem-food-loss-nigeria-solar-powered-refrigeration>.
- » Infralatam. (2019). Public Investment in Economic Infrastructure 2019. Available online at: <http://infralatam.info/en/home/>.
- » Instituto Hondureño de Café (IHCAFE). (2022). Nuestras seis regiones cafetaleras. Available online at: <https://www.ihcafe.hn/regiones-cafeteleras/>.
- » Integrated Food Security Phase Classification (IPC). (2021, September 13). El Salvador: Acute Food Insecurity Situation July - August 2021 and Projections for September 2021 - February 2022 and March to May 2022. Available online at: <https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1155106/>.
- » Integrated Food Security Phase Classification (IPC). (2021, June 14). Guatemala: Integrated Food Security Phase Classification Snapshot - May 2021 - January 2022. Available online at: https://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/docs/IPC_Guatemala_AcuteFoodInsecurity_2021May2022Jan_Snapshot_English.pdf.

- » Integrated Food Security Phase Classification (IPC). (2022, January 24). Honduras: Acute Food Insecurity Situation December 2021 to February 2022 and Projections for March to May 2022 and June to August 2022. Available online at: <https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1155409/>.
- » International Coffee Organization. (2020). Daily Coffee prices. ICO Statistics. Available online at: http://www.ico.org/coffee_prices.asp.
- » International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank and the World Health Organization (WHO). (2021). Tracking SDG 7: The Energy Progress Report. Study led jointly by the custodian agencies. Available online at: <https://www.irena.org/publications/2021/Jun/Tracking-SDG-7-2021>.
- » International Finance Corporation. (2021, December). Digital Entrepreneurship and Innovation in Central America. December 2021. Available online at: <https://www.ifc.org/wps/wcm/connect/e79b3d82-120e-4d2b-a013-79576f7cb7f7/Digital+Entrepreneurship+and+Innovation+in+Central+America.pdf?MOD=AJPERES&CVID=nUQLFqp>.
- » International Fund for Agricultural Development (IFAD). (2016). Central America strengthens partnerships for policy dialogue on family farming. Press release No.: IFAD/30/2016. Available online at: https://www.ifad.org/en/web/latest/-/news/central-america-strengthens-partnerships-for-policy-dialogue-on-family-farming?p_l_back_url=%2Fen%2Fweb%2Flatest%2Fgallery%3Fmode%3Dsearch%26page%3D67%26delta%3D125%26start%3D9.
- » International Institute for Strategic Studies (IISS). (2021, November 15). How climate change risks further destabilising Central America. Available online at: <https://www.iiss.org/blogs/analysis/2021/11/how-climate-change-risks-further-destabilising-central-america>.
- » International Labour Organization (ILO). (2022). ILOSTAT database. Data for El Salvador, Guatemala, Honduras, Costa Rica, Panama, LAC. Available online at: <https://ilostat.ilo.org/data/>.
- » International Renewable Energy Agency (IRENA). (2022). Renewable Energy Roadmap for Central America: Towards a Regional Energy Transition. International Renewable Energy Agency, Abu Dhabi.
- » International Telecommunication Union (ITU). (2022a). World Telecommunication/ICT Indicators Database. Individuals using the Internet (% of population) in Costa Rica, El Salvador, Guatemala, Honduras, Panama. Available online at: <https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>.
- » International Telecommunication Union (ITU). (2022b). World Telecommunication/ICT Indicators Database. Mobile Cellular Subscriptions (per 100 people) in Costa Rica, El Salvador, Guatemala, Honduras, Panama. Available online at: <https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>.
- » Jacoby, H. G., & Minten, B. (2009). On measuring the benefits of lower transport costs. *Journal of Development Economics*, 89(1), 28-38.
- » KNOMAD. (Accessed 2022, May 19). Database on Remittance Inflows. Data for El Salvador, Guatemala, Honduras, World. Available online at: <https://knomad.org/data/remittances>.
- » Latinobarómetro (2020). Survey data for El Salvador, Guatemala and Honduras in response to the question: ¿Ud y su familia han pensado en la posibilidad concreta de ir a vivir a otro país? Available online at: <https://www.latinobarometro.org/latOnline.jsp>.
