



POLICIES FOR HIGH QUALITY, SAFE, AND SUSTAINABLE FOOD SUPPLY IN THE GREATER MEKONG SUBREGION

Edited by Thomas R. D. Weaver, Pavit Ramachandran,
and Lourdes S. Adriano

MAY 2019



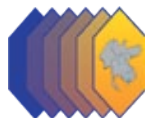
GREATER MEKONG
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CORE AGRICULTURE
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Foreword

The six countries of the Greater Mekong Subregion (GMS) are globally renowned for their diverse range of produce and delectable cuisines. It is little surprise that both domestically and internationally there has been steady and rising demand for the subregion's agriculture products. In recent years, consumers have been increasingly looking to GMS countries to provide higher-quality foods that are produced in a safe and sustainable manner.

The GMS Working Group in Agriculture (WGA), in coordination with the Core Agriculture Support Program, Phase II, has spearheaded a number of initiatives to increase the availability of safe food, with a focus on production quality, human health, and trade. Work to enhance the coordination, alignment, and harmonization of domestic, import, and export policy, legislation, and regulatory frameworks has helped increase market access for the subregion's smallholders and exporters.

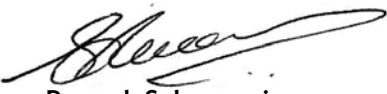
In 2017, the WGA hosted a series of events to promote GMS achievements in agriculture and food supply, and to disseminate the knowledge generated by these activities. The lively discourse at these events provided the foundation for a series of discussion papers on topics of critical importance to the food sector, including improving food safety, enhancing sustainability, and ensuring the continued growth of GMS agriculture.

These knowledge products helped inform discussions at the Second GMS Agriculture Ministers' Meeting in Siem Reap, Cambodia, in September 2017, which culminated in the unanimous endorsement of the new Strategy for Promoting Safe and Environment-Friendly Agro-Based Value Chains in the GMS. The strategy clearly defines the subregion's priorities in agriculture, and provides crucial guidance for policymaking, funding allocation, and industry decision-making for the sector's long-term prosperity.

This book, *Policies for High Quality, Safe, and Sustainable Food Supply in the Greater Mekong Subregion*, draws on much of the groundbreaking work conducted by the GMS WGA and its many collaborators in the areas of food safety, quality assurance, and environment and climate-friendly agriculture practices. It identifies key lessons on

enabling the transformation of the GMS agriculture industry from one that intensively applies synthetic agrochemicals to becoming low-input or organic, climate resilient, and gender responsive.

Each chapter of this book identifies specific lessons, as well as ongoing needs for investment, policy change, and institutional capacity building. Collectively, the chapters help form a basis for implementing the new GMS Strategy. It is our hope that the knowledge and experiences contained in this book will contribute to achieving a more competitive, safe, sustainable, and resilient GMS agriculture sector.



Ramesh Subramaniam
Director General
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Asian Development Bank

Acknowledgments

This book is a major output of the Core Agriculture Support Program, Phase II (CASP2). CASP2 is an Asian Development Bank (ADB) project aimed at assisting the Greater Mekong Subregion (GMS) economies in their efforts to produce safe, sustainable, and high quality food in the GMS and for export. The book was made possible by the contributions of many institutions and individuals.

Special thanks go to the GMS agriculture ministers for supporting and encouraging CASP2 and the production of this book, which is intended to help disseminate the knowledge gained from research and meetings.

The book's editors very much appreciate the guidance of ADB's Jiangfeng Zhang and Ramesh Subramaniam. The 16 authors who produced the papers for the events and this book are acknowledged individually in the Authors and Contributors section.

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The WGA-CASP2 technical experts include Francesco Goletti, Apichai Thirathon, Georgina Lim Nepomuceno, Vichelle Roaring-Arunsuwannakorn, Cynthia Gonzales, and other WGA secretariat technical team experts. Logistical support has been provided by Cecile Ramiro, Raquel Tabanao, Juraporn Sinlapharajanapanich, and Usama Jungudomporn. The National Secretariat Specialists are Somphavanh Nakhavong (for the Lao People's Democratic Republic), Chantola Nat (for Cambodia), Saowarop Panyacheewin (for Thailand), Yueming Shen (for the People's Republic of China), Le Truong Son (for Viet Nam), and Myat Thuzar Thein (for Myanmar).

Jill Gale de Villa edited the book and assisted with managing the book production project. Michael Cortes accomplished the design, layout, and typesetting. ADB's publications and printing units provided valuable assistance.

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Abbreviations

| | |
|---------|--|
| ACIAR | — Australian Centre for International Agricultural Research |
| ADB | — Asian Development Bank |
| AEC | — ASEAN Economic Community |
| AINS | — Agriculture Information Network System |
| ARAC | — ASEAN Risk Assessment Centre for Food Safety |
| ASEAN | — Association of Southeast Asian Nations |
| ASEAN+3 | — members of the ASEAN plus the People's Republic of China, Japan, and the Republic of Korea |
| CASP2 | — Core Agriculture Support Program, Phase II |
| CEDAC | — Center for Study and Agriculture Development in Agriculture (Centre d'Étude et de Développement Agricole Cambodgien) |
| CIRAD | — Centre de Coopération Internationale en Recherche Agronomique pour le Développement |
| CLM | — Cambodia, the Lao People's Democratic Republic, and Myanmar |
| CSA | — Community Supported Agriculture |
| DCZ | — disease control zone |
| DOA | — Department of Agriculture |
| EBA | — Everything But Arms |
| EU | — European Union |
| FAO | — Food and Agriculture Organization of the United Nations |
| FMD | — foot and mouth disease |
| GAP | — good agricultural practice |
| GDA | — General Department of Agriculture |
| GDP | — gross domestic product |
| GFSI | — Global Food Safety Initiative |
| GHG | — greenhouse gas |
| GI | — geographical indication |
| GMS | — Greater Mekong Subregion |
| GWM | — green water management |
| IAE | — Institute of Agricultural Environment |
| ICEM | — International Centre for Environmental Management |
| ICT | — information and communication technology |
| IFC | — International Finance Corporation |
| IFOAM | — International Federation of Organic Agricultural Movements |
| IRRI | — International Rice Research Institute |
| ISO | — International Organization for Standardization |
| IUSS | — International Union of Soil Scientists |
| IWMI | — International Water Management Institute |

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| IVY | — | International Volunteer Yamagata |
| Lao PDR | — | Lao People’s Democratic Republic |
| LOA | — | letter of agreement |
| MARD | — | Ministry of Agriculture and Rural Development |
| MOGPA | — | Myanmar Organic Growers and Producers Association |
| NAV | — | Natural Agricultural Village |
| NGO | — | nongovernment organization |
| NPK | — | nitrogen, phosphorus, and potassium |
| NUE | — | nitrogen use efficiency |
| OIE | — | World Organization for Animal Health (Organisation Mondiale de la Santé Animale, Organización Mundial de Sanidad Animal) |
| PAMCI | — | Production and Marketing Capacity Improvement for Sustainable Agriculture |
| PGS | — | participatory guarantee system |
| PRC | — | People’s Republic of China |
| R&D | — | research and development |
| RFID | — | radio-frequency identification |
| SDG | — | Sustainable Development Goal |
| SEAP | — | safe and environment- friendly agro-food product |
| SMEs | — | small and medium-sized enterprises |
| SOP | — | standard operating procedure |
| SPS | — | sanitary and phytosanitary |
| SPS Agreement | — | World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures |
| TAD | — | transboundary animal disease |
| TOAF | — | Thailand Organic Agriculture Foundation |
| TREA | — | Thai Rice Exporters Association |
| UNCTAD | — | United Nations Conference on Trade and Development |
| US | — | United States |
| USAID | — | United States Agency for International Development |
| WGA | — | Working Group in Agriculture |
| WHO | — | World Health Organization |
| WTO | — | World Trade Organization |
| YASVI | — | Yunnan Animal Science and Veterinary Institute |

Weights and Measures

| | | |
|----|---|----------|
| ha | — | hectare |
| kg | — | kilogram |
| t | — | ton |

Chapter 1

Introduction and Summary

Thomas R. D. Weaver and Lourdes S. Adriano

The Greater Mekong Subregion (GMS) comprises Cambodia, Guangxi Zhuang Autonomous Region and Yunnan Province of the People's Republic of China (PRC), the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam. The GMS has unique and often unharnessed comparative advantages in the supply of agro-food products, built upon its abundant natural resources, suitable climate, low production costs, proximity to large markets, and unique food items. The region is a perennial global leader in exporting key commodities—such as rice, coffee, and cashews. Intra and extra-GMS trade in a variety of agro-food products continues to grow strongly year-on-year, while infrastructure, trade facilitation and business environments are improving and the subregion is attracting increasing foreign direct investment in agriculture.

However, the subregion's current pest, disease, and residue issues hamper production, food safety, and market access. Local environmental degradation and the impacts of climate change threaten the sustainability of some systems. Many small and medium-sized agro-enterprises and producers in the GMS are limited by scale, are disconnected from markets, and suffer from inefficiencies in supply chains, which collectively reduce their competitiveness and ability to demonstrate food quality and safety. The GMS countries have made great progress in reforming national policies, enacting legislative and regulatory systems, and increasing food security; however, gaps remain and strategic investments, policy changes, and institutional capacity building are needed to ensure the sector's continued development. A regional approach to food policy driven by business and public interests can better protect consumers and suppliers in both domestic and export markets, support scaling up of production, and facilitate market access and GMS product branding and marketing. The GMS can become a global hub for the supply of safe and environment-friendly agro-food products (SEAPs).

Figure 1.1: The Greater Mekong Subregion



LAO PDR Lao People's Democratic Republic
 Boundaries are not necessarily authoritative.

This map was produced by the cartography unit of the Asian Development Bank. The boundaries, colors, denominations, and any other information shown on this map do not imply, on the part of the Asian Development Bank, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries, colors, denominations, or information.

Food safety and quality assurance are key challenges facing the global food sector, are a core component of food security, and form a major barrier to market access for the GMS countries. Food safety issues have become a priority for each GMS country in recognition of the high economic and social costs and in response to frequent headlines highlighting failures and scandals and consumer demand. Food safety failures cost the GMS economies billions of dollars per year in healthcare, lost labor and tourism, reduced demand for GMS products, and rejected consignments. Further, as the GMS countries become more integrated—collectively and with wider global markets—and as cross-border value chains continue to develop, it is imperative that the subregion’s food suppliers meet domestic and export market standards (from the farm to the consumer’s table) to remain competitive. Current policy and institutional gaps and priorities for investment need to be identified. It is essential that producers and the wider business community work closely with policymakers to develop unified regional approaches to address food safety. Establishing unified food safety systems that better protect consumers and suppliers in an inclusive and economically and environmentally sustainable manner is a recognized goal of the GMS countries. The systems are also needed to unlock markets for safe and environment-friendly GMS agro-food products.

The subregion’s agriculture is also threatened by local environmental degradation and the impacts of climate change. Identifying the best practices for building sustainable, resilient, and productive agricultural systems can reduce food safety risks presented by inappropriate use of synthetic agrochemicals such as fertilizers and plant protection products. Extensive research and development (R&D) on these topics is being conducted within the GMS. New supply models are being trialed and in many cases are gaining support, such as the participatory guarantee system (PGS) of peer-based assurance of organic production practices. The outcomes of these initiatives need to be shared within the region and the policy, institutional, and investment implications communicated to all public and private sector stakeholders.

Agricultural market value chains are typically complex and dynamic, nowhere more so than in the GMS. Strong economic growth, high rates of urbanization, and changing retail and consumption patterns are just some of the factors influencing food supply in the subregion. Moreover, with regional economic integration increasing through the establishment of the ASEAN Economic Community, GMS agricultural interests are confronting stiffer competition while being presented with new opportunities to link with multicountry processing and distribution networks. Developing a greater understanding of the mechanisms through which products, value, and information are generated and shared among stakeholders in GMS agriculture product supply is essential to identify and address the constraints and bottlenecks that currently hamper efficiency, limit market access and product differentiation, and present risks

to suppliers and consumers. Although agricultural supply in the GMS is extremely diverse, some key threats and opportunities are apparent across countries and products, making detailed investigation of select value chains and value chain issues pertinent to sector decision-making more broadly.

In light of these issues, a series of discussion papers were prepared for the Policy Forum and Special Session of the World of Food Safety Conference. The conference was hosted during THAIFEX–World of Food Asia, in Bangkok, Thailand, on 31 May through 4 June 2017. This event brought together public, private, and civil society from around the GMS with interest in agriculture and food. In addition, the informed discussions during the events contributed to the development of further papers presented at the Second GMS Agriculture Ministers’ Meeting held in Siem Reap, Cambodia, 6–8 September 2017 (Box 1.1, pp. 6–7).

This book, *Policies for High Quality, Safe, and Sustainable Food Supply in the Greater Mekong Subregion*, consolidates the papers, which are presented in chapters 2–10. The papers were prepared under the GMS Core Agriculture Support Program Phase II (CASP2) as a springboard for launching GMS stakeholders into examining some of the most pressing current and emerging development concerns affecting the subregion. They include, but are not limited to, the topics of food safety and quality assurance, environmental sustainability, climate change mitigation and adaptation, and inclusive value chains in the GMS agro-food sector.

CASP2 is implemented by the GMS Working Group in Agriculture (WGA) through the WGA Secretariat, with support from the Asian Development Bank (ADB). The GMS WGA oversaw the development of the discussion papers. The original papers are also available through the GMS WGA’s website (www.gms-wga.org).

The book is arranged in three main themes, with three chapters for each theme. These are:

- **Theme 1: Improving Food Safety and Quality**
 - Chapter 2:** Harmonizing Food Safety Systems and Increasing Market Access in the Greater Mekong Subregion
 - Chapter 3:** Increasing the Safety and Quality of Food Products from the Greater Mekong Subregion
 - Chapter 4:** Supporting Food Safety: Participatory Guarantee Systems—Issues to be Considered for Up-Scaling in the Greater Mekong Subregion;

- **Theme 2: Inclusive, Sustainable, Safe and Environment-Friendly Agrifood Products**
 - Chapter 5:** Green Water Management and Nitrogen Use Efficiency in the Greater Mekong Subregion: Promoting Synergy between Sustainable Agriculture and Food Safety
 - Chapter 6:** Soils Mapping and Identification of Potential Biochar Hot Spots and Pilot Sites in the Greater Mekong Subregion
 - Chapter 7:** Science-Based Approach to Promoting the Adoption of Safe and Environment-Friendly Practices and Policy Directions; and
- **Theme 3: Strengthening Value Chains for Safe and Environment-Friendly Agrifood Products**
 - Chapter 8:** A Natural Rice Supplier: Case Studies of Reduced-Input Rice Value Chains in the Greater Mekong Subregion
 - Chapter 9:** Tracing Cross-Border Cattle and Buffalo Movement from the Lao People's Democratic Republic and Myanmar to the People's Republic of China and Assessing Associated Foot and Mouth Disease Risk
 - Chapter 10:** Geographical Indications and Inclusive, Safe, and Sustainable Food Supply in the Greater Mekong Subregion.

The following sections present the executive summaries of the original papers, which are not repeated later in the book. Key terms used in the book are defined in Appendix 1.

1.1. Theme 1: Improving Food Safety and Quality

Harmonizing Food Safety Systems and Increasing Market Access in the Greater Mekong Subregion: Chapter 2

Economic growth in the GMS countries during the last 2 decades has been remarkable, averaging 7.5% of gross domestic product per capita at purchasing power parity between 1992 and 2014 (ADB 2016). During this period, the GMS countries have also achieved dramatic reductions in poverty and admirable increases in food security.

Although food security—the availability of and access to safe, nutritious, and preferred foods—has improved in the GMS, breakdowns in food safety systems continue to occur with alarming frequency. In the past, food safety issues in the GMS were primarily the concern of exporters seeking access to higher-value markets.

Box 1.1: Joint Ministerial Statement

GREATER MEKONG
SUBREGION
CORE AGRICULTURE
SUPPORT PROGRAM

**Second GMS Agriculture Ministers' Meeting
Siem Reap, Kingdom of Cambodia
8 September 2017**

JOINT MINISTERIAL STATEMENT***GMS: Towards inclusive, safe, and sustainable agricultural value chains*****Achievements and Regional Context**

1. We, the Ministers of Agriculture from the Greater Mekong Subregion (GMS) countries, namely, the Kingdom of Cambodia, the People's Republic of China (PRC), the Lao People's Democratic Republic, the Republic of the Union of Myanmar, the Kingdom of Thailand, and the Socialist Republic of Viet Nam, met in Siem Reap, Kingdom of Cambodia, on the 8th of September 2017 for the Second GMS Agriculture Ministers' Meeting.

2. We commend the historical importance of this meeting, following the first such meeting held a decade ago in Beijing, PRC. We continue to acknowledge the agriculture sector for its vital role in the subregion's socio-economic development.

3. We are committed to achieving the sustainable development goals (SDGs), in particular, SDG2, SDG13, and SDG17.

4. This is a most opportune time for establishing our collective goals for agriculture in the GMS. Our objectives are aligned with the ASEAN Economic Community Blueprint to 2025. Moreover, the Belt and Road Initiative presents many opportunities for GMS agricultural cooperation.

5. We congratulate the GMS Program on its 25th Anniversary and reconfirm the alignment of the Core Agriculture Support Program, now on its second phase (CASP2), with the GMS Strategic Framework's (2012–2022) core objectives and values. The progress of CASP2 has been commendable, in particular, through the successful implementation of the projects under the letters of agreement between the GMS agriculture ministries and the Asian Development Bank (ADB), such as the establishment of Participatory Guarantee Systems (PGS) which we will continue to support. We also commend the GMS Working Group on Agriculture (WGA) that has worked tirelessly towards the attainment of the CASP2 vision for the GMS to become a leading producer of safe and environment-friendly agriculture products.

6. We reaffirm that the GMS Regional Investment Framework presents opportunities for sustaining intra-GMS cooperation as acknowledged by the GMS Leaders at the 5th GMS Summit of Leaders in Bangkok in December 2014 and acknowledge that the consolidated agriculture project pipeline has been developed in recognition of these considerations and opportunities.

7. We recognize that the Strategy for Promoting Safe and Environment-Friendly Agro-based Value Chains in the Greater Mekong Subregion and Siem Reap Action Plan, 2018–2022 (GMS SEAP Strategy and Siem Reap Action Plan), acknowledged at the 21st GMS Ministerial Meeting, Chiang Rai, 2016, has been developed through strong engagement with stakeholders

representing the diversity of GMS agricultural interests and those of related sectors and addresses key national and regional priorities for GMS agriculture in the global context.

Our Commitments and the Way Forward

8. We formally endorse the GMS SEAP Strategy and Siem Reap Action Plan and state our commitment to its successful implementation. We will report this to the forthcoming 6th GMS Summit of Leaders in March 2018 and the consolidated agriculture project pipeline will be submitted for inclusion in the Ha Noi Action Plan 2018–2022.

9. We recognize that the intended outcomes of the GMS SEAP Strategy and Siem Reap Action Plan can only be achieved with the support and engagement of all stakeholders including the public sector and private sector. To this end, we will initiate public–private dialogue.

10. We are reinvigorating the Agriculture Information Network Service (AINS) portal—relaunched as version 2.0 into a more service- and client-oriented platform, which will increase coordination and cooperation among the GMS countries and will facilitate information sharing between stakeholders.

11. We instruct the WGA to oversee the implementation of the GMS SEAP Strategy and Siem Reap Action Plan through strong supervision and effective management.

12. We direct the WGA and its Secretariat to commence the formulation of the technical assistance document required to ensure the seamless implementation of the GMS SEAP Strategy and Siem Reap Action Plan.

13. We pledge to adopt a collaborative approach to controlling transboundary animal diseases. We appreciate the active role and contribution of the PRC as well as the GMS countries in this end and continue to emphasize the essential roles that each GMS country must play.

14. We sincerely appreciate the support of the ADB, the Government of Sweden, the Nordic Development Fund, and the Water Financing Partnership Facility to the CASP. However, further financial and technical support will be required to implement the GMS SEAP Strategy and Siem Reap Action Plan and so we turn again to our development partners.

15. Through this Strategy we envisage the development of vibrant, interconnected, and competitive agro-based value chains throughout the GMS, and supplying the subregion and beyond with safe food produced in a sustainable manner.

16. We thank the Royal Government of Cambodia for hosting this meeting and for the warm hospitality we have received. We also wish to show our appreciation to the ADB for its support in the holding of this meeting and the side events.

17. We reaffirm the necessity of convening GMS Agriculture Ministers' Meeting periodically as needed to keep policy coordination, guide the formulation and implementation of the GMS SEAP Strategy and Siem Reap Action Plan, and cope with the challenges of agriculture and rural development in the subregion.

Endorsed in Siem Reap, Kingdom of Cambodia on 8 September 2017.

However, domestic demand for safety assured products is rising and the costs of food safety failures are increasingly well-recognized among businesses and policymakers. In response, improving food safety is now enshrined in the agricultural development strategies of each GMS country.

The costs of foodborne illness are substantial. The World Health Organization (WHO 2015) estimated that in the Southeast Asia region the annual burden of foodborne diseases includes more than 150 million illnesses, 175,000 deaths, and 12 million disability-adjusted life years. Further, an estimated 75% of emerging infectious diseases in humans are zoonoses, and the GMS is among the highest risk areas in the world for emerging infectious disease events (Jones et al. 2008; Hill et al. 2015; Taylor et al. 2001). Emerging infectious diseases are significantly correlated with socioeconomic, environmental, and ecological factors.

Establishing harmonized food safety policies and effective surveillance systems that ensure consumers and producers are appropriately protected in an inclusive and sustainable manner is a major challenge for global food supply and a priority for the GMS countries.

Overarching Trends in GMS Food Supply

Most agricultural production in the GMS is consumed locally and the large majority of producers continue to operate subsistence or semi-commercial systems in fluid, often weakly connected market networks. However, considerable concentration and vertical integration in food supply is occurring, leading to longer supply chains that frequently cross national borders. The introduction of improved genetics, inputs, and production practices, and the intensification and increasing mechanization of production have led to increasing productivity in many areas; however, productivity has largely plateaued in the most productive regions. Local environmental degradation threatens future productivity in densely populated and intensively farmed areas, such as the Mekong Delta. And the predicted effects of climate change may alter conditions to the extent that traditional production systems may no longer be viable in some areas. In addition, high rates of urban migration further threaten the future of smallholder agriculture in the GMS. The decline of smallholder agriculture in the GMS could come at considerable social, economic, environmental, and biological costs. Revitalizing the agricultural economies of the GMS can support sustainable smallholder supply to drive further reductions in poverty and vulnerability and help to stem the flow of people away from the countryside.

Key constraints for smallholders and new entrants in GMS agriculture typically include lack of information, credit, inputs, and the specific services necessary to engage fully in efficient market value chains. Smallholders may struggle to compete on price, due to their limited scale and lack of capacity to meet the volume or quality and safety assurance standards required by buyers. These factors can limit access to the more stable and/or lucrative markets enjoyed by established players.

Changing GMS Food Demand and Food Safety Risk. Rising consumer awareness is increasing demand for safety assured food, and changing food supply systems are affecting food safety risks. Strong economic growth in the GMS has been closely associated with rising household incomes and a growing middle class. An increasingly urbanized population and skyrocketing access to information online mean consumers are better informed of food safety risks and more discerning in their choices. Demand for processed foods has increased, and food supply chains and retailing are evolving quickly with increasing concentration, integration, and the proliferation of supermarkets.

Key Concerns. Current high-priority foodborne hazards include a wide variety of pathogens and chemical residues. In addition, zoonoses, infectious animal diseases, pests, and residues limit market access for products. Increases in GMS food trade and high-volume food suppliers and longer supply chains present different and potentially higher levels of risk from key hazards. In this context, agricultural stakeholders are under increasing pressure to demonstrate good management of food safety and broader hazard risks in order to protect domestic consumers, meet customer requirements, and gain access to export markets.

Gaps in GMS Food Safety Systems and Barriers to Market Access

Although the GMS countries have generally made progress in upgrading food safety systems, increasing market access, and facilitating trade, further improvements are needed.

Surveillance systems in the GMS vary considerably in their design and implementation. Standards such as national good agricultural practices (GAP) differ between GMS countries and are not benchmarked to the Association of Southeast Asian Nations (ASEAN) GAP. Risk-based approaches that address priority hazards the length of value chains are needed to ensure product safety and to maintain and increase market access.

Interagency coordination is often limited and roles and responsibilities and chains of command are frequently uncertain. Further, research institutes and the private sector are not adequately represented and engaged in the discussion and establishment of standards, guidelines, and systems.

Food testing capacity is limited, often unable to achieve accreditation to international standards of proficiency. GMS suppliers are often either unable to demonstrate product safety, barring them from markets, or have to send samples outside their country, typically incurring additional direct costs, opportunity costs, and waste. Availability of technical and operational resources between and within GMS countries remains highly variable. Although large investments in infrastructure, such as laboratories, have been made in the GMS countries, strategies for covering operating costs are often neglected.

National emergency response plans for food safety hazards, zoonoses, and other infectious diseases are varied in their level of elaboration and capacity to be implemented in a timely, efficient, and effective manner. There are opportunities to coordinate and harmonize emergency response plans at the GMS level and incentives for countries to support control efforts beyond their borders, thereby reducing risks within their own territories.

Risk-based approaches to improving food safety and market access must address whole value chains to be effective. In the GMS, seed, plant protection, feed safety, and veterinary laws are at different stages of development and implementation. On-farm surveillance systems are generally lacking. Postharvest process control systems are in their infancy and vary widely. Transport and storage capacity and quality are highly variable between and within countries. Investments in cold chains and transport hubs are needed to reduce losses in transit and minimize the likelihood of contamination and/or multiplication of hazards in products. Education and communication initiatives can help retailers and consumers improve food handling and thus minimize contamination and waste.

The Way Forward

Risk-based approaches to food safety and broader hazard and risk management are essential for the GMS to address the issues and gaps. Due to the interconnectedness of the GMS food supply systems, it is in the interest of each GMS economy to improve risk analysis capacity for food safety and decrease trade-related hazards in the subregion. There are efficacy and efficiency benefits to coordinating and harmonizing policies and systems across the GMS, to build scale and better protect each country's

consumers, industries, and access to export markets. Coordination between countries toward the demonstration of systems' equivalence and benchmarking of standards can be highly beneficial. GMS-wide recognition of standards and systems can increase transparency and accountability and build trust between customers, suppliers, and regulators. Initiatives must engage smaller players, providing them access to certifying services and information about risks and best practices, to better protect all stakeholders. In addition, it is essential that approaches based on whole value chains are adopted to address GMS agriculture's challenges of food safety and market access.

Risk Assessment. Coordinating and harmonizing national risk assessment systems can facilitate demonstration of equivalence in relation to hazards of importance to trade. Sharing surveillance system design and expertise between countries will aid the early identification of problems and targeting of responses. For example, national and regional hazard lists are needed and further investment in laboratory capacity and proficiency for residue and pathogen testing is needed, ideally in line with ASEAN and international food reference laboratory standards. While each country is building such capacity, facilitating the transfer of samples to accredited laboratories within the GMS will help identify priority hazards and assess the risks from them. Given the close ties and shared borders between the GMS countries, it is in the interest of each nation that technical expertise and data be shared between countries openly and in a timely fashion. Platforms such as the ASEAN Risk Assessment Centre for Food Safety and the voluntary ASEAN Rapid Alert System for Food and Feed offer methods of sharing data, knowledge, and technical expertise and building GMS risk assessment capacity to regional standards across the subregion (ASEAN 2017).

Risk Management. Investment is needed in physical risk management infrastructure. Transport infrastructure such as good roads, transport hubs, storage facilities, and cold chains can mitigate risks, particularly to perishable products. Investment in quarantine stations, product handling facilities, and zoning infrastructure can also help. Policies that encourage the establishment and accreditation of sustainable, accessible certification bodies are, likewise, required. Defined budget and cost coverage mechanisms are required for operating and maintaining risk management systems, to keep them useful.

The roles and responsibilities of the government and private sector interests and chains of command in emergency responses must be established in accordance with best practices (FAO 2012). Moreover, investment in technical and management training is needed to build system capacity. Emergency response plans for food safety and for zoonotic and wider infectious diseases need to be established and/or revised in the GMS countries, and should be harmonized between the subregion's associated countries. The importance of building leadership cannot be overstated. Joint

simulation exercises present an opportunity to strengthen capacity and collaboration within the region.

Risk management systems must adopt inclusive whole chain approaches to be effective. Public-private partnerships can help to establish sustainable, effective, and fair risk management systems. Further, research and teaching institutions can add significant value when included in exercises for optimizing systems and building future capacity.

Risk Communication. Current communication channels between risk assessors and risk managers can be strengthened. Messages to all stakeholders must be clear and consistent. Clear messaging on risk and best practices will build trust among consumers, retailers, and agriculture product suppliers while reassuring export markets. Current data sharing and risk communication initiatives within and between GMS countries can be improved. To be effective, awareness raising initiatives about priority hazards, risks, and best practices for risk mitigation must be dynamic, timely, and targeted to consumers, retailers, and suppliers.

Continued engagement with regional food safety initiatives can bolster food safety systems. The 2012 Regional Food Safety Strategy was endorsed by the GMS member countries; and the subregion is also engaged in the International Food Safety Authorities Network, through national focal points, Codex Alimentarius (Food Code) committees, and focal points for the World Organisation for Animal Health and International Plant Protection Convention (WHO 2012; WHO et al. 2013). Further, the GMS economies, except the PRC regions, contribute to the ASEAN Food Safety Network for which Thailand is a coordinator (ASEAN 2017). These and other platforms present opportunities for mentoring, knowledge and data sharing, and coordination and harmonization of current systems.

Increasing the Safety and Quality of Food Products from the Greater Mekong Subregion: Chapter 3

Improving the control of foodborne hazards and threats important to trade are priorities for each GMS country. By acting collectively to manage foodborne and agricultural risks through coordination and cooperation, the countries can establish the GMS as a global hub for supplying safe food products and ensuring that agriculture continues to support rural livelihoods and contribute to national economic development within the GMS.

The GMS countries recognize that the focus of food safety strategies and pilot initiatives must shift from export markets to include domestic markets. Improving food control systems at home will benefit domestic populations and economies, mitigate risks across borders, and lead to increased access to international markets.

Developing and institutionalizing a “quality culture” and common internal control systems for food safety that reflect standards of the Global Food Safety Initiative is the stated goal of each GMS country. In line with global norms, GMS-wide adoption of risk-based approaches that address whole supply chains is necessary.

Hazards. The GMS countries need to jointly address three priority hazard categories of importance to domestic consumers and industries and to market access under the terms of the World Trade Organization Sanitary and Phytosanitary Measures Agreement:

- foodborne hazards, including pathogens and toxic residues;
- pathogens of importance to production and trade; and
- pests of importance to production and trade.

To this end, Chapter 3 identifies three key issues in GMS food control systems that will best be addressed through coordinated efforts.

- (1) Establish mutually agreed GMS-wide approaches and entry points—in terms of products, locations, and flashpoints in supply chains—for improving food control systems.
- (2) Establish greater coordination and cooperation between the GMS countries toward harmonization and mutual recognition of equivalence in food control systems in the areas of legislation, regulation and policy, knowledge and data sharing, and capacity sharing and building.
- (3) Prioritize investments in human and institutional capacity building and key infrastructure at the GMS-level.

Chapter 3 also proposes initiatives to address the issues. First, the GMS countries could agree to promote the adoption of locally, nationally, and subregionally appropriate and rigorous risk-based systems that address priority hazards the length of supply chains, with the domestic markets and cross-border areas as entry points to strengthening systems across the subregion.

Second, the countries could agree to increase coordination and cooperation toward harmonizing their systems and mutually recognizing their systems’ equivalence. This can be initiated by

- (1) developing and sharing objective and science-based national food safety status assessments;

- (2) establishing mechanisms for joint review of current national legislation, regulations, and standards, and a pathway to mutual recognition of equivalence;
- (3) establishing mechanisms for sharing laboratory capacity within the GMS, and agreeing to jointly draft standard operating procedures relating to chains of custody, roles and responsibilities, confidentiality, and intellectual property rights;
- (4) developing joint emergency response simulation exercises, focused initially on priority land borders and economic corridors within the GMS; and
- (5) promoting adoption of e-commerce based on information and communication technology, specifically in relation to cross-border trade.

Third, in alignment with the GMS Strategy and Action Plan for Promoting Safe and Environment-Friendly Agro-based Value Chains 2018–2022, jointly develop a subregional investment plan for increasing the capacity of the GMS food control system, including prioritization of institutional and infrastructural investments and the development of coordinated national food safety pilot projects.

Chapter 3 identifies three areas for immediate action to kick-start achievement of the above proposals.

First, establish food safety data sharing and risk communication through the Agriculture Information Network System (AINS) version 2.0. This initiative is led by CASP2, is reliant on the program's staff, and is immediately actionable. The system can be used as a platform for building and strengthening food safety at domestic levels through the open sharing of information from around the subregion and as a mouthpiece for risk communication. A pilot application of AINS to food safety data sharing and messaging in one cross-border area can commence immediately. Priority information includes sharing hazard lists for key commodities where available; sharing best practices on food safety and quality; and making risk information available to the public, policymakers, suppliers and retailers, and current and potential trading partners.

Second, establish collaboration between GSI and the GMS WGA to facilitate trade in food and agriculture products, initially focusing on piloting barcode and quick response-based traceability systems and broader data collection systems in cross-border food trade situations.

Third, pursue further public–private dialogue on capacity building for increased food safety, commencing with the Food Industry Asia, Global Food Safety Initiative, and

other participants at the GMS@THAIFEX 2017. A broader public–private dialogue was held during the GMS Second Agriculture Ministers meeting in September 2017.

Supporting Food Safety: Participatory Guarantee Systems— Issues to be Considered for Up-Scaling in the Greater Mekong Subregion: Chapter 4

To effectively improve food safety from the farm to the table, governments need both regulations and options for certifying fresh and processed products. Certification options available in the GMS include the ASEAN GAP, organic third-party certification, and PGSs.

Pilot PGSs. The Participatory Guarantee System Capacity Building in the GMS project was started in 2014 and implemented by IFOAM Organic International. The project supported two CASP2 pillars: (1) food safety and trade modernization, and (2) climate-friendly agriculture. The project aimed to develop two PGS pilots in each GMS country. In addition, via letters of agreement (LOAs) between the governments of Cambodia, the Lao PDR, Myanmar, and Thailand, the project supported complimentary PGS initiatives.

Successful PGS groups are now operating in each GMS country. The main reason for the project's success is that market-orientated multiple stakeholder engagement supported the development and implementation of the PGSs. The experience gained and the lessons learned from the pilots demonstrate the potential for PGS as a credible certification option. The experience also provides a basis for elaborating on how up-scaling PGS can contribute to the wider food safety strategies being implemented in the GMS.

PGSs were developed to provide an alternate tool for addressing the dilemma faced by the many millions of producers around the world who continue to operate subsistence farming or produce semi-commercial small volumes of seasonal products and have fragmented and weak connections with markets and few opportunities to add value postharvest or address food safety issues relating to production methods.

PGS quality assurance is based on the IFOAM Organic International *PGS Guidelines*. They support the goal of improving food safety, primarily focused on organic production. The *PGS Guidelines* provide a structure and methodology for coordinating production and for enhancing product quality by improving post-harvest handling systems, increasing sales, and improving livelihoods. At the same time, the PGS is a mechanism for providing consumers with trustworthy certification for safe food products.

The issues discussed in Chapter 4 are drawn from the lessons learned through implementing CASP2's PGS project and subsequent stakeholder exchanges and workshops, including the THAIFEX 2017 food safety conference.

Although each GMS country is at a different stage in developing food safety policies and regulations concerning organic and PGS certification, some common themes can help guide the process and provide for a PGS system that shares common standards within the GMS.

These themes are reflected in the following recommendations for increasing the establishment and use of PGS.

- (1) Each country needs policies and regulations that recognize and support the opportunity for PGSs to be established and to function. The design of such policies and regulations should consider both the national and GMS-wide implications and opportunities for mutual recognition to facilitate future cross-border trade.
- (2) Any regulation that applies to organic certification should be inclusive, specifically recognizing the PGS alongside other systems as an option for certifying produce and products sold domestically and in other GMS countries.
- (3) Keeping in mind the potential for cross-border trade in PGS-certified products, to facilitate this process, the GMS countries could adopt common baseline standards. For PGS and organic products, this would mean adopting the ASEAN Regional Organic Standard for the production of organic products and the IFOAM PGS Guidelines.
- (4) For markets with emerging organic sectors, governments could consider promoting voluntary use of the PGS whereby operators can apply for and use an official national organic logo to enhance their access to markets.
- (5) At the national level, government leadership could support PGS governance, ideally engaging both government and private sector stakeholders in developing a national PGS coordinating body and PGS management systems.
- (6) The PGS must be regarded as a component of a wider strategy for promoting food safety. In this context, PGS-certified products should be included in the government's food safety sampling and residue testing program. Government resources should be allocated to this activity and PGS operators should be made aware of the importance of complying with government food safety laws.

1.2. Theme 2: Inclusive and Sustainable, Safe and Environment-Friendly Agriculture Products

Green Water Management and Nitrogen Use Efficiency in the Greater Mekong Subregion—Promoting Synergy between Sustainable Agriculture and Food Safety: Chapter 5

CASP2 envisions garnering international recognition for the GMS as a hub for safe and environment-friendly agriculture products (SEAPs). Chapter 5 summarizes the importance of addressing physical environmental drivers of change in order to achieve the CASP2 vision. The chapter highlights the strong correlation between securing a steady supply of SEAP and the practices of sustainable agriculture. The message is clear: if farmers are producing safe food there is progress toward a sustainable environment. The chapter

- summarizes the socioeconomic context and introduces a conceptual approach that summarizes a cycle of trust and web of connections necessary among all players in the values cycle to build market confidence for SEAP;
- summarizes the breadth of the CASP2 LOA activities, highlights important changes in land and water management approaches that the green water management (GWM) and nitrogen use efficiency (NUE) LOAs have provided, and posits the holistic approach needed for promoting SEAP value chains;
- uses Cambodia as a case study of the current state-of-play of the LOA activities pursued under CASP2, and highlights the contribution that they are making, especially their achievements in smallholders' production and supply of vegetables to markets;
- emphasizes the important dividend that farmers working in groups such as PGSs provide toward sustainability; and
- suggests the way forward with policy recommendations and other action including investments and institutional reforms that are needed to respond appropriately.

Socioeconomic Context. In the last 2 decades the GMS economies have grown rapidly and the GMS population of over 330 million is becoming larger, richer, and more urbanized. Growth is occurring within a context of very tangible social and physical change across the GMS. The GMS economies share common natural endowments suitable for agriculture production and the situation presents a great opportunity for the GMS to be a major supplier of SEAP, but there are challenges. The 5-year GMS Strategy and Siem Reap Action Plan's focus on value chain development, food safety and quality, and climate-friendly supply chains is moving in the right direction.

Promoting and Supporting Smallholders. Existing smallholder production in the GMS is unsustainable, requiring change. The GWM and NUE activities were applied to the case study and assisted in increasing productivity. The GWM activities are more advanced than those of the NUE work, and have combined to improve the vigor and response of soils during the early to middle dry-season period. This was achieved by using micro drip as supplementary irrigation reticulated from on-farm harvesting of rainwater, which is stored in on-farm ponds, and using pumps to gravity feed plants from tanks. The GWM work has also included consideration for planting windbreaks and addressing surface evaporation. All these activities have opened a productivity and small enterprise window that for many smallholders had been nonexistent. Participating farmers have also joined PGS groups and commenced marketing their produce directly.

The initiatives fit into the very holistic perspective that is required to link smallholders to what is recognized as an increasing demand for SEAPs. Currently there is limited support for smallholders to be involved in mainstream supply to markets, and while the LOAs have increased production potential, there is a clear need to link to markets.