- » Llanto, G. M. (2012). The impact of infrastructure on agricultural productivity. Discussion Paper Series No. 2012-12. Manila: Philippine Institute for Development Studies.
- » Lopez, C.A.; Salazar, L., and De Salvo, C.P. (2017). Public Expenditures, Impact Evaluations and Agricultural Productivity. Technical Note IDB-TN-1242, Inter-American Development Bank, Washington, DC.
- » Lopez, R., and Galinato, G.I. (2007). Should Governments Stop Subsidies to Private Goods? Evidence from Latin America. *Journal of Public Economics* 91: 1071-94.

- » Lopez-Ridaura, S.; Sanders, A.; Barba-Escoto, L.; Wiegel, J.; Mayorga-Cortes, M.; Gonzalez-Esquivel, C.; Lopez-Ramirez, M.A.; Escoto-Masis, R.M.; Morales-Galindo, E., and García-Barcena, T.S. (2021, August). Immediate impact of COVID-19 pandemic on farming systems in Central America and Mexico. CIMMYT. In *Agricultural Systems* 192 (2021) 103178.
- » Asociación Maíz y Sorgo Argentino (MAIZAR). (2010). Serie de estudios sectoriales: Caso del maíz. Available online at: <http://www.maizar.org.ar/documentos/maiz-informe-final.pdf>.
- » McKinsey & Company. (2020). Brazilian farmers' approach to digital: Embracing digital. Available online at: <https://www.mckinsey.com/industries/agriculture/our-insights/brazilian-farmers-approach-to-digital>.
- » Meister, E. (2017). *New York City Coffee: A Caffeinated History*. American Palate Series. Stroud: The History Press. p. 144.
- » Mercy Corps. (2017, January 18). Technology connects snow pea farmers to success. Available online at: <https://www.mercycorps.org/blog/guatemala-technology-farmers>.
- » Méthot, J., & Bennett, E.M. (2018, May 24). Reconsidering non-traditional export agriculture and household food security: A case study in rural Guatemala. *Plos One*. Available online at: <https://doi.org/10.1371/journal.pone.0198113>.
- » Morris, M.; Sebastian, A.R.; Perego, V.; Nash, J.D.; Diaz-Bonilla, E.; Pineiro, V.; Laborde, D.; Chambers, T.T.; Prabhala, P.; Arias, J.; De Salvo, C.P., and Centurion, M.E. (2020). *Future Foodscapes : Re-imagining Agriculture in Latin America and the Caribbean*. Washington D.C.: World Bank Group.
- » Mugwagwa, I.; Bijman, J., and Trienekens, J. (2020). Typology of contract farming arrangements: a transaction cost perspective. *Agrekon*, 59:2, 169-187.
- » Nestlé. (2016). *Nestlé in Society: Creating Shared Value and Meeting our Commitments 2016*. Available online at: https://www.nestle.com/sites/default/files/asset-library/documents/library/documents/corporate_social_responsibility/nestle-in-society-summary-report-2016-en.pdf.
- » Olivares, I. (2021, May 28). Walmart exporta hortalizas y granos básicos de Nicaragua al resto de Centroamérica. 25 Confidencial. Available online at: <https://www.confidencial.com.ni/economia/walmart-exporta-hortalizas-y-granos-basicos-de-nicaragua-al-resto-de-centroamerica/>.
- » Oliveros, C.; Sanz-Urbe, J., Montoya-Restrepo, E.C., and Ramirez-Gomez, C.A. (2011). Equipo para el lavado ecológico del café con mucílago degradado con fermentación natural. Universidad de Los Andes. *Revista de Ingeniería*. Bogotá D.C., Colombia. Issue 33, January 2011, pp. 61-67.
- » Organización Latinoamericana de Energía (OLADE). (2021). *Energy Prices in Latin America and the Caribbean: Annual Report - April 2021*. The World Bank and OLADE. Available online at: <https://biblioteca.olade.org/opac-tmpl/Documentos/old0463.pdf>.
- » Oxford Business Group. (2020). The impact of Covid-19 on global supply chains. Available online at: <https://oxfordbusinessgroup.com/news/impact-covid-19-global-supply-chains>.