The chapter provides 15 policy and enabling environment recommendations, in three categories.

To achieve sustainable production at the farm level through GWM and NUE,

- (1) accelerate opportunities for farmers to implement GWM ponds on their farms;
- (2) promote parallel R&D for up-scaling the GWM with appropriate academic partners;
- (3) strengthen and improve extension services and know-how regarding GWM, and enhance capacity building;
- (4) maintain support for the ongoing trialing of NUE, and communicate findings through the AINS; and
- (5) consider promoting clustered organic fertilizer production to provide greater availability of and access to a quality soil input medium that is important in the SEAP equation.

To develop market synergies using the PGS,

- (1) develop LOAs for working in collaboration the Pro-GAP “clean and green” outlets in Phnom Penh;
- (2) give high priority to fostering opportunities for urban households to benefit from contracts with farmer groups, knowing where their produce comes from;

- (3) start small, have small targets, and establish links between farmers and consumers whereby the demand for SEAP is successfully satisfied through an acknowledgment of the needs of all parties on AINS;
- (4) acknowledge in a tangible way the achievements of farmers and farmer groups engaged in best “clean and green” practice in member countries; and
- (5) provincial and district agriculture departments, along with all the players involved, could consider a roundtable to find ways to secure a range of markets for farmers to sell their PGS produce.

Institutional support may be provided by

- (1) initiating one major GWM program in each member country to roll out simple initiatives that can make a huge difference in food security and livelihoods;
- (2) dedicating an LOA to examining and developing relevant metrics and data, and using AINS to communicate this data;
- (3) supporting farmer groups that are producing clean and green food by giving them the highest priority to supply their produce at formal “state” functions, etc.;
- (4) providing explicit support and overt acknowledgment of R&D in promoting the involvement of research institutes and universities in the GMS to engage with the issues highlighted; and
- (5) exploring import-substitution strategies in situations (such as in Cambodia) where smallholders are predominantly locked out of market dynamics by an imbalance in trade from neighboring countries.

The recommendations promote the need for scaling up GWM and NUE; seeking ways to exploit market opportunities for smallholder involvement by strengthening the link with the consumer; and facilitating the important role of government in promoting GWM, PGSs, and AINS. Under institutional support, come recommendations for promoting SEAP by explicitly using SEAP products at government functions and for applying appropriate import-substitution strategies to enhance smallholder involvement in SEAP.

Soils Mapping and Identification of Potential Biochar Hot Spots and Pilot Sites in the Greater Mekong Subregion: Chapter 6

CASP2 included a biochar use study. Its objective was to develop “biochar hot spots” in the GMS. The study prepared maps to determine the areas best suited for biochar production and use, and pilot trials in the GMS.

Biochar is a carbon rich product created when biomass such as wood, manure, and leaves is heated with little or no available oxygen. Biochar production and application into soils offer multiple potential benefits, including

- storing organic carbon in the soil, thus providing climate change mitigation benefits;
- significantly improving soil quality;
- reducing farmers' input costs by 25%–50%, increasing crop yields, and increasing farmers' incomes;
- supplying efficient and renewable energy; and
- being appropriate for small-scale farmers.

Devising the biochar hot spots map entailed a four-staged process. First, a soil map was developed, using information on the characteristics of soil types. Second, data on topography were juxtaposed on the soil map to produce a map of soil suitable for biochar in the GMS. Third, land-use features, focusing on the availability of agricultural and animal waste suitable for biochar production, were overlaid on the soil suitability for biochar map. And fourth, data on the GMS economic corridors were added to identify the biochar hot spots in the GMS. Seventeen hot spots were identified: two in Cambodia, four in the PRC, two in the Lao PDR, two in Myanmar, four in Thailand, and three in Viet Nam.

Through an LOA between ADB and the concerned GMS agriculture ministries, on-farm research and demonstration of the multiple benefits of biochar application were carried out from early 2015 to the end of 2016. Two case studies were presented. The use of biochar in the production of baby corn in Thailand showed improved soil quality, reduced production costs, increased yield, and higher net incomes for the farmers. The case study in Cambodia used biochar in rice and vegetable production. As in the Thai case, soil quality improved; yields improved significantly, especially for the formula that used 50% biochar and 50% animal waste; and farmers' production costs were lowered and net incomes increased, and in fact doubled, in vegetable production. Women farmers were highly satisfied as they were the main producers of vegetables. The empirical modeling applied by Viet Nam's Institute of Agricultural Environment showed that biochar application reduced greenhouse gas (GHG) emissions and benefited farmers' incomes and health.

Biochar application is an option that can be presented to small-scale farmers in the GMS toward more inclusive and sustainable approaches for diversifying their products and expanding their revenue streams. There is merit in up-scaling the pilot experiences in the identified biochar hot spots to study more options for biochar use and development and more systematically and widely validate the benefits and costs of biochar development. The end-purpose of the exercises is to provide a

menu of options from which farmers may choose in order to enable them to switch from excessive use of agrochemicals to approaches that benefit their well-being, economy, and environment. Such a switch will result in more climate-resilient and gender-responsive methods of farm production. Biochar development should also be considered as an option for paving the GMS' pathway to becoming the ASEAN regional hub for SEAPs and SEAP value chains.

Actions recommended to support the switch are as follows:

- In the immediate future (1) expand the farm areas using biochar, (2) update the soil map and share it in the AINS, (3) provide capacity building, and (4) improve market links.
- Invest in R&D to (1) determine the appropriate ratio of biochar to animal wastes that will maximize farmers' returns; (2) in the medium term, investigate mangrove vegetation for sustainable biochar production; (3) investigate more sustainable approaches such as biochar development and support biochar innovation laboratories, possibly through public-private ventures; (4) enhance research and analytical capabilities for biochar and soil analyses in the GMS, particularly in Cambodia, the Lao PDR, and Myanmar; and (5) conduct long-term field experiments comparing biochar with traditional fertilizer treatments for monitoring the agronomic and environmental benefits of biochar with the existing systems.
- Policy measures could include (1) incubator schemes, (2) smart subsidies, (3) inter-trade relations for development of biochar value chains, and (4) development of regulatory frameworks.
- Institutional measures could include (1) a biochar network and center, (2) clustered production and a logistics center, and (3) media links.

Enhancing Rice Production and Lowering Greenhouse Gas Emissions by Recycling Crop Residues as Fertilizer: Chapter 7

Through an LOA between ADB and Viet Nam's Ministry of Agriculture and Rural Development, the Institute of Agricultural Environment (IAE) undertook a technical investigation and produced a report, *Sustainable Paddy in Red River Delta through Recycling Crop Residues toward Fertilizer Usage and toward Green-House Gases Emission Reduction*.

Chapter 7 summarizes the research, suggests directions for R&D, discusses policies in the context of their implications for the strategic restructuring and repositioning of the rice economy of Viet Nam and its role in the GMS rice value chain, and points the way forward.

The Research Study. Nam Dinh Province was selected as the pilot area for the study. Nam Dinh is situated in the Red River Delta of northern Viet Nam and is the country's second-largest rice-producing region.

Farmers' incomes from rice production have become less stable and secure as the soil has become less productive due to excessive use of fertilizers; costs of production continue to rise with the continued price increases of synthetic agrochemicals; and rice production losses have resulted from frequent flooding, drought, and salt intrusion due to climate change. Farmers lack the knowledge of viable climate-friendly or smart agriculture practices that would help them adapt, mitigate, and cope with the vagaries of climate change.

To reduce the problem of overuse of fertilizers and lack of crop residue management, the IAE examined five fertilizer mixture menus in control tests. The IAE employed several approaches to find out which options produce the greatest yield, lowest GHG emissions, and greatest increase in farmers' incomes. The methods of analysis included (1) scientific approaches (farm trials, using the DeNitrification-DeComposition model for GHG emissions, geographic information systems, and statistics); (2) an interdisciplinary approach (the physical science of climate change and benefit-cost analysis to determine the economic gains); and (3) a participatory approach (using focus groups and key informants). On the basis of the findings, the IAE conducted awareness-raising and capacity-building activities.

Results. The major findings are as follows:

- Applying biochar, compost, and combinations of these increased the rice yield by an average of 2.4%–11.1% over the intensive use of agrochemicals alone.
- Applying compost mixed with 75% nitrogen, phosphorus, and potassium, (NPK) yielded the highest productivity increase, followed by biochar mixed with compost and NPK. Reducing NPK by 25% significantly reduced the yield, by an average of 4.5% from the conventional approach.
- Soil nutrients and water absorption improved when biochar and compost were applied (although the tests were too few and of short duration for the finding to be considered scientifically conclusive).
- GHG emissions declined significantly when applying biochar mixed with 75% NPK, followed by composting, biochar, and reduced NPK.
- In the longer term (30–40 years), the model simulation suggested GHG emissions from Nam Dinh would increase if farmers continue to apply only chemical fertilizer for rice, but would be significantly reduced if biochar is applied with or without mixing it with compost and NPK.

- The benefit–cost ratios with biochar and compost were lower than the conventional approach’s ratio because of the higher labor costs incurred for producing biochar and compost at the farm level. More research is needed in this regard.
- A 25% reduction in fertilizer use resulted in the lowest production cost among the five options, and the highest net benefit–cost ratio despite garnering the lowest gross benefit among the five options.

Lessons Learned. Three major lessons arose from the trials. First, the present agronomic practice of intensive application of fertilizers (and pesticides) coupled with the near absence of proper agriculture residue management proved hazardous to the environment, detrimental to rice farmers’ incomes and livelihoods, and contributory to GHG emissions.

Second, farmers found the options of reducing synthetic agrochemical use and replacing it partly with biochar and either with or without compost were desirable, because of the reduced environmental footprint and a slight enhancement of their gross revenue streams. However, the farmers were not inclined to change their current practice because making biochar and compost is labor-intensive and thus also costly. For farmers to adopt environment- or climate-friendly innovations, they would need to gain economically from the change.

Third, the IAE action of linking research with training for and awareness-raising among the farmers and government extension workers hastened the adoption process.

Research and Development Agenda. The recommended agenda for R&D is as follows:

- Additional R&D support is needed, initially from the government and subsequently through public–private collaboration. Experience has shown that the government should set aside at least 1% of the agricultural gross domestic product for agricultural R&D. For example, research is needed to develop technologies for producing organic fertilizers that reduce labor inputs and are women-friendly.
- Test input mixtures that could be suitable for other agroecological zones.
- Look into the viability of commercial production and marketing of biochar and compost. Government support may be needed initially to help the private sector establish biofertilizer value chains.
- Implement policies that support farmers to use biochar and enterprises to mass produce and market biochar and other biofertilizers.

- Develop an integrated and interdisciplinary approach to crop residue and natural resource management, including water-use efficiency, seed varietal development, and land-use management.
- Viet Nam's National Extension System should work closely with the IAE.
- The IAE's technical expertise on climate change modeling and knowledge of economic analysis should be shared with other research institutes and extension departments in the agriculture ministries of the less-developed GMS economies, particularly Cambodia, the Lao PDR, and Myanmar.
- For developing sustainable rice cultivation and SEAPs, explore knowledge sharing modalities such as the internet and networking among the GMS-based research institutes.

Policy Directions. While the government is shifting toward a more sustainable agriculture pathway, strategic restructuring and repositioning are urgently needed, especially regarding the overuse of chemical fertilizer and the low labor profitability. The following policy directions are suggested:

- A policy road map is needed with a strategic set of programs on soil nutrient development; crop residue management (including promoting biochar and composting); and integrated pest management.
- One program could be to develop centers of excellence on crop residue management innovations such as biochar and composting. Thailand has indicated its interest in developing such a center. Similarly, a consortium or networking of the research institutes, academe, national research and extension systems, and the private sector could be formed to share knowledge and expertise.
- Internationally recognized metrics for sustainable rice are needed. The Sustainable Rice Platform has recently developed a global rice standard that combines the parameters for technology and good agronomic practices with synergies among productivity, sustainability, food safety and quality assurance, and value distribution. The application of the Platform's sustainable rice standard as a basis for harmonizing the food safety and quality assurance standards for sustainable rice within the GMS merits closer consideration.
- A policy on extension services is needed that ensures close collaboration between research and academic institutions on the one hand and government extension agencies on the other; triangulation of public research, extension services, and private agribusinesses; incentives for developing "on-the-ground" soil and plant "doctors" and service centers; and knowledge and expertise sharing between fairly advanced rice economies (Guangxi and Yunnan in the PRC, Thailand, and Viet Nam) and less-developed ones (Cambodia, the Lao PDR, and Myanmar).

- A policy agenda is needed for strengthening the farmers' links to their downstream partners in the rice value chain.
- To substantiate the GMS Strategy for 2018–2022, a road map is needed for a GMS sustainable rice value chain. The map should have the following aims: (1) improved rice productivity and diversification; (2) value chain facilitation (especially reduced wastes and losses in rice); (3) a predictable trade policy and trade facilitation services for cross-border rice trade; and (4) support for market intelligence, branding, and marketing campaigns.

Conclusion and Way Forward. Using the lessons learned from the IAE study and their implications for Viet Nam's rice economy, Chapter 7 posits the directions for R&D and the policy agenda for influencing the change in the growth course of Viet Nam's rice subsector to one that is environment friendly, productive, inclusive, and climate resilient.

Moving forward, the restructuring of Viet Nam's rice economy needs to be contextualized as an integral part of the GMS' rice value chain. The GMS Strategy for 2018–2022 envisages the subregion as a web of interlinked supply chains for safe and environment-friendly agro-based products. One of the chains will surely be the GMS sustainable rice value chain. At this stage, it may be judicious for the GMS to develop a road map for a subregional rice value chain that is premised on the key principles laid out in the GMS Strategy and with a thematic focus on food safety and quality assurance, inclusiveness, and sustainability. For Viet Nam, the urgent agenda will be moving toward producing rice with fewer inputs and closer links between farmers and their downstream partners, locally and at an intra-GMS level. With better connected GMS rice value chains and a rice standard that is internationally recognized, the branding of a distinctly GMS rice will be the way for the future.

1.3. Theme 3: Toward Value Chains for Safe and Environment-Friendly Agriculture Products

A Natural Rice Supplier: Case Studies of Reduced-Input Rice Value Chains in the Greater Mekong Subregion: Chapter 8

The GMS is a leader in the supply of low-cost and premium rice and rice-derived products to global markets. The subregion has enjoyed dramatic increases in rice productivity in recent decades. However, this has been broadly associated with considerable intensification through widespread expansion of irrigation, the use of higher-yielding varieties, mechanization, and increasing application of commercial

fertilizers and plant protection products, which is well-documented. The negative impacts of intensive application of synthetic agrochemical products on land quality and local environments in the GMS are also well-recognized, particularly in the most productive agricultural areas. In addition, rejection of rice consignments due to the presence of agrochemical residues threatens to decrease access to lucrative export markets for GMS rice.

The GMS countries share porous land borders and the volume of paddy (unhulled rice) and rice crossing borders both legally and informally is high and increasing, presenting potential food safety and quality risks to domestic consumers and exporters. Ample demand for high-value rice and rice products exists in markets in the GMS, ASEAN+3 (ASEAN members plus the PRC, Japan, and the Republic of Korea), and beyond. Identifying and addressing the current constraints on and opportunities for developing inclusive, safe, and sustainable rice and rice product value chains in the GMS can support food security, livelihoods, and economic development throughout the subregion. There is value in adopting a GMS approach to support the development of more sustainable, inclusive, and safe rice value chains that elicit price premiums in domestic markets and enable greater access to export markets.

Study Design

Case studies of rice value chains were conducted in three locations in the GMS. The objectives were to assess the competitiveness of reduced-input rice production and supply; to identify current constraints and opportunities; and to make policy and investment recommendations to support inclusive, safe, and environmentally sustainable GMS rice supply. The case studies selected were (1) low-input (a system of rice intensification) rice supply (from suppliers employing organic production practices) in Battambang Province, Cambodia; (2) organic rice value chains in Roi Et Province, Thailand; and (3) low-input rice in Chuong My District, Ha Noi, Viet Nam. In each case, comparison was made with local conventional rice value chains. A qualitative and quantitative study design was employed involving a detailed review of available literature and secondary data; key informant interviews; three focus group discussions; and 80–100 surveys of input suppliers, producers, processors, traders, wholesalers, and retailers in each location.

Issues and Gaps

Value Chain Efficiency, Value Addition, and Branding and Marketing. Inefficiencies in rice value chains continue to hamper suppliers, particularly smallholders operating in fragmented chains such as those observed in the

Cambodian case study. The lack of market linkages, limited producer organization, and lack of market information means that smallholders in these value chains have little ability to set prices at the farm gate.

Limited availability of quality-assured seed and variable quality of fertilizer and plant protection products hamper productivity. Poor quality seed and lack of or poorly enforced regulations relating to input standards and constituents and to recommended usage lead to suboptimal performance in production and present risks to producers' health, local environments, and product safety.

The limited use of reliable moisture meters in assessing paddy quality and value continues to inhibit fair negotiations at the farm gate. Downstream, access to dryers is often limited in less well-developed areas of the GMS and milling quality varies considerably. This was observed in the Cambodian case study and, to a lesser extent, in Thailand. In Cambodia, the costs of postharvest services and distribution are onerous due to high utility rates and weak transport infrastructure and competition, which reduces margins the length of value chains.

While there has been considerable consolidation in rice value supply in the GMS, in remote areas smallholders often continue to cultivate small areas and exist in fragmented value chains with weak linkages both up- and down-stream. This limits delivery of extension services and limits access to economies of scale on inputs. Further, limited capacity to dry and store paddy can force producers to sell at suboptimal times and prices. Greater organization among producers and coordination with actors up- and down-stream can create efficiencies. However, efforts to create greater organization among producers are not new, and novel approaches are needed. There is great potential to increase organization and market connectivity through information and communication technology and e-commerce platforms, but, again, many attempts have been made in this area in recent years, generally with limited success. Approaches need to be developed with inclusiveness and economic sustainability in mind.

Greater coordination and integration of women, smallholders, and small and medium-scale enterprises in rice value chains can support rural development and drive safe and sustainable rice supply. This can help to revitalize rural areas and reduce the current labor drain to urban centers within the GMS. Contracted supply arrangements may present opportunities to better integrate smaller players but also present risks of less scrupulous players tying producers into unfavorable arrangements. Ethical contractual arrangements must be ensured through appropriate regulatory and legislative oversight that considers inclusiveness and fairness.

Where product premiums do exist, they do not necessarily translate into higher prices at the farm gate. This is partly due to asymmetries in access to information, limited production scale, and lack of producer organization. The case studies indicated that the more organized chains with strong producer groups or associations and a degree of vertical integration better rewarded stakeholders along value chains and generated greater trust among consumers, to mutual benefit.

Risk Management and Safety and Quality Standards and Assurances. GMS consumers recognize product quality and are frequently willing to pay a premium for safety and quality assured products. However, many consumers do not trust current certifications of food safety and quality. Assurances such as GMS geographic indications (GIs), organic systems of rice intensification, and PGSs can be competitive and attract consumers but can require improvements in chain management to ensure product safety and quality and to build recognition and trust among consumers. Safety and quality assured rice can be competitive in domestic markets but improved supply chain management is needed to provide such assurance. Further investment in product traceability from farm to table can help to build consumer trust in suppliers and assurance systems.

Investments. Additional investment in downstream processing facilities is needed to alleviate bottlenecks in rice value chains, such as access to drying capacity. Public-private partnership models could draw in private investment; however, opaque terms and conditions and regulations deter investors by raising risks and perceptions of risk. Clarity and transparency is needed.

The quality and costs of transport and logistics infrastructure vary widely within and between GMS countries and suppliers, which limits producers' access to wider value chains and increases the costs of supply. Linking regions through the continued development of transport and economic corridors can facilitate the flow of raw materials and end products to and from areas with comparative advantages, promote inclusiveness and competition, and increase the subregion's competitiveness in both least-cost and premium rice markets.

General Recommendations

Recommendations in Chapter 8 can be grouped into three categories.

- (1) Enhance value chain efficiency, value addition, and branding and marketing.
 - Review and harmonize policy and regulation relating to seed quality and agrochemical inputs across the GMS; coordinate with the Sustainable Rice Platform.