- » Parada, J. (2016). *Access to modern markets and the impacts of rural road rehabilitation: Evidence from Nicaragua*. Job Market Paper; University of California: Davis, CA, USA.
- » Perego, V.M.E.; Romero, J.; Freeman, K.; Lopez, A.; Ortiz, G.; Salas, H.; Ramirez, R.; Locatelli, A.; Orihuela, D., & de Ferrari, C. (2022). DIGITAGRO - Investing in Digital Technology to Increase Market Access for Women Agripreneurs in Guatemala. Report No: ACS34060. The World Bank. Washington, D.C.
- » Perfect Daily Grind. (2017, August 3). Green Coffee: How Wet Milling is Becoming More Eco-Friendly. Available online at: <https://perfectdailygrind.com/2017/08/green-coffee-how-wet-processing-is-becoming-more-eco-friendly/>.
- » Piñeiro. (2005). *Rural Development in Latin America: Trends and Politics*. Grupo CEO. Argentina. Available online at: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.470.6727&rep=rep1&type=pdf>.

- » Popkin, B. M. and Reardon, T. (2018). Obesity and the food system transformation in Latin America. *Obesity reviews: an official journal of the International Association for the Study of Obesity*, 19(8), 1028–1064.
- » Programa de Diálogo Regional Rural. (2017). Política de Agricultura Familiar Campesina, Indígena y Afrodescendiente PAFCIA 2018-30. Available online at: <https://www.ruralforum.org/wp-content/uploads/2021/10/pafoia.pdf>.
- » Quezada, M.Y.; Moreno, J., et al. (2006). Hermetic storage system preventing the proliferation of *Prostephanus truncatus* Horn and storage fungi in maize with different moisture contents. *Postharvest Biology and Technology*. 39 (3): 321–326. Available online at: <https://www.sciencedirect.com/science/article/pii/S0925521405002048?via%3Dihub>.
- » Reardon, T.; Belton, B.; Liverpool-Tasie, L.S.O.; Lu, Liang; Nuthalapati, C.S.R.; Tasie, O., & Zilberman, D. (2021). E-commerce's fast-tracking diffusion and adaptation in developing countries. *Applied Economic Perspectives and Policy*. 2021;1–17. Available online at: <https://doi.org/10.1002/aepp.13160>.
- » República de Guatemala. (2004, January). IV Censo Nacional Agropecuario. Instituto Nacional de Estadística. Available online at: <https://www.ine.gob.gt/sistema/uploads/2014/01/16/cv9H2R2CyhS1n0c1XfKqXVf4pLlxONTg.pdf>.
- » Reyes Hernandez. (2013).
- » Roa, G.; Oliveros, C.E., et al. (2010). Ecological Processing of Coffee at the Farm Level. CENICAFE. Available online at: https://www.ctahr.hawaii.edu/Hawaii/downloads/Low_Water_use_processing.pdf.
- » Romero W. (2013). La Agricultura Familiar en Guatemala. Informe del Proyecto Análisis de la Pobreza y de la Desigualdad en América Latina Rural. Available online at: https://www.rimisp.org/wp-content/files_mf/1438712425148_Agricultura_Familiar_Guatemala_Romero_editado.pdf.
- » Ruiz Soto, A.G.; Bottone, R.; Waters, J.; Williams, S.; Louie, A., and Wang, Y. (2021). Charting a New Regional Course of Action - The Complex Motivations and Costs of Central American Migration. World Food Programme, Migration Policy Institute, and Civic Data Design Lab at Massachusetts Institute of Technology. Rome, Washington, DC, and Cambridge, MA. Available online at: https://www.migrationpolicy.org/sites/default/files/publications/mpi-wfp-mit_migration-motivations-costs_final.pdf.
- » Samper Kutschbach, M. (2019). The Central American Coffee Commodity Chain. Oxford Research Encyclopedia of Latin American History. Oxford University Press. Available online at: <https://oxfordre.com/latinamericanhistory/view/10.1093/acrefore/9780199366439.001.0001/acrefore-9780199366439-e-606>.
- » Sanders, A. (2019). Assembling the Horticulture Value Chain in Western Honduras. Pennsylvania State University. Available online at: https://etda.libraries.psu.edu/files/final_submissions/20075.