- Promote the virtues of local GMS rice varieties by strengthening current rice GIs and establishing additional GI protection.
 - Continue to fund and direct R&D into reduced-input rice production methods and disseminate findings through subregional platforms.
 - Identify best practices in producer organization and innovative approaches to developing market linkages along smallholder-based rice value chains.
 - Platforms such as the AINS 2.0 and novel initiatives that draw on other sectors, such as the “MATCh: Mekong AgTech Challenge,” are ripe for developing new ways of building social capital and creating and disseminating technical and market-related information.
 - Investigate opportunities for further value addition, such as pre-prepared products and novel uses for by-products, and establish joint branding and marketing initiatives among suppliers of safe and environment-friendly rice and rice products subregionally.
- (2) Employ risk management and safety and quality assurances.
- Coordinate risk management systems related to diseases, pests, and chemical residues as a crucial step toward harmonizing systems between GMS countries.
 - Harmonize quality and safety assurance standards and regulatory environments from inputs through to end products between GMS countries.
 - Improve hygiene the length of value chains to improve the safety of GMS rice and reduce the risk of costly consignment rejections in export markets.
- (3) Increase investment.
- Catalyze direct public and private investment in safe and environment-friendly rice-related value chain infrastructure.
 - Provide the legislative and regulatory systems needed to ensure transparent and ethical terms and conditions for investment in GMS rice supply.

Proposed Initiatives

Six short-term initiatives were identified.

- (1) Establish access to extension materials on reduced-input rice and marketing through AINS 2.0. Identify areas for potential collaboration with the “MATCh: Mekong AgTech Challenge” on specific communication and data-related solutions to social, technical, and market-related bottlenecks.
- (2) Review national regulations for addressing rice safety and quality issues, especially hygiene. Assure that farmers have accurate and transparent

information about input constituents and their optimal use for domestic and export markets.

- (3) Establish standard operating procedures for the flow of rice samples for residue testing between GMS countries. Establish domestic food safety and quality metrics and skills in partnership with the United Nations Economic Commission for Europe.
- (4) Pilot GS1 barcode-based systems for tracking and tracing exported premium rice varieties from the GMS, such as GI protected rice and organic rice.
- (5) Review current national regulations and legislation pertaining to contract paddy supply arrangements to ensure inclusiveness, transparency, and fairness.
- (6) Establish standard operating procedures for ethical domestic and foreign investment in rice processing facilities and wider value chain investments among the GMS countries.

Tracing Cross-Border Cattle and Buffalo Movement from the Lao People's Democratic Republic and Myanmar to the People's Republic of China and Assessing Associated Foot and Mouth Disease Risk: Chapter 9

Demand for beef and beef products is high and increasing in the PRC. The large cattle and buffalo populations in Cambodia, the Lao PDR, Myanmar, Thailand, Viet Nam, and the South Asian countries present great opportunities to supply the large and growing PRC market. However, unchecked animal movement poses considerable risks for animal and human health. The large numbers of cattle and buffalo that transit through the GMS, mainly informally and to meet the demand from the PRC, present considerable risks of spreading important pathogens such as the foot and mouth disease (FMD) virus and *Escherichia coli*. These risks threaten livestock producers, allied businesses, and consumers throughout the GMS.

The Yunnan Animal Science and Veterinary Institute estimates that approximately 1 million live cattle and buffalo from the GMS entered the PRC through Yunnan Province illegally in 2015. The study determined that a high proportion of these animals had been exposed to the FMD virus; thus, many of them may be carrying the virus. FMD is extremely infectious. It destroys livelihoods and bars GMS trade in many livestock products to potentially lucrative FMD-free markets internationally. FMD spreads rapidly, typically through livestock movement. Illegal and poorly controlled animal movement across GMS borders is a key pathway for transmitting the FMD virus. Moreover, other hazards of importance to human health and GMS trade

products affect GMS consumers and businesses and limit market access for livestock and livestock products from the GMS. In this context, illegal and poorly controlled animal trade presents a risk to regional food security, producer livelihoods, and animal trade in the subregion.

Mapping Animal Movement. To begin to address these issues, CASP2 allocated a \$60,000 grant under an LOA between ADB and the PRC's Ministry of Agriculture. The main objectives of the grant project were to better understand cattle and buffalo movement patterns and to improve livestock traceability, which are essential for the rapid identification of FMD and implementation of effective preventative measures. The project also sought to identify animal movement pathways in key counties within Yunnan Province, where control measures might best be targeted to reduce the risk of FMD spread.

The project mapped the four main pathways through which cattle and buffalo enter the PRC from the Lao PDR and Myanmar and conducted extensive serological sampling to identify exposure to the most common FMD serotypes circulating in Asia. The study findings indicated key areas for policy change—institutional capacity building and investment to regulate cross-border livestock movement. Appropriate changes can reduce the risk of FMD spread and thereby promote trade in animals and animal products. The findings and recommendations also have implications for the design of food safety and broader livestock-related hazard surveillance and risk management systems.

Findings and Recommendations. The study concluded that appropriate regulation of cross-border livestock trade and the establishment of disease control zones (DCZs) could promote legal livestock trade and contribute to controlling FMD. Such initiatives must include animal identification and traceability systems, transparent livestock movement management systems, risk-based monitoring of animal health status, and vaccination at borders. Five primary recommendations emerged.

- (1) Establish bilateral and/or multilateral mechanisms to improve the coordination of national policies, investments, and institutional capacity building for (a) the control of live cattle and buffalo trade between the Lao PDR and the PRC, and between Myanmar and the PRC; and (b) the management of associated disease and broader hazard risks.
- (2) Establish bilateral and/or multilateral coordinating mechanisms for the surveillance of cattle and buffalo movement, the FMD virus, and other hazards of importance to animal production, food safety, and trade among GMS countries, in coordination with the OIE-led SEACFMD¹ program.

¹ The Sub-Commission for Foot and Mouth Disease Control in South-East Asia and China (SEACFMD) is led by the World Organization for Animal Health (Oficina Internacional de Epizootias—OIE).

- (3) Identify investment opportunities that support the establishment and management of the DCZs, under the direction of the GMS WGA.
- (4) Mobilize funds for the establishment of traceability systems and DCZs, through technical assistance and infrastructural investments, as proposed in the Strategy for Promoting Safe and Environment-Friendly Agro-based Value Chains in the Greater Mekong Subregion and Siem Reap Action Plan, 2018–2022.
- (5) Establish cross-border animal DCZs to assess and control FMD and broader hazard risks and to increase legal access to the PRC market. Facilitate the establishment of public–private partnerships for investment in the necessary infrastructure and services.

Encouraging legal animal movement and the development of DCZs along the Lao PDR–Yunnan and Myanmar–Yunnan borders is a novel strategy that can mitigate and manage the risk of FMD spread to the PRC; promote livestock trade to the PRC to the benefit of communities living in the border areas; and support smallholder farmers in the Lao PDR, Myanmar, and the wider GMS whose livelihoods depend on livestock raising and trade. The establishment of FMD-focused DCZs in Yunnan can provide lessons for the control of other production pathogens and foodborne hazards associated with cattle and buffalo in other areas of the GMS. Moreover, the approach can be built on and/or replicated to address the movement of pigs and poultry and the sustainable management of broader human and animal health risks associated with trade in the GMS while promoting trade and wider market access for the subregion’s animal suppliers and their products.

Geographical Indications and Inclusive, Safe, and Sustainable Food Supply in the Greater Mekong Subregion: Chapter 10

The book’s final chapter outlines key issues relating to GIs in the GMS and makes recommendations for establishing their presence in domestic and international markets. Interest in the use of GIs has developed quickly among both public and private sector stakeholders in the GMS. GI can protect local producers and facilitate movement from reliance on raw material markets to more value-added and/or distinguished end-use products while promoting biodiversity, food safety, and environmental sustainability. Greater coordination between the GMS countries on GIs can benefit each country and individual GIs by increasing market access, generating scale, and building consumer recognition of GIs as a trusted sign of quality and value. Sharing experiences, lessons, and best practices between countries and joint planning and marketing initiatives (such as GMS sub-working-groups on GIs and GMS GI logo development) can establish effective and efficient registration and enforcement

systems that protect the reputation of GIs and bolster local and international demand for their use.

Chapter 10 identifies five areas in which supporting policy and institutional capacity building can advance the development of GIs in the GMS.

- (1) Embed national GI legislative and regulatory systems, adopt multisectoral approaches, and have mutual recognition of GIs between GMS countries.
- (2) Reduce the complexity in GI registration and minimize the costs associated with the establishment and maintenance of GIs through improved internal control systems and wider recognition of certifying bodies.
- (3) Within national GI legal frameworks and within individual GI specifications, embed rules and regulations on gender empowerment; inclusion of smallholders, small and medium-sized enterprises, and poor and vulnerable groups; and environmental protection.
- (4) Build and maintain the reputation of GI products by ensuring product consistency, safety, and quality through effective enforcement of GI requirements and social and market-led incentives.
- (5) Increase GMS GI recognition in domestic and export markets and generate scale and price premiums through improved supply chain management and efficiency.

The continued development of GIs in the GMS can be catalyzed through public and private investment in agriculture and allied sectors. Investment needs include value chain infrastructure and services, trade facilitation infrastructure, risk management infrastructure, and requisite human and operational resources. In particular, further investment is needed in transport and logistics infrastructure, food testing laboratory capacity, food traceability, and foodborne and non-foodborne (other agricultural) hazard surveillance systems.

Four initiatives have been identified for immediate action.

- (1) Showcase the GI products from around the subregion at the GMS Market Place at the Second GMS Agriculture Ministers' Meeting hosted in Siem Reap, Cambodia, 6-8 September 2017.
- (2) Showcase a selection of GIs from the GMS countries at the 2017 GI event in the PRC. Support GMS GI participation in other ASEAN+3 GI events.
- (3) In coordination with the Food and Agriculture Organization (FAO) of the United Nations, establish multisector national committees, or sub-working-groups, on GI under the leadership in the GMS WGA.
- (4) In coordination with the FAO, and through the national sub-working-group on GIs, establish a GMS taskforce on GIs to develop a road map to the demonstration of equivalence of national GI legal frameworks and mutual recognition between the GMS countries.

Appendix 1: Glossary of Key Terms

| Term | Definition |
|--------------------------------|--|
| Burden of Disease | Combines quantification of morbidity, disabling complications such as long-term sequelae, and mortality. Typically expressed in the summary figure disability-adjusted life years (DALYs). The DALY is a “health gap measure that combines the years of life lost due to premature death and the years lived with disability from a disease or condition, for varying degrees of severity, making time the common metric for death and disability. One DALY equates to 1 year of healthy life lost” (Havelaar et al. 2015). |
| Foodborne Disease | A disease commonly transmitted through ingested food. Comprises a broad group of illnesses, and may be caused by microbial pathogens, parasites, chemical contaminants, and biotoxins (Havelaar et al. 2015) |
| Food Defense | The Food Protection and Defense Institute defines food defense as “the sum of actions and activities related to prevention, protection, mitigation, response, and recovery of the food system from intentional acts of adulteration. This includes intentional adulteration from both terrorism and criminal activities. Criminal activities include economically motivated adulteration, as well as acts by disgruntled employees, consumers, or competitors intending to cause public health harm or business disruption” (FPDI 2017). |
| Food Protection | A term that combines both food safety and food defense. |
| Food Safety | Refers to the prevention of consumer exposure to foodborne hazards, which may be biological, chemical, or physical in nature. |
| Food Security | The availability of and access to food, recognized as a fundamental human right; achieved “when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 2015). |
| Geographical Indication | A sign used on products that have a specific geographical origin and possess qualities or a reputation that are due to that origin (World Intellectual Property Organization http://www.wipo.int/geo_indications/en/). |
| Hazard | The European Commission Scientific Committee for Food (1997) defined a foodborne hazard as a “biological, chemical or physical agent in food, or condition of food, with the potential to cause adverse health effects.” For these purposes, risk is defined as a combination of the likelihood of adverse health effects on animals and/or humans and the severity of the effect as a consequence of the hazard (Manning and Soon 2013). |
| Participatory Guarantee System | A community-based quality assurance system for the supply of food products produced using organic agriculture methods (see Chapter 2). |
| Risk | A combination of the likelihood of an adverse health effect and the severity of the effect as a consequence of the hazard (Manning and Soon 2013). |
| Risk Analysis | The development of an understanding of risk in a given context (Manning and Soon 2013). The process of risk analysis comprises hazard identification, risk assessment, risk management, and risk communication (ISO 2009). |
| Risk Assessment | The evaluation of the likelihood and the biological and economic consequences of entry, establishment, or spread of a pathogenic agent within the territory of an importing country. |
| Risk Communication | The interactive exchange of information on risk among risk assessors, risk managers, and other interested parties. |
| Risk Management | The process of identifying, selecting, and implementing measures that can be applied to reduce the level of risk. |
| Zoonosis | Any disease or infection that is naturally transmissible from animals to humans (OIE 2016). |

Sources: Authors, European Commission Scientific Committee for Food (1997), FAO (2015), FPDI (2017), Havelaar et al. (2015), Manning and Soon (2013), ISO (2009), OIE (2016), World Intellectual Property Organization http://www.wipo.int/geo_indications/en/.

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Theme 1
**Improving
Food Safety
and Quality**

Chapter 2

Harmonizing Food Safety Systems and Increasing Market Access in the Greater Mekong Subregion

Chapter 2 is a collective effort of the Mekong Institute and experts from the Asian Development Bank. The authors are Pavit Ramachandran, Thomas R. D. Weaver, Maria Theresa S. Medialdia, and Lourdes S. Adriano.

2.1. Introduction

The Greater Mekong Subregion (GMS) countries have enjoyed remarkable economic growth during the last 2 decades, averaging 7.5% of gross domestic product (GDP) per capita (at purchasing power parity) between 1992 and 2014 (ADB 2016). During this period, the GMS countries achieved dramatic reductions in poverty and admirable increases in food security.

Although food security—the availability of and access to food—has improved in the GMS, breakdowns in food safety systems continue to occur with alarming frequency. In the past, food safety issues in the GMS were primarily the concern of exporters seeking access to higher-value markets. However, domestic demand for safety assured products is rising and the costs of food safety failures are increasingly well-recognized among businesses and policymakers. In response, improving food safety is now enshrined in the agricultural development strategies of each GMS country.

Market access for GMS agriculture products continues to be hampered by variable ability to demonstrate effective and equivalent risk assessment and control systems for foodborne hazards, infectious diseases, and pests of importance to trade. This is particularly apparent among smaller players in food systems, who are hindered by their limited scale, the high costs of certification, and availability of and access to appropriate certification bodies.

Establishing harmonized food safety policies and effective surveillance systems that ensure consumers and producers are appropriately protected in an inclusive and sustainable manner is a major challenge for global food supply and a priority for the GMS countries. It is essential that producers and the wider business community work closely with policymakers, regulators, and legislators to build optimal systems that protect both consumers and industries in a cost-effective manner.

Addressing food safety and food related hazards can support the creation of a more integrated, climate-friendly agriculture sector in the GMS that sustainably harnesses the sector's competitive advantages and unique characteristics. Modernization of trading systems and linking of regional markets can help suppliers meet changing patterns of consumption while presenting opportunities to sustainably strengthen supply. Opportunities exist to increase and diversify GMS exports and establish the GMS as a recognized supplier of safe, high quality, environment- and climate-friendly products in regional and global markets.

A candid assessment of current policy gaps and priorities related to investment at national and GMS levels is needed to achieve the goal of establishing the subregion as a leading regional and global supplier of safe and environment-friendly agro-food products. Identifying the right policies and investments, through the combined efforts of GMS governments, the private sector, civil society, and development partners, can harness the considerable strengths of the subregion in agriculture and food production and build the capacity needed to protect domestic consumers and industries adequately while unlocking new markets.

This chapter provides an overall background of the food safety situation in the GMS in terms of risks, the current policy and investment environment, and implications for public health and market access. It first provides an overview of key concepts relating to food development, the link between food safety and market access, the key drivers of food safety initiatives, and the importance of risk analysis. Attention then turns to the GMS, beginning with an overview of the subregion, the current agro-based value chains, and the food safety situation at present. The chapter then discusses the key gaps and constraints. Finally, recommendations for the “way forward” to achieving improved food safety and market access for GMS agro-food products are proposed.

2.2. An Overview of Food Safety Concepts, Drivers, and Risk Analysis

Key Food Development Issues

Food Security. In the aftermath of the 1997 global food price crisis, a number of fundamental food development issues became apparent. The abrupt rise in the price of cereals at that time, especially of rice, the staple of Asian diets, highlighted the importance of food security. Food security is recognized as a fundamental human right. Despite international efforts to end hunger it remains a global challenge both in terms of availability and food preferences but also in terms of food safety, quality, and nutritional value (ACIAR 2017). Although the GMS countries have made admirable achievements in terms of food availability and access, challenges remain, particularly in relation to food safety and nutritional value.

The Food and Agriculture Organization (FAO) of the United Nations defines food security as “when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 2015). The concept of food security is founded on the four related components of availability of food, access to food, utilization of food as a source of nutrition and overall health, and stability of food supply. That food is safe and nutritious is a foundation of the concept food security. Therefore, food safety is an essential part of the human right to food security.

Maintaining and increasing global food security will become more challenging as the world’s population grows toward 9 billion by 2050. In addition, while global poverty levels are declining, malnutrition—due to undersupply of food—and obesity remain a blight on the world’s populations, and malnutrition in the form of poor diet is growing.

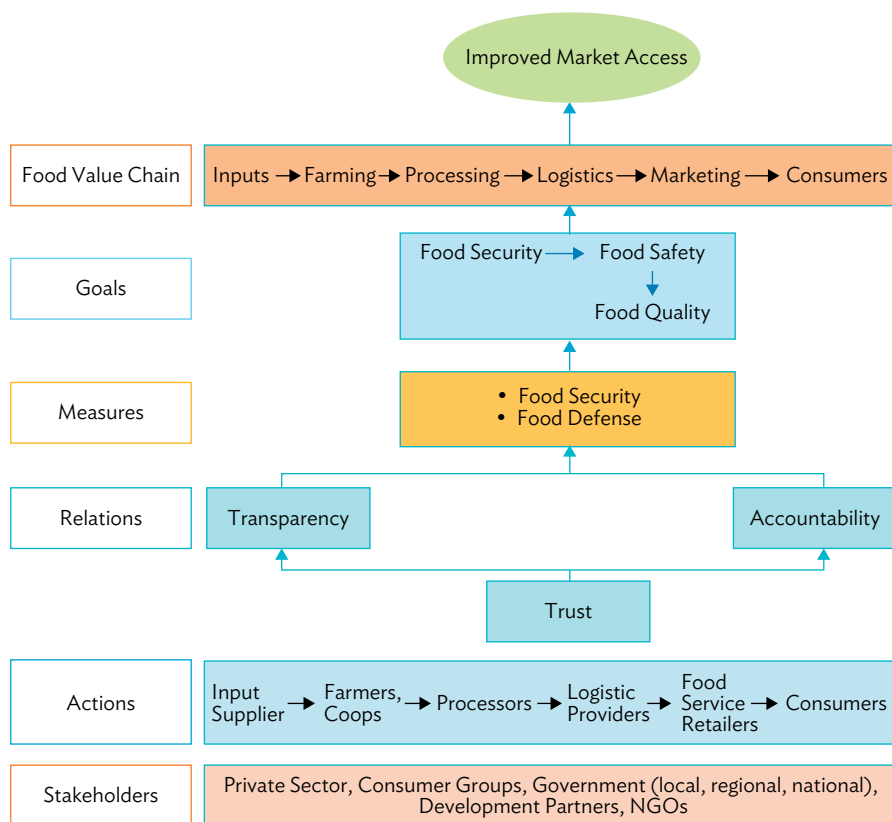
Increasing the efficiency of food value chains is part of the solution. Losses and waste in food supply need to be minimized. Supply of higher-quality, more nutritious food that minimizes damage to natural resources is essential. Continued progress requires a concerted effort among the multitude of stakeholders involved in global food supply chains. These include initiatives—food protection and food defense measures—that increase food system stability and protection from unintentional and intentional adulteration of food.

Food safety, food quality, food protection, and food defense are linked (Figure 2.1), emphasizing the importance of applying measures the length of food value chains.¹ The effectiveness of these measures in protecting consumers and food industries

¹ Appendix 1 provides a glossary of key terms.

hinges on the establishment of transparent and accountable relationships between key stakeholders in food chains, which is anchored on building trust between players.

Figure 2.1: Interdependence of Food Safety and Improved Market Access of the GMS with Organizational and Individual Relations of Stakeholders in the Food Value Chain



GMS = Greater Mekong Subregion, NGO = nongovernment organization.
Source: Authors.

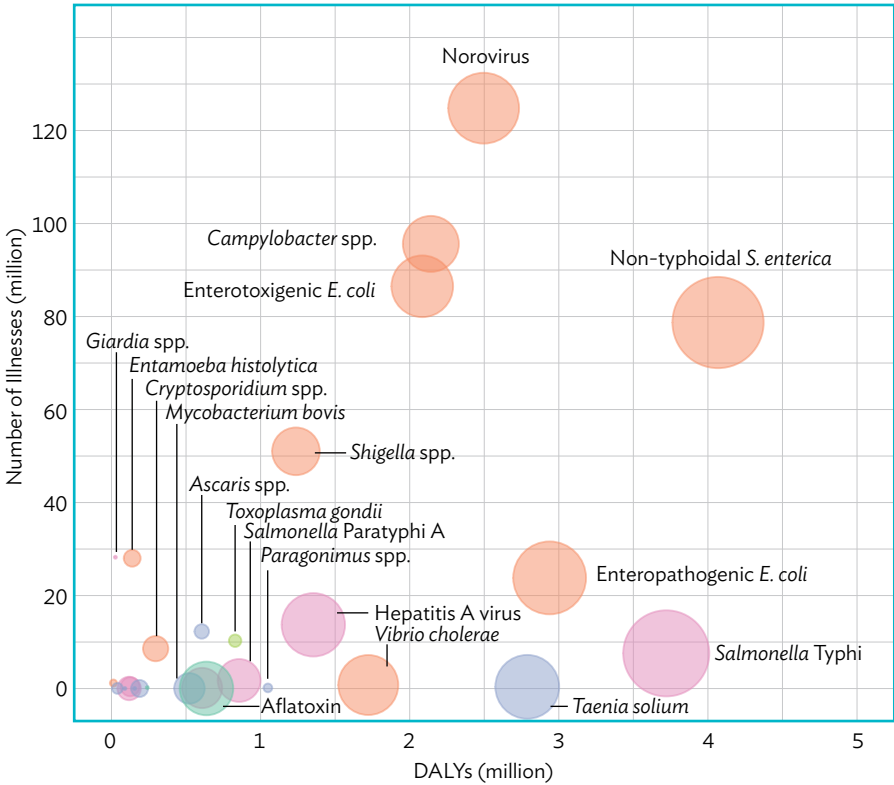
Food Safety and Market Access. Foodborne hazards arising from unsafe food are a major global public health and economic burden. Recognition of the impacts of unsafe food has increased among consumers, suppliers, and governments, in both developed and developing economies. The increasing globalization of food supply has changed the food safety landscape—food safety systems must be adjusted to meet new challenges.

The costs of food safety failures are manifold, including the direct costs of healthcare, lost labor, lost tourism, and loss of consumer and retailer confidence in suppliers and food industries. Moreover, foodborne hazards in products can lead to the costly rejection of consignments and loss of trading partners' confidence. This, in turn, can lead to higher regulatory burdens and/or loss of market access under the terms of the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures (the SPS Agreement). Companies and entire industries can become embroiled in food safety scandals. Recovery from such scandals can take years, or may not happen. An example is the continued impact that the 1993 *Escherichia coli* outbreak at Jack in the Box restaurants had on United States (US) food standards, Chipotle's ongoing food safety crisis; the costs of the 2008 melamine scandal in the People's Republic of China (PRC), estimated to be in the tens of billions of dollars; and the multidimensional effects of the recent horsemeat and place of origin scandals in the European Union (EU).

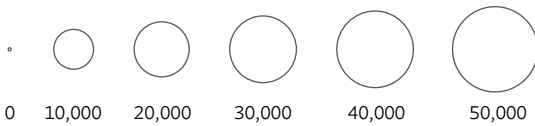
More than 600 million cases of foodborne illness are estimated to have occurred globally in 2010, causing over 5.5 million disability-adjusted life years (Havelaar et al. 2015). The World Health Organization (WHO 2015a) estimates that foodborne illnesses account for 420,000 deaths worldwide each year. Pathogenic foodborne bacteria and viruses are the greatest contributors to total numbers of foodborne illnesses, costs, and deaths (Figure 2.2). Parasites, chemicals, and toxins are also major contributors, although the numbers are lower in surveillance data because they are typically harder to isolate and/or diagnose. They also often cause long-term sequelae. Moreover, specific hazards may be more or less prevalent in different contexts and geographic regions, influenced by a multitude of factors including climate, human and animal population density, level of development, the capacity of food safety systems, culture, and politics.

The food safety, animal, and plant health requirements for trade between countries were established under the SPS Agreement in 1995. The SPS Agreement "permits countries to take legitimate measures to protect the life and health of consumers, animals, and plants provided such measures can be justified scientifically and do not impede trade" (ARAC 2017). The SPS Agreement is founded on the principles and application of risk analysis and the demonstration of system equivalence in relation to hazards, typically reliant on internationally or bilaterally agreed standards, norms, and/or risk analysis systems. Codex Alimentarius establishes standards, guidelines, and codes of practices related to food and food safety; the World Organization for Animal Health maintains the equivalent requirements for disease and zoonotic agents among production animals; and the International Plant Protection Convention manages the equivalent for plant-based hazards (FAO and WHO 2003, 2001, 2009, 2010, 2012, 1995; FAO 2013; OIE 2016).

Figure 2.2: Global Estimates of the Incidence of Foodborne Illnesses, their Costs, and Resulting Deaths



Scaled by number of deaths implicating specified hazard



Hazard Category

- Chemicals and toxins
- Diarrheal disease agents
- Helminths
- Invasive infectious disease agents
- Protozoa

DALY = disability adjusted life year, *E.* = *Escherichia*, *S.* = *Salmonella*, spp. = species.
 Notes: Chemicals and toxins, diarrheal disease agents, helminths; invasive infectious disease agents, protozoa.
 Scaled by number of deaths implicating specified hazard: 0, 10,000, 20,000, 30,000, 40,000, 50,000.
 Hazard categories: Global estimates of number of foodborne illnesses, cost of foodborne illnesses in disability-adjusted life years (DALYs) and number of deaths by hazard per year (based on estimates from 2010). Figure produced from supplementary data in Havelaar et al. (2015), less significant contributors to the global health burden (<600,000 DALYs per year, <2,000,000 illnesses per year, <10,000 deaths per year) have not been labeled.
 Source: Figure produced from supplementary data published in Havelaar et al. (2015).

Access to export markets is also affected by business environments, including national policies, regulations, and legislation. The potential value of increased international trade flows through trade facilitation is estimated to be in the hundreds of billions of dollars, and emerging economies are expected to gain the most.

Drivers of Food Safety Initiatives

Five key drivers of food safety initiatives have emerged in the global setting: (1) the increasing burden of foodborne diseases, (2) scientific advances, (3) high volume production and processing of foods and longer supply chains, (4) consumer awareness and demand, and (5) changing retailer requirements. These are discussed briefly below, and are elaborated on in the GMS context in subsequent sections.

Increasing Burden of Foodborne Diseases. The global costs of foodborne diseases are considerable and appear to be increasing. Foodborne disease impacts economic development. For example, in the US, economic losses from foodborne illnesses increased from \$35 billion in 1997 to \$152 billion in 2010.

Scientific Advances. Scientific and technological breakthroughs are increasing our ability to detect and differentiate hazards, to attribute the ultimate sources of hazards, and to accurately assess the risk they pose. Technologies are rapidly developing and becoming commercially viable, such as routine application of whole genome sequencing and rapid on-site testing and traceability systems based on global positioning systems. Innovative concepts, such as the use of unmanned aerial vehicles (drones) could have commercial applications to make food safer in the near future (Schroeder 2015). Along with data analytics, these technologies can enable tighter controls along the entire length of supply chains, and could considerably improve the quality and efficiency of risk assessment. Such advances can increase accountability and enable companies to respond more quickly and efficiently, during product recalls, for example. In addition, traceability and social media can provide consumers with unprecedented access to information on product origin and safety.

High-Volume Production and Processing of Food and Longer Supply Chains. The industrialization and globalization of food supply has changed the risk profile of many foods. The advent of large-scale production and processing has increased efficiency and uniformity of product, but a failure of just one control step can lead to widespread risk of consumer exposure to hazards. Furthermore, responses are complicated by the geographic scope, level of exposure, and longer shelf lives that risk consumers storing contaminated product for extended periods. Longer and/or more complex supply chains also increase the risk of poor food handling; for example, high storage temperatures and cross-contamination can increase and multiply hazards.

Consumer Awareness and Demand. Globally, consumer awareness of foodborne hazards is increasing, and is reflected in increasing demand for safer products. Eating habits are changing, urban populations are growing, abilities to diagnose foodborne disease and attribute source are improving, and public access to information is increasing via the proliferation of information sources such as social media. The internet allows consumers access to vast quantities of information relating to food and health issues. At the same time, social media enable consumers to share and document their views on the quality and safety of food products. High-profile food safety and food fraud scandals trigger public outrage and damage trust in food industries and governments.

Retailers' Changing Requirements. Voluntary safety and quality standards among retailers are increasingly stringent, typically outstripping national regulatory requirements. Developing countries are becoming more integrated into the global food market, due to increased consumer demand in Western countries for a year-round supply of exotic products and global sourcing by food retailers. However, standards are becoming increasingly difficult to meet and the risk of wasting safe food is increasing due to the designation of products as substandard for aesthetic or other reasons.

Risk Analysis

Effective risk analysis is now widely regarded as the optimal solution for monitoring and controlling agricultural hazards. Appropriately designed and implemented risk-based approaches can provide more cost-efficient means of effectively protecting domestic agriculture and consumers, provide more objective evidence to better direct policy and resources, and increase access to export markets.

Ideally, risk-based systems provide cost efficiency and efficacy benefits to risk mitigation and management, although this is often limited by the systems' cost and other practical limitations. However, such systems are essential for assessing and recommending policy and investment actions on food safety, zoonoses, broader infectious diseases, and pests. Hazards of importance to food safety and trade are numerous; examples are given in Table 2.1. While the primary objective of hazard control is to protect domestic consumers and industries, risk-based approaches are now often essential for agricultural produce to access international markets under the terms of the SPS Agreement. The objective of risk-based approaches is to reduce the probability of a negative outcome—illness or rejection of a consignment—to levels acceptable to stakeholders (Vose 2008; Manning and Soon 2013; Stärk et al. 2006). To function optimally, risk-based systems must be reliable, transparent, accountable, and trusted.

Table 2.1: Examples of Hazards of Importance to Food Safety and Trade in Food Products

| | Category | Type | Example | Disease |
|--------------------------|-------------------------------|--|---|---------------------------------------|
| Foodborne | Pathogen | Bacterial | Non-typhoidal <i>Salmonella enterica</i> | Salmonellosis |
| | Residue | Viral Parasite Toxin Animal health product/growth promotant | <i>Norovirus</i> <i>Taenia solium</i> Heavy metals Olaquinox | Enteritis Cysticercosis Various |
| Infectious Agents | Non-foodborne zoonoses | | Influenza A virus | Influenza |
| | Animal disease (non zoonotic) | | FMD virus | FMD (of ungulates) |
| Pests | Production | Arthropod | <i>Sitophilus oryzae</i> (rice weevil) | |

FMD = foot and mouth disease.

Source: Authors.

There has been considerable development in the approaches to and design of risk-based control systems for food. Food safety risk management has evolved from end-product control to whole chain systems. Early food safety initiatives employed heat treatment methods; the subsequent establishment of Codex Alimentarius outlined broader approaches, protocols, and best practices; and recently the application of quantitative risk assessment and legislative and regulatory enforcement of hazard analysis and critical control points and other process-focused approaches is increasing. Designation of food safety objectives now seeks to establish appropriate levels of protection, particularly in relation to microbial levels in food chains, and the International Organization for Standardization (ISO) has done a great deal to standardize testing protocols and food safety management systems globally (Zweiring 2013; Doménech and Martorell 2016; ISO 2005). Ideally, risk management systems should address risk from inputs (e.g., feed safety, antimicrobials, dioxins, diseases, and residues) through postharvest steps to consumption (De Busser et al. 2013; Alban et al. 2012; Snary et al. 2016).

Optimal risk management systems seek to provide an adequate level of protection while minimizing the suppliers' burden from direct and opportunity costs and waste. However, the proliferation of voluntary food standards and requirements for supply, primarily for producers and retailers to match or differentiate themselves from their competitors, continues to drive up safety and quality requirements. This can cause unnecessary food waste and exclude smaller suppliers unable to demonstrate

compliance with distributor requirements due to the costs, their production scale, and/or limited access to accredited certification bodies.

Food Safety and Quality Standards

A plethora of food safety standards and guidelines has evolved internationally, and many of them are risk-based. In production, these include a variety of holistic standards such as good agricultural practices (GAPs) and third-party certified organic agriculture. Hazard analysis critical control point and good manufacturing practices are now widely applied in postharvest processing. In addition, culturally driven food safety systems such as halal production and slaughtering provide some food safety assurances. Meanwhile, various traceability systems are employed by private companies and there are increasing numbers of public-sector-led systems designed to demonstrate origin, minimize risk of hazard contamination, and aid surveillance and responses. However, enforcement of many of the current safety and quality assurance systems remains highly variable, which has damaged consumer trust.

The following sections discuss the current situation of the GMS in relation to agriculture, food safety, and market access. The discussion will center on the food safety environment in the GMS and will explore the gaps in food safety and market access and the measures required to better protect domestic consumers and businesses and to expand export market access for agro-based GMS products.

2.3. GMS: An Emerging Hub for Regional and International Food Supply

GMS Food Production

The GMS economies, except for the PRC regions, are members of the Association of Southeast Asian Nations (ASEAN) and the recently established ASEAN Economic Community (AEC). The AEC blueprint for 2025 ensures close coordination with the GMS, particularly for reducing economic development gaps between GMS countries.

The GMS has various unique and often unharnessed comparative advantages in specific food supply, built on its abundant natural resources, climate, low production costs, proximity to large markets, and unique food items. Currently, the bulk of GMS food production is consumed locally. The large majority of producers operate subsistence or semi-commercial systems in fluid, often weakly connected, market

networks. The introduction of improved genetics, inputs, and production practices and the intensification and increasing mechanization of production has increased productivity in most of the GMS. However, productivity has largely plateaued in the most productive regions.

New entrants and small-scale producers in the GMS often lack access to information, credit, inputs, and the specific services necessary to engage fully in market value chains. This can limit access to the stable and/or lucrative markets enjoyed by more established players. Due to limited scale, small-scale producers may also struggle to compete on price, and lack the capacity to meet the volume or quality and safety assurance standards required by buyers. In addition, environmental concerns threaten production. Local environmental degradation threatens future productivity in densely populated and intensively farmed areas such as the Mekong Delta. And the predicted effects of climate change may alter conditions to the extent that traditional production systems may no longer be viable in some areas.

Economic Growth and Trade

The GMS has enjoyed remarkable economic growth during the last 2 decades (Figure 2.3), averaging 7.5% GDP growth per capita at purchasing power parity between 1992, when the GMS program was launched, and 2014 (ADB 2016). Intra- and extra-GMS trade has, in part, fueled the economic upsurge in the region. However, Cambodia, the Lao People's Democratic Republic (Lao PDR), and Myanmar (CLM) remain among the world's least-developed countries, with GDP per capita below \$2,000. Agriculture products comprise a quarter of the GMS total exports and imports (Table 2.2 and Appendix 2.1).

Table 2.2: Gross Domestic Product and Agriculture Trade of the GMS

| Variable | GMS |
|---|-----------|
| GDP (billion, current \$, 2015) | 11,552.68 |
| GDP per Capita (\$, 2012–2015) | 7,934.00 |
| Trade per Capita (\$, 2012–2015) | 1,483.17 |
| Share of Agricultural Export Products in Total Values (%) | 66.8 |
| Share of Agricultural Import Products in Total Values (%) | 33.5 |

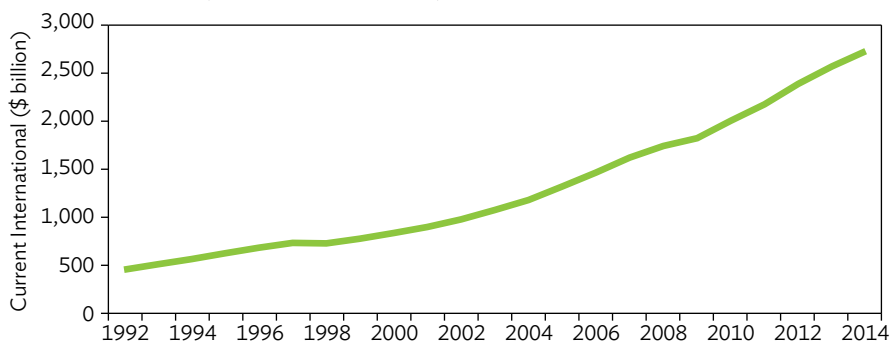
GDP = gross domestic product, GMS = Greater Mekong Subregion.

Note: Agriculture trade shares do not include the Lao People's Democratic Republic, and for the People's Republic of China, data are for the whole country and not only for Yunnan and Guangxi.

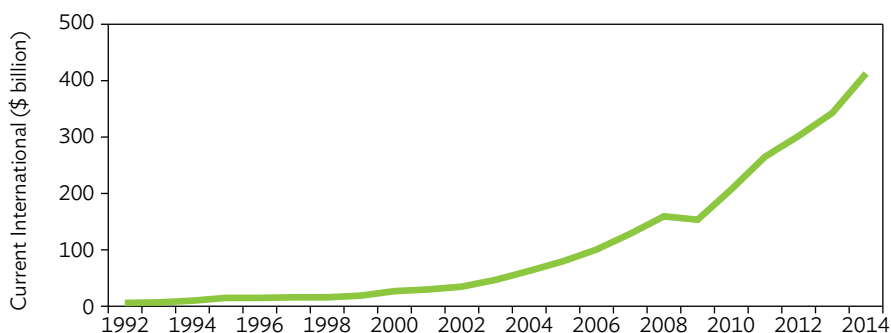
Source: Appendix 2.1.