- » Sanders, A.; Thomas, T.S.; Rios, A., & Dunston, S. (2019). Climate Change, Agriculture, and Adaptation Options for Honduras. IFPRI Discussion Paper 01827, April 2019.
- » Sánchez, H.A. (2019). Urban and Peri-urban Agriculture. Territorial Rearrangement and Potential of Urban Food Systems. Geographical investigations, Universidad Nacional Autónoma de México.
- » Schroeder, K.; Lampietti, J., and Elabed, G. (2021). What's Cooking: Digital Transformation of the Agri-food System. The World Bank. Washington, D.C. Available online at: <https://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-1657-4>.
- » Secretaría de Integración Centroamericana (SICA). (2019). Opinión - ¿Un tren para Centroamérica? Available online at: https://www.sica.int/noticias/opinion-un-tren-para-centroamerica_1_119821.html.
- » Secretaría de Integración Económica Centroamericana (SIECA). (2018). Articulación productiva y cadenas regionales de valor: Una propuesta metodológica para la región SICA. Available online at: <http://www.oie.sieca.int/documentos/BajarDocumento?archivo=Articulación+productiva+y+cadenas+regionales+de+valor.pdf>.
- » Secretaría de Integración Económica Centroamericana (SIECA). (2022). Sistema de estadísticas de comercio de Centroamérica. Available online at: <http://www.sec.sieca.int>.

- » Shamdasani, Y. (2021). Rural road infrastructure & agricultural production: Evidence from India. *Journal of Development Economics*
- » Stads, G.-J.; Hartwich, F.; Rodríguez, D., and Enciso, F. (2008). Agricultural R&D in Central America: Policy, investments and institutional profile. ASTI, IFPRI, IICA joint publication. Available online at: <https://www.ifpri.org/publication/agricultural-rd-central-america>.
- » Swiss Agency for Development and Cooperation. (2015). Food Losses: Simple Technology, Big Impact. Rural 21: The International Journal for Rural Development. Available online at: https://www.rural21.com/english/news/detail/article/simple-technology-big-impact.html?no_cache=1
- » Trocaire. (2014). Feeling the Heat: How climate change is driving extreme weather in the developing world. Available online at: <https://www.oxfordmartin.ox.ac.uk/blog/cold-chains-covid-19-food-crisis/>.
- » Trotter, P., & Mugisha, M. (2020, June 19). Cold chains can help mitigate the COVID-19 food crisis: key lessons from Uganda. Oxford Martin School. Available online at: <https://www.oxfordmartin.ox.ac.uk/blog/cold-chains-covid-19-food-crisis/>.
- » Udomkun, P.; Romuli, S.; Schock, S.; Mahayothee, B.; Sartas, M.; Wossen, T.; Njukwe, E.; Vanlauwe, B., and Müller, J. (2020). Review of solar dryers for agricultural products in Asia and Africa: An innovation landscape approach. *Journal of environmental management* 2020 v.268 pp. 110730. Available online at: <https://pubag.nal.usda.gov/catalog/6954022>.
- » United Nations. (2022). International Trade Statistics Database - COMTRADE. Available online at: <https://comtrade.un.org>.
- » UNDP. (2021, July 8). Agricultural cold storage. SDG Investor Platform. Available online at: <https://sdginvestorplatform.undp.org/market-intelligence/agricultural-cold-storage>.
- » United States Agency for International Development (USAID). (2021). Monitoring and Evaluation Support for Collaborative Learning and Adapting (MESCLA), National Victimization Security and Migration (NVSM) Survey, 2021. Available online at: https://pdf.usaid.gov/pdf_docs/PA00XXC9.pdf.
- » United States Department of Agriculture (USDA), Economic Research Service. (2005). New Directions in Global Food Markets. Chapter 4. Supermarket Expansion in Latin America and Asia: Implications for Food Marketing Systems. Thomas Reardon, C. Peter Timmer, and Julio A. Berdegue. Agriculture Information Bulletin Number 794. Washington, D.C.
- » United States Department of Agriculture (USDA), Economic Research Service. (2019, April). Calculations on consumer expenditures spent on food, alcoholic beverages and tobacco by selected countries for 2018 based on annual household expenditure data from Euromonitor. Available online at: <https://www.google.com/>



2022