Figure 2.3: Greater Mekong Subregion GDP and Trade

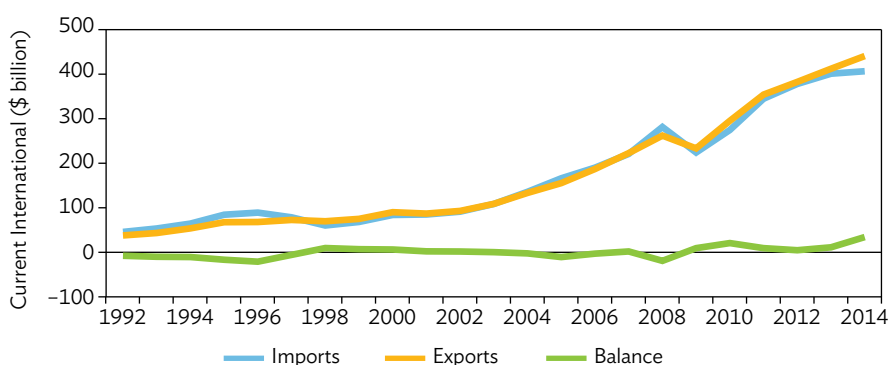
2.3.a: GMS GDP (\$ PPP year-on-year)



2.3.b: Intra-GMS Trade



2.3.c: Trade in Merchandise



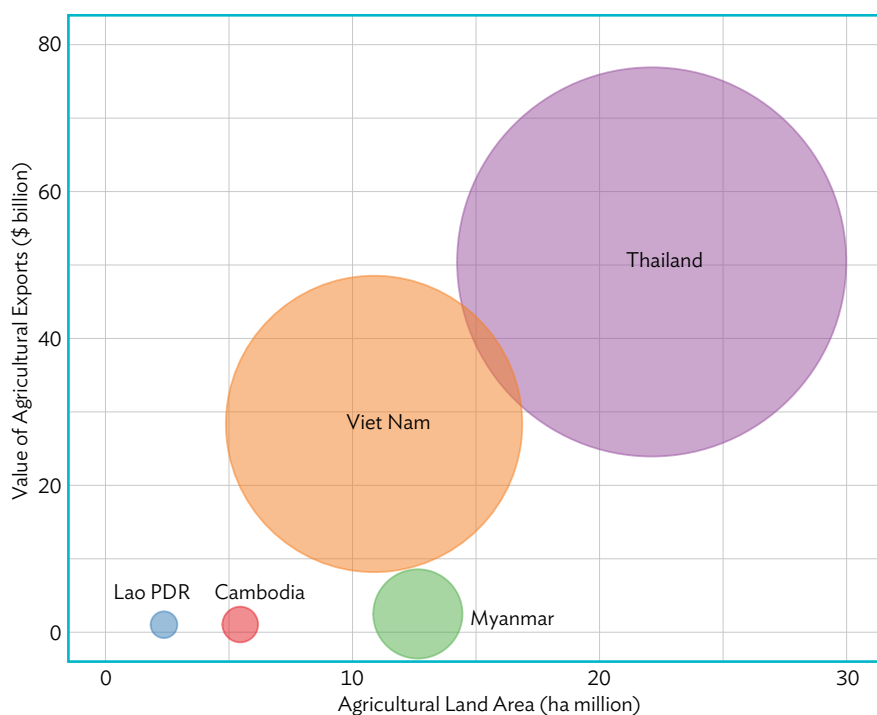
ADB = Asian Development Bank, GDP = gross domestic product, GMS = Greater Mekong Subregion, PPP = purchasing power parity.

Note: scale of y-axis in Figure 2.3.a differs from 2.3.b and 2.3.c.

Sources: 2.4.a: ADB estimates; ADB Statistical Database System (<https://sdb.s.adb.org>); All China Data Center; and International Monetary Fund World Economic Outlook database, accessed October 2015. 2.4.b: ADB Asian Regional Integration Center (ARIC) database. 2.4.c: ADB estimates; ADB Key Indicators for Asia and the Pacific (2005, 2015); and All China Data Center.

Current agricultural exports from the GMS countries show the discrepancies within the subregion (Figure 2.4). Intra-industry trade in the GMS is largely between the PRC, Thailand, and Viet Nam, indicating that CLM products are less integrated into regional production networks. While there has been some rebalancing toward regional markets, the share of intra-GMS trade (except with the PRC) remains low. Lowering trade barriers and facilitating trade within the GMS could have positive impacts, particularly for the CLM countries.

Figure 2.4: Value of Agricultural Exports versus Agricultural Land Area, GMS except the People's Republic of China



ha = hectare, Lao PDR = Lao People's Democratic Republic.

Notes: The People's Republic of China's Guangxi Zhuang Autonomous Region and Yunnan Province are excluded because data are not available. Bubble scale (linear) indicates total value of agricultural exports.

Source: Data from Goletti (2016), FAO FAOSTAT (accessed 2017).

The GMS exports a diverse collection of food products to various markets:

- exports from the CLM are dominated by raw and low-value-added products;
- rice is a major export item for Cambodia, Myanmar, Thailand, and Viet Nam;
- sugar and root crop products (cassava, arrowroot, and salep [orchid root flour]) are considerable exports for Cambodia and Thailand;

- Thailand exports large volumes of meat products, primarily poultry products;
- Viet Nam's coffee exports are currently more valuable than its rice exports; other major Vietnamese export products include nuts, black pepper, starches, and inulin;
- the PRC exports vegetable products—the main export destinations include the other countries within the subregion, Canada, the EU, the Russian Federation, and the US.

The main imports also vary between countries:

- the PRC, Thailand, and Viet Nam import large volumes of soybean, primarily for animal feed;
- the PRC and Myanmar import large amounts of palm oil and products derived from it;
- the PRC also imports considerable grain sorghum and barley;
- Myanmar imports substantial quantities of cereal grains and milk products;
- Thailand imports significant amounts of wheat and meslin;
- Viet Nam also imports corn, coconuts, Brazil nuts and cashew nuts, principally for further processing.

Rising Intra-GMS Agricultural Trade. Intra-GMS agricultural trade is expected to continue to increase, aided by the development of regional transport infrastructure, information and communication technology (ICT), and banking. The PRC, and to a much smaller extent Cambodia and the Lao PDR, are expected to remain net importers of agricultural goods and food products due to constraints on domestic production growth, population growth, and rising incomes. In addition, integrated supply across borders is rising. Increasingly, upstream activities are conducted in lower-cost countries, notably Cambodia at present, and processing activities are done in countries with more established food manufacturing, such as Thailand and Viet Nam. For example, Thailand has become a considerable importer of lower-value raw agriculture products and exporter of food preparations. Some Thai conglomerates have expanded their upstream activities in neighboring countries. For example, Khon Kaen Sugar Industry, the largest publicly listed sugar manufacturer in Thailand, has invested in plantations and mills in Cambodia and the Lao PDR. Meanwhile, the company's investments in downstream facilities and value adding continue to operate in Thailand.

Looming Non-Foodborne Challenges to GMS Trade. The construction of multiple hydropower dams on the Mekong River and plans for further investments will affect ecosystems, irrigation, and land profiles in the GMS (Rasanen et al. 2017). The Mekong

River is a cornerstone of livelihoods and food security for approximately 60 million people in the GMS; poor management of the Mekong could prove catastrophic.

Climate change is expected to cause a significant increase in average temperatures. In the GMS, the temperature has steadily risen on the average by 0.65 degrees Celsius during years 2006–2016 (CEP 2017) and is projected to increase by about 3 degrees Celsius by 2050 (SEA START RC 2017). The impacts will be complex, but without increased adaptive capacity will likely include losses due to heat stress, altered dynamics of pests and diseases, and reduced yields and crop suitability (USAID 2014b, 2014a). Moreover, agricultural land area could diminish due to coastal erosion, rising sea levels, and land salinization—which will threaten to increase poverty, vulnerability, food insecurity, and urban migration.

Rising protectionism internationally may affect trade prospects (ADB 2016a). The impacts of the SPS Agreement and technical barriers to trade measures are now evident in virtually all global trade negotiations relating to agriculture products. While these measures are largely employed legitimately, their overly stringent application can become unnecessarily onerous in terms of costs and delays, harming trade flows. The GMS countries joined Codex Alimentarius in the 1960s–1980s and became members of the World Trade Organization in the 1990s and early 2000s.

2.4. Drivers of GMS Food Safety and Market Access Initiatives

With increasing household incomes and greater access to information, regular food safety scandals have fueled consumer and government concern and impacted suppliers. Effective food safety systems across the GMS are crucial to protect consumers and industries and facilitate and diversify cross-border trade and investment in GMS agriculture.

Current foodborne hazards of importance to consumer health in the GMS include a wide variety of pathogens and chemical residues, such as antibiotics, hormones, pesticides, and heavy metals. Individual countries have suffered from specific food safety failures, such as melamine in the PRC and antibiotic and hormone residues in livestock and fishery products in Myanmar, Thailand, and Viet Nam. The nature of GMS agricultural supply is such that food safety issues in one country can readily affect its neighbors' domestic food supply.

Increasing Burden of Foodborne Diseases

The economic costs of illnesses caused by foodborne diseases in the GMS have not been adequately estimated. However, direct healthcare costs and lost labor, tourism, and spending are undoubtedly a considerable economic drain. Although notoriously difficult to estimate, due to the lack of effective surveillance systems and underreporting, the World Health Organization (2015b) estimated that, in the Southeast Asia subregion, the annual burden of foodborne diseases includes more than 150 million illnesses, 175,000 deaths, and 12 million disability-adjusted life years.

The GMS countries suffer frequent outbreaks of foodborne illness; regular high-profile cases of food-related health scares; and continuing concerns about quality, notably misrepresentation of products (ProMED-mail 2016). Such concerns include foodborne pathogens and chemical residues in food products, primarily from plant protection agents and antibiotics. Furthermore, the presence of infectious agents and residues exceeding maximum residue limits in exports all too frequently results in costly rejections of GMS produce in international markets.

Scientific Advances

The design, human resources, laboratories, and consumables for the technical and operational capacity of surveillance systems are improving throughout the GMS, but remain highly variable. Laboratories in the PRC, Thailand, and, to a lesser extent, Viet Nam have the capacity and resources to effectively implement technically challenging surveillance systems. However, systems in the CLM underperform due to insufficient expertise, infrastructure, and budget.

GMS Trade in Food

Cross-border food supply chains are now prevalent within the GMS and interest in export markets continues to grow. The development of common food safety standards benchmarked against international standards is a vital precondition for increasing GMS products' access to markets. Although the establishment of a common GMS food safety system is a long-term prospect, structures that could enable formation of such a system exist. For example, the Core Agriculture Support Program, Phase II and AEC strategic frameworks could enable and provide the impetus for GMS countries to develop harmonized food safety systems. At this juncture, a framework for monitoring

and managing standards across a range of actors and national contexts is a necessary but challenging proposition.

Increasing Presence of Higher-Volume Food Supplies, Additional Processing, and Longer Supply Chains

The GMS food sector has undergone considerable concentration to achieve cost efficiencies and in response to growing urbanization, rising incomes, and increasing demand for processed food products. Large-scale production of processed food products, often with long shelf lives, complicates food safety risk management and emergency responses and risks widespread outbreaks of food-related illness. Longer supply chains and further processing increase the time from product preparation to consumption. Without adequate control, the longer supply chains and processing times increase the likelihood of contamination or hazard multiplication. Furthermore, longer supply chains and increasing cross-border trade in raw and processed foods between GMS countries risk transmitting hazards across borders.

Consumer Awareness and Demand

In 2015, the middle class population of Asia and the Pacific surpassed that of the US and Europe combined. The GMS population has also become increasingly urbanized and better informed through new sources of information and greater connectivity. The changes have contributed to increasing consumer awareness of, and demand for, safety and quality assured food products (Kharas 2017).

Changing Retailer Requirements

As demand for processed food in the GMS has increased considerably, food supply chains and retailing are evolving quickly. Increasing concentration and integration of food industries is apparent, with vertical integrators becoming more prevalent and influential. The number of supermarkets has proliferated. In this context, agricultural stakeholders in the GMS are under increasing pressure to demonstrate that their management of food safety risks is adequate to protect domestic consumers and meet customer requirements.

The rapid emergence of supermarkets across much of the GMS has also had a considerable impact on the subregion's food sector. The region's supermarkets have gained considerable power over suppliers, which is reflected in increasingly stringent requirements to provide a stable supply of good quality, safety assured, and appropriately packaged products. Voluntary standards that supermarkets use to protect their reputations and differentiate themselves from (or match) competitors, can make it difficult for smallholders to engage with the supermarkets and can increase food waste.

Infectious Diseases and Other Barriers to Export

An estimated 75% of emerging infectious diseases in humans are zoonoses, and the GMS is among the highest risk areas in the world for emerging infectious disease events (Jones et al. 2008; Hill et al. 2015; Taylor et al. 2001). Emerging infectious diseases are significantly correlated with socioeconomic, environmental, and ecological factors. The relatively high human, livestock, and wildlife population densities in the GMS increase the risk of a new or dormant pathogen emerging within the subregion. The rapid spread of the highly pathogenic avian influenza A H5N1 ("bird flu") and the high number of human cases in the GMS countries relative to elsewhere provides a compelling example of the rapid emergence and spread of an infectious pathogen in the subregion. Recent modeling by Hill et al. (2015) demonstrates that human-poultry contact rates are high in the GMS (Figure 2.5), which is also true for human contact with pigs, ruminants, and wild animals.

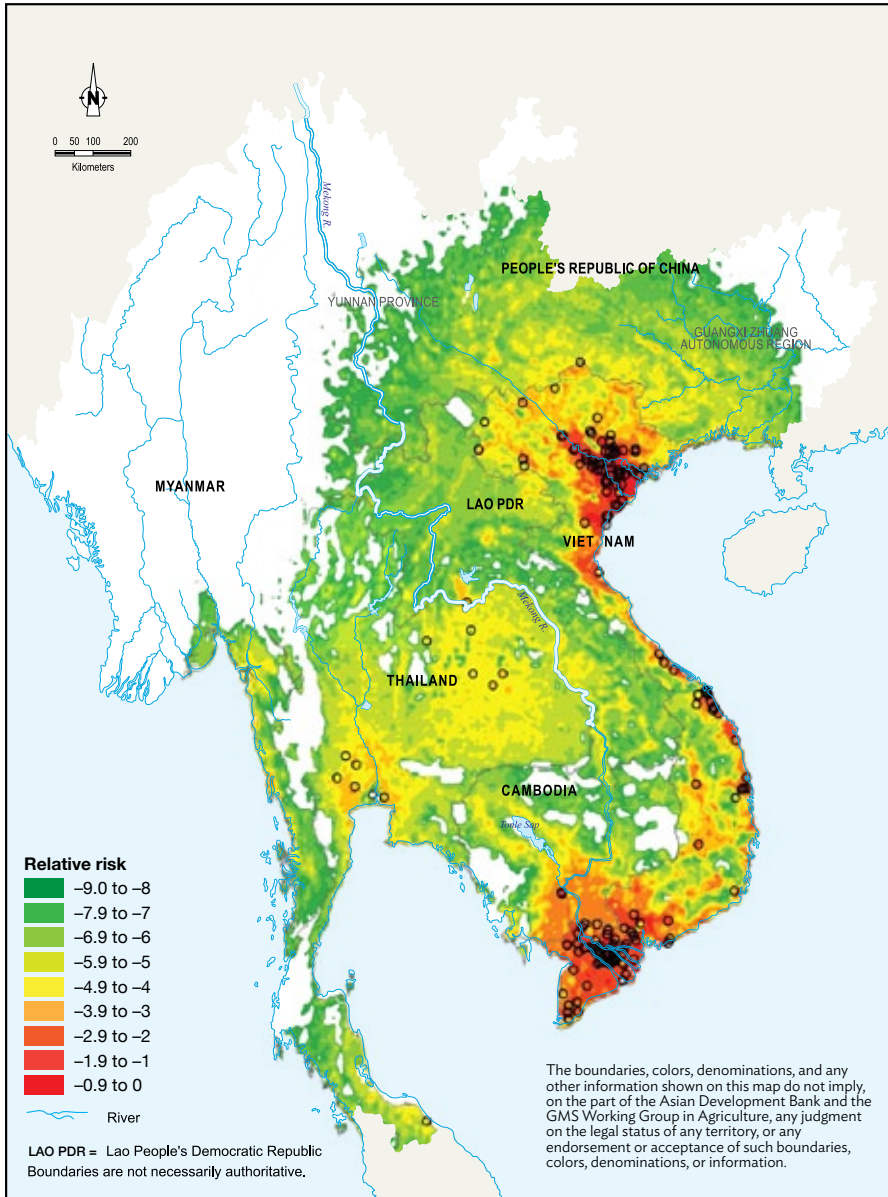
In addition, the high prevalence and frequent outbreaks of non zoonotic pathogens and pests form barriers to trade. Examples include the foot and mouth disease virus and porcine reproductive and respiratory syndrome virus, and a multitude of pests. Such issues form barriers to accessing potentially lucrative markets under the terms of the SPS Agreement.

2.5. Current Food Safety Policy, Investment, and Projects in the GMS

The Food Safety Policy Landscape

Food safety is now prioritized in the policy agenda of each GMS economy. Each country has in place many of the requisite legislative and regulatory frameworks for food safety and quality assurance and has dedicated implementing agencies

Figure 2.5: Normalized Contact Intensity Map for Domestic Chicken–Human Interaction in the GMS



Note: Red areas indicate the top 10% of cells with regards to contact intensity, which represents approximately 92% of all global contacts.

Inset: Risk map showing relative likelihood of one or more human infections with HPAI H5N1 clade 1, for the 6 months prior to 20 May 2004 (99th percentile risk values shown for clarity). Relative risk on log₁₀ scale. Black circles represent outbreaks with known longitude and latitude coordinates.

Source: Based on Hill et al. (2015).

(Appendix 2.2). However, the less-developed economies lack sufficient food control systems, facilities, and technical and operational capacity.

Although in some cases commodity specific legislation is still required (Appendix 2.3), national food safety policy and legislative and regulatory systems in the GMS countries are now more comprehensive and better aligned with the core principles and provisions of the ASEAN food safety policies and their associated frameworks (Table 2.3). This is an important step toward harmonizing GMS systems with internationally recognized food safety systems and requirements, replacing hazard-by-hazard approaches that hamper demonstration of equivalence between countries (Teoh 2016).

Roles and Responsibilities and Chains of Command

Due to the multisector nature of food safety, multiple agencies are involved in implementing and enforcing food safety laws and food control systems. The key agencies vary between GMS countries (Appendix 2.2). In all GMS countries except the PRC, the ministries of health and agriculture are among the main food safety agencies. Ministries of industry, trade and commerce, economy, and education have roles in food safety in the GMS countries. Support agencies include the ministries of industry, finance, commerce, interior, and university affairs, as well as the prime minister's offices. In many cases, interministerial committees on food safety have been created to coordinate the activities of the different ministries, generally led by the ministry of health. The situation is somewhat different in the PRC, where two ministerial-level agencies are responsible for food safety—the Food and Drug Administration and the General Administration of Quality Supervision, Inspection, and Quarantine.

National food safety agencies should work closely with local authorities and enforcement officers to ensure food laws are applied the entire length of food supply chains. A clear chain of command is required for operating surveillance systems and emergency responses. Implementation and enforcement of food safety standards in less-developed countries have not yet reached the level of efficiency observed in the more-developed economies (e.g., Thailand), presenting an opportunity for the former to learn from the latter's experience.

Table 2.3: Alignment of GMS Country Food Safety Policies and Frameworks with ASEAN Frameworks

| ASEAN Food Safety Legal Framework Provisions | Country Legal Framework | | | | | |
|--|--|--|---|--|---|--|
| | Cambodia | PRC | Lao PDR | Myanmar | Thailand | Viet Nam |
| ASEAN Food Safety Policy 2016 (AFSP) and Its Core Principles ^a | New Food Safety Law (draft #2, 2017) ^c | Food Safety Law 2015 ^k | National Food Safety Policy 2009 ^e | National Food Law 1997; Amended National Food Law 2013; New Food Safety Law 2017 (for enactment ^g) | National Food Committee Act 2008 and National Strategic Framework for Food Management 2012 ^l | Law on Food Safety 2010 ^h |
| Integrated Food Chain Approach | ✓ | M | ✓ | ✓ | ✓ | ✓ |
| Systematic Risk Analysis Framework | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Science-Based, Independent Risk Assessment Process | ✓ | ✓ | M | ✓ | ✓ | M |
| Primary Responsibility of Food Business Operators | ✓ | ✓ | X | ✓ | ✓ | ✓ |
| Consistency with ASEAN Trade in Goods Agreement and WTO SPS and TBT agreements | ✓ | M | M | ✓ | ✓ | ✓ |
| Equivalence and Mutual Recognition | ✓ | X | ✓ | ✓ | ✓ | ✓ |
| Harmonization with International Standards | ✓ | M | ✓ | ✓ | ✓ | ✓ |
| Reliable Traceability System | ✓ | ✓ | X | ✓ | ✓ | ✓ |
| Strengthening and Harmonization of Regional and National Food Control Systems | ✓ | ✓ | M | ✓ | ✓ | M |
| Transparency | ✓ | ✓ | X | ✓ | ✓ | M |
| ASEAN Food Safety Regulatory Framework that operationalizes the AFSP (drafting stage in 2016) ^b | Inter-Ministerial Prakas 868 on Implementation of Food Safety, 2010 ^d | National Food Safety Regulatory and Strategic Framework, 2007 ^l | MOH Ministerial Regulation 518, 2009 ^f | No counterpart | National Strategic Framework for Food Management, 2012 ^l | Food Safety and Agricultural Health Action Plan, 2006 ⁹ |

Continued next page

Table 2.3 continued

✓ = specified, M = specified with some modifications, X = not specified, AFSP = ASEAN Food Safety Policy 2016, ASEAN = Association of Southeast Asian Nations, MOH = Ministry of Health, SPS = sanitary and phytosanitary, TBT = technical barriers to trade, WTO = World Trade Organization

Sources:

- ^a ASEAN (2016). ASEAN Food Safety Policy. http://www.aseanfoodsafetynetwork.net/Food_safety_policy/bk/foodsafety_policy/9fier-2016-11-04.pdf
- ^b The ASEAN Food Safety Regulatory Framework (AFSRF). nd. <http://asean.org/storage/2016/08/ASEAN-Food-Safety-Regulatory-Framework.pdf>
- ^c Personal communication, DDG Camcontrol, Cambodia.
- ^d Kingdom of Cambodia. 2010. Inter-Ministerial Prakas on the Implementation and Institutional Arrangements of Food Safety Based on the Farm to Table Approach. http://www.camcontrol.gov.kh/userfiles/file/Inter-Ministerial%20Prakas%20no._%20868_From%20farm%20to%20table%20for%20Food%20Safety_English%20Version_20101022.pdf
- ^e Lao People's Democratic Republic. 2009b. National Food Safety Policy. Vientiane. <https://laosfoodsafetylaws.files.wordpress.com/2011/03/laos-law-food-safety-13jan2009.pdf>
- ^f Lao People's Democratic Republic. 2009a. Ministerial Regulation on the Basic Principles in the Application of Sanitary and Technical Measures for the Food Safety Management. Vientiane. <https://laosfoodsafetylaws.files.wordpress.com/2011/03/laos-law-sanitary-technical-18mar2009.pdf>
- ^g Zaw, T. 2015. Food safety in Myanmar. Symposium on Ensuring Food Safety: An Important Challenge Today. 30th CMAAO General Assembly & 51st Council Meeting, 23-25 Sept 2015, Yangon, Myanmar.
- ^h United States Department of Agriculture. Foreign Agricultural Service. https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Food%20Safety%20Law%20and%20Guiding%20Decree%20Released_Hanoi_Vietnam_6-12-2013.pdf
- ⁱ World Bank. 2006. Vietnam Food Safety and Agricultural Health Action Plan http://siteresources.worldbank.org/INTVIETNAM/Resources/vietnam_sps_report_final_feb_06.pdf
- ^j Thailand Food Committee. 2012. Strategic Framework for Food Management in Thailand. http://tnfc.fda.moph.go.th/file/fileDoc/2015-04-20_5469.pdf
- ^k United States Department of Agriculture. 2015. China's Food Safety Law. https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Amended%20Food%20Safety%20Law%20of%20China_Beijing_China%20-%20Peoples%20Republic%20of_5-18-2015.pdf
- ^l ADB. Technical Assistance Completion Report. n.d. <https://www.adb.org/sites/default/files/project-document/65508/37599-prc-tcr.pdf>

Food Safety and Food Control System Infrastructure

Securing sufficient investment in food safety and food control systems is a major challenge in the GMS countries, particularly among the smaller economies. Nevertheless, GMS governments are making concerted efforts to strengthen their food safety capacity, often in coordination with development partners. For example, the ADB-supported project—Regional Trade Facilitation: Improved SPS Handling in GMS Trade—has financed the construction of infrastructure and capacity building in Cambodia, the Lao PDR, and Viet Nam. The project established enhanced surveillance and inspection systems for plant health, animal health, and food safety; improved training of specialists; and promoted regional cooperation and harmonization of SPS measures. Laboratory capacity in Myanmar has increased—including establishing the first ISO/IEC 17025:2005² accredited laboratory (in Nay Pyi Taw), with support from the US-based ANSI-ASQ National Accreditation Board. In addition, a pharmaceutical chemistry laboratory is being developed by the United Nations Office for Project Services (UNOPS) and a food microbiology laboratory is being developed with support from the United Nations Industrial Development Organization (UNIDO); both will seek recognizable accreditation. More initiatives are discussed below.

² ISO/IEC = International Organization for Standardization and International Electrotechnical Commission.

Notable Initiatives

Regional Initiatives. Numerous ASEAN technical working groups are working on food safety, including the Product Working Group on Prepared Foodstuff, the ASEAN Expert Working Group on the Harmonization of Maximum Residue Limits of Pesticides, the ASEAN Task Force on Codex, the ASEAN Sectoral Working Group on Livestock, the ASEAN Sectoral Working Group on Fisheries, the ASEAN Sectoral Working Group on Crops, the ASEAN Working Group on Halal Food, the ad-hoc Working Group on Food Irradiation, and the ASEAN Expert Group on Food Safety.

Donor-Led Initiatives. Several multicountry and national food safety initiatives have been implemented (Appendix 2.4). The Mekong Institute and FAO have been the main implementers of multicountry projects, the former with funding from the New Zealand Aid Programme, the latter funded by the governments of Sweden and Japan. Other multicountry projects have been supported by ADB, the EU, GIZ,³ and the Asian Productivity Organization.

SPS and Codex Alimentarius initiatives have been pursued in CLM and Viet Nam (Appendix 2.5). The FAO, with funding from the Japanese government, coordinates a multicountry capacity building project in the four countries, for developing and implementing international food safety standards. The FAO has also implemented projects in the Lao PDR, to assist the development of an SPS-related legal framework, and in Viet Nam, to strengthen SPS capacity more broadly. ADB also supports SPS capacity building, primarily in Cambodia, the Lao PDR, Myanmar, and Viet Nam. In addition, the ADB-led GMS Core Agriculture Support Program and technical assistance address food safety and market access.

Private-Sector-Led Initiatives. Many larger private interests in food systems have adopted or established their own more stringent requirements, based on standards such as ASEAN GAP, good manufacturing practices, hazard analysis critical control point, and other international third-party certifications that meet and often surpass requirements of national, regional, and global systems. A private-sector-led public-private partnership project to promote safe food and increased market access of small and medium-sized enterprises (SMEs) is currently underway in Cambodia, the PRC, the Lao PDR, Myanmar, and Viet Nam.

Various regional and global private sector-driven initiatives address food safety and market access (Appendix 2.6). The Global Food Safety Initiative (GFSI) is of particular note. The GFSI is a nonprofit foundation supported by a number of the world's leading

3 GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit, GmbH

food retailers which, in collaboration with UNIDO, share technical expertise with SMEs to build their compliance with international food safety standards. The GFSI currently has several initiatives in the GMS.

The participatory guarantee system (PGS) offers a community-based quality assurance system for the supply of food products produced using organic agriculture methods. The approach is participatory and peer-based, certifying groups of producers on the basis of trust, social networks, and knowledge exchange between peers. PGS initiatives are serving thousands of small-scale organic farmers and their consumers globally, and their numbers are increasing annually. A PGS is typically initiated by the private sector with minimal government support. Approximately 50 PGS groups are now operating in the GMS, with more than 2,500 participating farmers, mainly in Thailand and Viet Nam.

Notable Gaps

Despite the heavy burden of foodborne hazards on the GMS countries, their capacity for managing food safety risks remains suboptimal. Issues include infrastructure bottlenecks; variable and often limited technical capacity; and uncertain leadership, roles, and responsibilities. The effective control of hazards in all GMS countries is of paramount importance to each country given the increasing volumes of cross-border trade in food products.

Policy and institutional gaps hamper subregional harmonization. Creating a policy environment for enabling food safety in the agri-food industry is a prerequisite to realizing the sector's potential to boost economic growth, reduce poverty and inequality, provide food security, and deliver environmental services (World Bank 2017). Government policies and regulations play a key role in shaping the business environment through their impacts on costs, risks, and barriers to competition for various players in value chains. By setting the right institutional and regulatory framework, governments can help increase the competitiveness of farmers and agricultural entrepreneurs, enabling them to integrate into regional and global markets.

Surveillance Systems. Considerable variability exists in the design and implementation of surveillance systems. Further, GMS country standards such as national GAPs differ, and equivalence is not yet recognized for technical and political reasons. At present, internationally recognized risk management approaches are generally confined to the few larger processors or export-oriented suppliers.

Policies, Laws, and Regulation. The GMS countries have national food safety policies and laws. These may include sector- or commodity-specific legislative and/or regulatory systems, for example veterinary and rice laws. However, systems are poorly coordinated and lack coherence in some jurisdictions.

Regulatory systems are often opaque and can be unnecessarily burdensome. Transparency and accountability is highly variable. Excessive regulation can also drive suppliers and producers to use informal means to reduce costs, presenting greater risk to all. Poorly designed or enforced regulations can impose unnecessary transaction costs and hamper productivity and access to finance, for example.

Information Dissemination. Considerable information gaps exist, such as the lack of estimates of the prevalence of key hazards, consumption volumes, and consumer behavior. Research institutes and the private sector are not adequately engaged in setting standards, guidelines, and policy and regulatory systems. Yet, these stakeholders are essential to developing systems that function effectively.

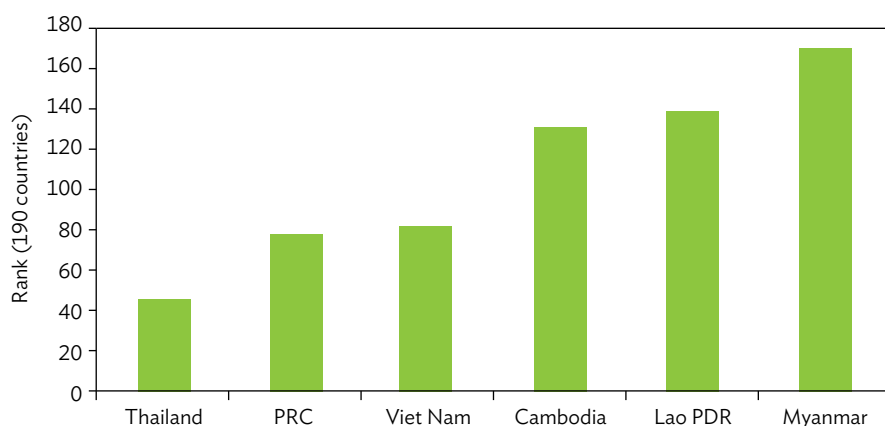
Ease of Doing Business

The terms and conditions for conducting business in the GMS could be improved. The situation varies across the region. In particular, the CLM faces considerable difficulty in mainstreaming food control systems due to unfavorable business conditions (Figure 2.6). Improvements needed include facilitation of legal cross-border trade, business start-ups, enforcement of contracts, access to electricity, and protection of minority investors. While the GMS countries have made considerable advances in expediting border transit for goods, primarily through reduced documentation and broader streamlining, there are considerable opportunities for further increasing the efficiency. GMS countries can learn from each other and other ASEAN nations by understanding their policies, institutional capacity, and infrastructural investment for creating conditions that support all business ventures, including SMEs.

Investment Gaps in Food Supply Chains and Food Controls

Current gaps in food safety and market access investment in the GMS are apparent the length of agriculture value chains. Infrastructure gaps create bottlenecks in food supply systems in the GMS. Specific infrastructure needs vary between and within countries, between products, and at different points in supply chains.

Figure 2.6: GMS Country Rankings for Ease of Doing Business
(190 countries)



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Based on data from World Bank (2017).

Investment is required in developing safer, higher quality, more transparent input supply (including seed, plant protection, and feed), and in regulating the use of veterinary products in animals destined for the market. In production, further investment in on-farm surveillance systems is needed. Moreover, better communication of best practices and risk mitigation and risk management strategies is needed.

Post farm gate, process control systems are in their infancy in some GMS countries and vary widely between large and small-scale processors. Again, best practices, assurances, and risk communication initiatives are needed. Ease of transport and the capacity and quality of storage vary widely across the GMS. Transport is hampered by improving but still suboptimal requirements for movement within countries and across borders. Investments in expediting consignment movement by further reducing red tape, increasing the availability and quality of cold chains, providing transport hub services such as weighing stations and truck parking, and improving access to deep-sea ports can reduce losses in transit and minimize the likelihood of waste and of contamination and multiplication of hazards in products.

Retailers' food handling may be improved by better practices and by risk communication initiatives. Promoting safe consumer steps in handling and preparing food is also needed. Finally, systems to alert stakeholders of food safety and other hazard risks are generally underdeveloped. Systems for identifying a problem early and addressing it via alerts, product recalls, movement bans, vaccination campaigns, culling, and the like, are required.

Additionally, food testing laboratories and transport- and logistics-related infrastructure are typical infrastructural gaps. The few food testing laboratories in the GMS lack international accreditation. Some GMS countries do not have laboratories that meet international standards for detecting key hazards. As a result, suppliers either remain uncertified or must send samples outside their country, thus incurring additional expense and considerable opportunity costs and potential waste. Other key gaps include disease control infrastructure, such as quarantine facilities.

Human and Operational Capacity, and the Business Environment. The common constraints in the CLM are technological and relate to human resource skills, technical training, and surveillance and traceability systems. Viet Nam also suffers from deficient technical capacity and underperforming or nonexistent traceability systems. The enforcement of food laws, occurrence of forgeries, and poor value chain coordination also hamper food safety throughout the GMS. Improper processing, inefficient use of natural resources (including overfishing and waste dumping in rivers), and GMS suppliers' and public authorities' uncertainty about the responsibility for protecting consumers and the environment also negatively impact food safety. SMEs' limited interest in applying food safety management systems, associated with suboptimal policies and uncertain incentive structures, are particularly apparent in the CLM. Improper use of agrochemicals is exacerbated by the failure of pesticide companies to provide recommendations on the optimal use of their products, which is particularly notable in Myanmar. Delays in customs processing also contribute to difficulties encountered. A key Thai constraint is insufficient support for food businesses that mainstream food safety management systems, which is not yet adequately rewarded in the domestic market. Limited value addition in various food chain segments could be addressed to increase competitiveness and improve the safety and quality of food products for national and export markets.

Effective risk management requires considerable leadership, technical, and operational capacity, which is currently highly variable within the GMS. Current chains of custody for sample handling and chains of command in decision-making related to risk management initiatives need clarification and harmonization.

Capacity to effectively implement risk analysis remains limited. Surveillance systems vary in design, implementation, and reliability; ICT systems are suboptimal; and harmonization and adoption of standards and technical regulations frequently suffer delays. Most traceability systems require considerable upgrading. The main technical constraints are commonly amplified by a lack of coordination with universities and research institutes and insufficient knowledge transfer about food safety

risk management. This is the case across the GMS, including Thailand, where the technical capacity in food control systems is considerably more advanced than in the other countries.

Emergency response plans for food safety hazards, zoonosis, and broader infectious diseases of importance to production and trade are at various stages of development, as is the capacity of different countries to implement such responses in a timely, efficient, and effective manner. Given national interests in controlling hazards and the porous nature of GMS borders, there are opportunities to harmonize emergency response plans at the subregional level.

Effective food systems require considerable maintenance and operating budgets. To cover the costs will also require inputs from all stakeholders. For example, surveillance and traceability systems inevitably require continuing investment in staff, vehicles and fuel, consumables, data management, and broader ICT services. Furthermore, risk communication is an essential component of risk analysis related to both food safety and hazards of importance to trade. Data sharing and risk communication initiatives within and between GMS countries can be improved. To be effective, awareness raising initiatives on priority hazards, risks, and best practices for risk mitigation must be dynamic, timely, and targeted to consumers, retailers, and suppliers.

2.6. The Way Forward

Although the GMS countries have made progress in developing appropriate food safety policies, establishing risk-based surveillance systems, upgrading food safety systems, and facilitating trade, further improvements are desirable. To develop more credible and robust systems that build trust will require (1) reliance on evidence-based national and regional policy, legislative, and regulatory environments and systems; and (2) strategic investment in infrastructure and human and operational capacity. Further, risk communication initiatives can be strengthened to build risk awareness among stakeholders and facilitate optimal responses.

Addressing gaps related to food safety standards and hazards of importance to trade in agriculture products in the GMS requires holistic value chain approaches that include all stakeholders. Strengthening risk-based approaches can upgrade food safety systems and help to unlock market access in a cost-effective manner. Effective implementation will also increase transparency and accountability of food safety measures, which can increase trust between customers, suppliers, and regulators.

Food control systems in the GMS can be improved by better aligning them with the regional standards. The ASEAN Common Principles for Food Control Systems (ASEAN 2015) provides a guide for developing and harmonizing food control systems across the GMS. The key principles include integrated farm-to-table approaches, risk analysis, transparency, and regulatory impact assessment. Strategic evidence-based policymaking, institutional capacity building, and investment are needed to achieve the goals of the principles.

The next chapter—Increasing the Safety and Quality of Food Products from the Greater Mekong Subregion—specifically assesses gaps and recommends actions and short-term initiatives to improve GMS food safety systems and increase market access for GMS food suppliers.

Appendixes

Appendix 2.1: GDP and Trade Scenarios in GMS Countries

| Particulars | Cambodia | PRC | Lao PDR | Myanmar | Thailand | Viet Nam |
|---|----------|-----------|---------|---------|----------|----------|
| GDP (billion current \$, 2015) | 18.05 | 10,866.44 | 12.33 | 66.98 | 395.28 | 193.60 |
| GDP per Capita (\$, 2012–2015) | 1,093 | 7,503 | 1,756 | 1,203 | 6,003 | 2,024 |
| Trade per Capita (\$, 2012–2015) | 771 | 1,677 | 557 | 220 | 3,918 | 1,756 |
| Trade (% of GDP, 2012–2015) | 70.5 | 22.3 | 31.7 | 18.9 | 65.3 | 86.7 |
| Commodity Exports (billion current \$, 2014–2015) | 11.96 | 2,274.95 | 2.34 | 5.95 | 214.38 | 162.11 |
| Agriculture products (%) | 4.9 | 3.2 | ND | 26.5 | 17.0 | 15.2 |
| Fuel and mining products (%) | 0.1 | 2.4 | ND | 43.8 | 5.0 | 3.4 |
| Manufactures (%) | 66.1 | 94.3 | ND | 29.5 | 74.6 | 81.4 |
| Others (%) | 28.9 | 0.1 | ND | 0.3 | 3.4 | |
| Main Export Destinations (%, 2010–2015) | | | ND | | | |
| European Union | 38.5 | 15.6 | | | 10.3 | 18.6 |
| United States | 25.0 | 18.0 | | | 11.2 | 19.1 |
| Japan | 6.7 | 6.0 | | | 9.4 | 9.8 |
| Canada | 6.5 | | | | | |
| Hong Kong, China | | 14.6 | | 21.1 | | |
| Thailand | | | | 41.7 | | |
| India | | | | 12.6 | | |
| PRC | | | | 6.2 | 11.1 | 9.9 |
| Others | 23.3 | 45.8 | | 18.4 | 58.1 | 42.6 |
| Top Agricultural Exports (\$ million, 2010–2014) | | | ND | | | |
| Rice | 231 | | | 156 | 4,544 | 2,937 |
| Sugar (cane or beet) | 28 | | | | 2,628 | |
| Cassava, arrowroot, salep | 23 | | | | 1,543 | |
| Cigars, cheroots, cigarillos | 16 | | | | | |
| Preparations used in animals | 15 | 1,599 | | | 1,214 | |
| Dried vegetables, whole or cut | | 2,812 | | | | |
| Plants' parts otherwise preserved | | 2,572 | | | | |
| Onions, shallots, garlic, leeks | | 2,385 | | | | |
| Other vegetables, not frozen | | 1,878 | | | | |

Continued next page

Appendix 2.1 continued

| Particulars | Cambodia | PRC | Lao PDR | Myanmar | Thailand | Viet Nam |
|--|----------|----------|---------|---------|----------|----------|
| Dried leguminous vegetables | | | | 890 | | |
| Other oil seeds, oleaginous fruit | | | | 69 | | |
| Meat and edible meat offal, salted | | | | 16 | | |
| Other prepared or preserved meat | | | | | 2,187 | |
| Maize (corn) | | | | 12 | | |
| Coffee | | | | | | 3,311 |
| Coconuts, Brazil nuts, cashew nuts | | | | | | 2,050 |
| Pepper of the genus <i>Piper</i> | | | | | | 1,206 |
| Starches, inulin | | | | | | 739 |
| Commodity Imports (billion current \$, 2015) | 14.40 | 1,681.95 | 3.86 | 15.92 | 202.65 | 166.10 |
| Agriculture products (%) | 7.3 | 9.5 | ND | 4.9 | 7.9 | 11.2 |
| Fuel and mining products (%) | 1.7 | 21.3 | ND | 12.3 | 18.5 | 8.0 |
| Manufactures (%) | 60.8 | 64.4 | ND | 75.1 | 69.6 | 75.0 |
| Others (%) | 30.2 | 4.8 | ND | 7.6 | 4.0 | 5.7 |
| Main Import Origin (%, 2010–2015) | | | ND | | | |
| PRC | 36.8 | | | 27.1 | 20.3 | 29.5 |
| Thailand | 14.6 | | | 11.4 | | |
| Viet Nam | 8.7 | | | | | |
| Hong Kong, China | 6.7 | | | | | |
| European Union | | 12.4 | | | 8.9 | |
| Korea, Republic of | | 10.4 | | 6.1 | | 14.7 |
| United States | | 9.0 | | | 6.9 | |
| Singapore | | | | 27.0 | | |
| Taipei, China | | 8.6 | | | | 7.5 |
| Japan | | | | | 15.4 | 8.7 |
| Others | 33.2 | 59.6 | | 28.1 | 48.5 | 39.6 |
| Top Agricultural Imports (\$ million, 2010–2014) | | | ND | | | |
| Cigars, cheroots, cigarillos | 395 | | | | | |
| Malt and malt extract | 169 | 2,896 | | 8.4 | | |
| Preparations used in animals | 101 | | | | | |
| Waters containing sugar | 72 | | | | | |
| Soybeans | | 34,895 | | | 1,117 | 873 |

Continued next page

Appendix 2.1 continued

| Particulars | Cambodia | PRC | Lao PDR | Myanmar | Thailand | Viet Nam |
|------------------------------------|----------|-------|---------|---------|----------|----------|
| Solid residues from soybean mill | | | | | 1,235 | 1,860 |
| Palm oil and its fractions | | 3,705 | | 168 | | |
| Grain sorghum | | 2,971 | | | | |
| Barley | | 2,859 | | | | |
| Cereal grains otherwise worked | | | | 58 | | |
| Milk and cream, concentrated | | | | 49 | | |
| Other food preparations | | | | 16 | 517 | |
| Wheat and meslin | | | | | 1,132 | |
| Cotton, not carded or combed | | | | | 532 | 1,423 |
| Maize (corn) | | | | | | 1,216 |
| Coconuts, Brazil nuts, cashew nuts | | | | | | 651 |

GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, ND = no data, PRC = People's Republic of China, WTO = World Trade Organization.

GDP is the sum of output within the economy's territory minus the sum of intermediate consumption (increased by taxes net of subsidies on products). It is measured in nominal terms and with market exchange rates; GDP per capita is estimated as an economy's GDP divided by the population. It is calculated on the basis of data for the three latest years available; Trade per capita is estimated as an economy's trade in goods and commercial services (average of exports and imports, balance of payments basis) divided by the population. It is calculated on the basis of data for the latest 3 years available; Trade-to-GDP ratio is estimated as an economy's trade in goods and commercial services (average of exports and imports, balance of payments basis) divided by GDP, on the basis of data for the latest 3 years available; Agriculture products refer to food and raw materials; Fuels and mining products include ores and other minerals, fuels and non-ferrous metals; Manufactures refer to iron and steel, chemicals, other semi-manufactures, machinery and transport equipment, textiles, clothing and other consumer goods. Due to the products not classified in the three main product groups, the sum of the shares may not add up to 100; Agriculture products, top exported products, and top imported products are the top five traded agricultural goods of an economy at the Harmonized System 4-digit level. According to the definition of the WTO Agreement on Agriculture, agricultural goods refer to HS chapters 1 to 24 (excluding fish and fish products) and a number of manufactured agriculture products (for further information, see "The Legal Texts: The Results of the Uruguay Round of Multilateral Negotiations," WTO). This definition does not correspond to the definition of agriculture products above. Source: WTO (2016).

Appendix 2.2: Food Safety Laws, Regulations, and Implementing Agencies in the GMS

| Country | Laws and Regulations | Agencies and main functions |
|-----------------|---|---|
| Cambodia | <p>Law on the Management of Quality and Safety of Products and Services (2000) Covers inspection procedures to ensure quality and safety of products, goods, and services as well as guidelines on production and commercialization, consumers' rights and economic operators' obligations, labeling, commercial fraud repression, etc.</p> | <p>Ministry of Agriculture, Forestry and Fisheries—Takes charge of the registration and/or permission to establish and operate food business at primary production and primary processing; will be carried out by the Ministry's Competent Authority. Ministry of Industry and Handicraft—Monitors food safety compliance of large-scale production of processed food products and handicrafts especially those for export. Ministry of Commerce, General Department of CAMCONTROL—Ensures consumer protection, implements a framework for cross-border market surveillance activities, works on custom-related services with General Department of Customs and Excise of Cambodia (GDCE) and other concerned agencies, and leads the inter-ministerial committee on food safety. Ministry of Health—Implements policies and programs promoting compliance with hygiene and sanitation requirements Ministry of Economy and Finance, GDCE—Provides effective and efficient coordination in food safety inspection at the international checkpoints.</p> |
| | <p>Law on Standards of Cambodia (2007) Seeks to improve the quality of products and services to (1) raise production efficiency, (2) ensure fair and simplified trade, (3) rationalize product use, and (4) enhance consumer protection and public welfare.</p> | |
| | <p>Law on Management of Pesticides and Fertilizers (2012) Aims to enhance public awareness of the implementation of standard requirements of pesticides and fertilizers.</p> | |
| | <p>Prakas on Good Agricultural Practices (2010) Promotes good agricultural practice (GAP) rules on fruit and vegetable production to promote food safety; minimize environmental impact; protect health, safety, and well-being of producers; and improve the quality of agro-products.</p> | |
| | <p>Prakas on the Implementation and Institutional Arrangements of Food Safety Based on the Farm-to-Table Approach (2010) Aims to improve the implementation of a food safety system that will protect consumer health, enhance Cambodian food export competitiveness, and set up institutional arrangements.</p> | |

Continued next page

Appendix 2.2 continued

| Country | Laws and Regulations | Agencies and main functions |
|---|---|---|
| China, People's Republic of | <p>Food Safety Law 2009 (repealed Food Hygiene Law 1997) Imposing more stringent controls on food safety risks and ensuring greater government accountability toward consumers</p> <p>Food and Drug Administration Law 2013, amends Food and Drug Administration Law 2001 and establishes China Food and Drug Administration (CFDA) from a state to a ministerial-level agency created to increase vertical integration and focused oversight of food safety regulation.</p> | <p>Food and Drug Administration (FDA), a ministerial level agency,</p> <ul style="list-style-type: none"> • is responsible for food safety management, risk assessment, formulation of standards, information dissemination, establishment of codes of practice for food testing organizations, and the investigation of major food safety incidents; • oversees food manufacture, distribution, and consumption, and manages regulation processes for food and drug safety; and • works closely with the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) <p>AQSIQ is a ministerial-level agency under the PRC State Council that is in charge of national quality, meteorology, entry–exit commodity inspection, entry–exit health quarantine, entry–exit animal and plant quarantine, import–export food safety, certification and accreditation, standardization, as well as administrative law enforcement.</p> |
| Lao People's Democratic Republic | <p>National Food Safety Policy (2009) Aims to protect and promote better health by ensuring people consume safe, hygienic, and nutritious food as well as promote safe food production and trade.</p> <p>Food Law (2013) Defines the principles, regulations, and measures to manage, monitor, and inspect food and food businesses ensuring quality, effectiveness, safety, and nutrition as well as protecting consumers' health and contributing to the country's development.</p> <p>Food Inspection Regulation 297, MOH (2012) Provides guidelines in food inspection.</p> | <p>Ministry of Health (MOH)—Develops national food safety plans and policies and coordinates intersectoral linkages in implementing regulations.</p> <p>Ministry of Agriculture and Forestry—Monitors food safety practices from primary production, processing, and preservation; implements codes of practices.</p> <p>Ministry of Industry and Commerce—Inspects factories and other industrial establishments.</p> |

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Appendix 2.2 continued

| Country | Laws and Regulations | Agencies and main functions |
|-----------------|--|--|
| Myanmar | National Food Law (1997) Regulates production, import, export, storage, distribution, and sale of food; enables public to consume food of genuine quality and free from danger. | Ministry of Health and Sports, Department of Food and Drug Administration—In charge of the registration, licensing, and quality control of registered drugs, processed food, and food for import/export. Ministry of Agriculture, Livestock, and Irrigation, Department of Agriculture—Promotes GAP and regulates use of chemical inputs in agriculture products. Ministry of Education, Department of Research and Innovation—Ensures compliance with international standards and regulations. Ministry of Commerce, Department of Consumer Affairs—Establishes consumer dispute settlement groups at regional, state, and township levels. |
| | Consumer Protection Law (2015) Seeks to protect rights of consumers by forming Consumer Complaint Committee to receive complaints regarding food quality and safety. | |
| | Public Health Law (1972) Aims to control the quality and cleanliness of food and drugs, maintain environmental sanitation, and prevent epidemics. | |
| | Pesticide Law (1990) Regulates the use and trade of pesticides and other toxic substances. | |
| Thailand | Note: abbreviations in this column are defined in the column to the right. Agricultural Commodity Standards Act BE2551 (2008)—ACFS Fertilizer Act BE2518 (1975) amended 2550 (2007)—DA Plant Quarantine Act BE2507 (1964) amended 2551 (2008)—DA Fisheries Act BE2490 (1947)—DF Control of Animal Slaughter & Sale of Meat Act BE2535 (1992)—DLD Animal Feed Quality Control Act BE2525 (1982) amended 2542 (1999)—DLD Animal Epidemics Act BE499 (1956) amended 2542 (1999)—DLD Dairy Cattle and Milk Product Act BE2551 (2008)—DLD | Ministry of Agriculture and Cooperatives (MAC)—Responsible for safety and quality of food at farm production for domestic and export markets and food (fresh and processed) through standard setting and control of using the standard; controls import of living plants and animals, meat, tuna, shrimp, animal feed, agrochemicals and agro-hazardous substances. MAC includes the <ul style="list-style-type: none"> • National Bureau of Agricultural Commodity & Food Standard (ACFS) • Dept of Agriculture (DOA) • Dept of Fisheries (DOF) • Dept of Livestock Development (DLD) • Dept of Rice (DOR) • Dept of Agricultural Extension (DAE) |

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Appendix 2.2 continued

| Country | Laws and Regulations | Agencies and main functions |
|---------|--|---|
| | <p>Food Act BE2522 (1979) (FDA) Communicable Disease Act BE2523 (1980) (DDC) Public Health Act BE2535 (1992) (DH)</p> <hr/> <p>National Food Commission Act BE2551 (2008) (ACFS & FDA)</p> | <p>Ministry of Public Health (MPH)—Responsible for safety and quality of food (fresh, processed, and cooked) and import of food for domestic consumption through standard setting and control of using the standard of food labeling, advertisement, and packaging; consumer education; foodborne disease prevention and control for both domestic and export food. MPH includes the</p> <ul style="list-style-type: none"> • Food and Drug Administration (FDA) • Food Safety Operations Center (FSOC) • Dept of Health (DH) • Dept of Medical Sciences (DMS) • Dept of Disease Control (DDC) • National Food Commission (NFC). <p>NFC—Responsible for the formulation of national policy direction and strategies covering all dimensions of food, including food quality, safety, security, and education. All policies and strategies will guide all national agencies throughout the food chain to move in the same direction, to have more coordination and integration in order to achieve the highest possible level of national food management.</p> |
| | <p>Industrial Product Standards Act BE2511 (1968) amended 2548 (2005)—TISI National Standardization Act BE2551 (2008)—TISI Hazardous Substances Act BE2535 (1992) amended 2544 (2001)—MI Hazardous Substances Act BE2535 (1992) amended 2544 (2001)—MI Export and Import of Goods Act BE2522 (1979)—DFT Consumer Protection Act BE2522 (1979) amended 2541 (1998)—OCPB Liability for Damages Arising from Unsafe Products Act BE2551 (2008)—NHC National Health Act BE2550 (2007)</p> | <p>Support ministries:</p> <p>Ministry of Industry (MI)—Thai Industrial Standards Institute (TISI), standards; National Food Institute (NFI), upgrading food industry to international standard, lab services, R&D; Finance and Trade (DFT), Customs Dept—Coordinates with FDA at major ports for import testing; Commerce, Foreign Trade Dept—Controls import/export of controlled goods Interior, with provincial governors as head of food safety activities at local level; University Affairs, Knowledge Network Institute of Thailand and Institute of Nutrition, Mahidol University—R&D Prime Minister’s Office—Consumer Protection Board (OCPB); National Health Commission (NHC).</p> |

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Appendix 2.2 continued

| Country | Laws and Regulations | Agencies and main functions |
|-----------------|--|---|
| Viet Nam | Food Safety Law (2010) Outlines conditions for food safety from food production, testing, labeling, trading, and consumption. | Ministry of Health (MOH)—Manages food safety from production, processing, and retail of pre-packed and processed food, food additives, and other substances. Ministry of Agricultural and Rural Development (MARD)—Monitors food safety compliance in cereal, egg, meat, seafood, fruits, vegetables, and other related by-products and produce. Ministry of Industry and Trade (MOIT)—Regulates production, processing, and retail of alcoholic beverages, processed milk, vegetable oil, etc. |
| | Decree No.163/2004/ND-CP (2004) Regulates the implementation of some articles of the Ordinance on Food Hygiene and Safety in detail. | |
| | Decree No.79/2008/ND-CP (2008) Stipulates the organization, management, inspection, and testing of food hygiene and safety systems. | |
| | Resolution No. 34/2009/NQ-QH12 (2009) Promotes the implementation of policies and legislation on the management of food quality, hygiene, and safety. | |
| | Decree No. 38/2012/ND-CP (2012) Guides interagency coordination to implement the Food Safety Law. | |

Source: Mekong Institute.

Appendix 2.3: Gaps and Bottlenecks along the Food Chain

Table A2.3.1: Gaps along the Food Chain in the GMS

| Stage | Gaps | Cambodia | PRC | Lao PDR | Myanmar | Thailand | Viet Nam |
|---------------------|--|----------|-----|---------|---------|----------|----------|
| Input Supply | Lack of quality inputs, especially seeds | √ | | | √ | | |
| | Lack of seed storage facility | | | | √ | | |
| | No plant variety protection | | | | √ | | |
| | Contamination of animal feed | | | | | √ | |
| | Limited access to capital to acquire inputs | | | | √ | | |
| Production | Lack production and marketing plan; no system | | √ | | | √ | |
| | Misuse of pesticides, hormones, antibiotics, fertilizers | √ | √ | √ | √ | √ | √ |
| | Limited capacity for proper production (integrated pest management, good agricultural practices, irrigation, food safety control, optimum input use) | √ | | √ | √ | √ | √ |
| | Low quality downstream water | | | | | √ | |
| | Heavy metal pollution of soils | | √ | | | | |
| | Waste from industries near farms | | √ | | | | |
| | Weak food safety inspection; no border quarantine | √ | | | | | |
| | High production cost and difficulty in farm supervision | | √ | | | | |
| | Low incentive to apply food safety control | | | √ | | | |
| | Small-scale, scattered, seasonal production | | √ | | | √ | √ |
| | Lack of affordable credit | | | | | √ | |

Continued next page

Appendix Table A2.3.1 continued

| Stage | Gaps | Cambodia | PRC | Lao PDR | Myanmar | Thailand | Viet Nam |
|---|--|----------------------------------|-----|---------|---------|----------|----------|
| Processing | Misuse/illegal use of food additives | √ | √ | | | | |
| | High energy and freight cost | √ | | | | | |
| | High postharvest losses | √ | | | √ | | |
| | Limited knowledge and capacity; insufficient science and technology inputs | √ | √ | √ | √ | | √ |
| | Limited support to small and medium enterprises to upgrade processing | √ | | √ | | | |
| | Lack of processing facilities and limited processed items | | | | √ | | |
| | Lack of interest to apply food safety standards | | | √ | | | |
| | Lack of accrediting organizations for export foods | | | | √ | | |
| | Lack of control over small processors | | | | | | √ |
| | Lack of responsibility to protect consumers and the environment | | | | | √ | |
| | Loss of public confidence in regulatory system | | √ | | | | |
| | Storage and Transport Retail | High cost of transport/logistics | √ | | | √ | |
| Lack of facilities for proper temperature control | | √ | √ | √ | √ | √ | √ |
| Lack of technical knowledge | | √ | | √ | √ | | |
| Underdeveloped distribution channel | | | | | | | √ |
| Lack of food safety and hygiene capacity | | √ | √ | √ | √ | | √ |

Continued next page

Appendix Table A2.3.1 continued

| Stage | Gaps | Cambodia | PRC | Lao PDR | Myanmar | Thailand | Viet Nam |
|------------------------|---|----------|-----|---------|---------|----------|----------|
| Retail Consumer | Lack of incentive to apply food safety regulations | | | √ | √ | | |
| | Lack of responsibility for ensuring food safety | | | √ | | | |
| | Lack of systematic data storage and analysis | | √ | | | | |
| | Lack of awareness of food safety and good practices | √ | √ | √ | | | |
| | Lack of representation of consumer organization | √ | | | | | |
| Consumer | No national consumer protection committee | | | | √ | | |
| | Lack of differentiated products | | | | | | √ |
| | Lack of effective and trusted certification | | | | | | √ |
| | Poor risk communication | | | | | | √ |
| | Lack of rapid response to consumer issues | | √ | | | | |

√ = presence of gaps; Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Mekong Institute data.

Table A2.3.2: Bottlenecks in the Supply of Safety and Quality Assured Food and Increased Market Access for Greater Mekong Subregion Food Supply

| Bottleneck Area | Details | Cambodia | Lao PDR | Myanmar | Thailand | Viet Nam |
|--|---|---|---------|---------|----------|----------|
| Supply Chain Management | Lack of technology and skilled manpower | √ | √ | √ | | √ |
| | Lack technical training | √ | √ | √ | | |
| | Poor infrastructure/ logistics | √ | √ | √ | | |
| | Weak traceability system | √ | √ | √ | | √ |
| | Lack of access to reliable electricity and water | √ | | | | |
| | Weak enforcement of food laws | | √ | | | √ |
| | Poor value chain coordination | | | √ | √ | √ |
| | Poor market access | √ | √ | √ | | |
| | Improper processing | | | | √ | |
| | Wasteful use of natural resources | | | | √ | |
| | Lack of responsibility to protect consumers and the environment | | | | √ | |
| | Business Environment and Availability of Business Services | Lack of knowledge of marketing, applying technologies, and enforcing or applying food safety laws/regulations | √ | √ | √ | √ |
| Lack of specialists in food safety work and research | | √ | √ | √ | √ | √ |
| Low interest in applying food safety systems | | | √ | √ | | |
| Lack of incentives for applying food safety systems | | | √ | | | |
| Failure of pesticide producers to inform farmers about correct use | | | | √ | | |
| Delays in custom processing | | | | √ | | |
| Large volume of low-value products (no value addition) | | | | | | √ |
| Lack of options to sustain competitiveness | | | | | | √ |
| Need to improve safety of domestic and export products | | | | | | √ |
| Insufficient support | | | | | √ | |

Continued next page

Table A2.3.2 continued

| Bottleneck Area | Details | Cambodia | Lao PDR | Myanmar | Thailand | Viet Nam |
|--|---|----------|---------|---------|----------|----------|
| Availability of Technical Services (certification bodies, laboratory capacity, etc.) | Inadequate laboratory capacity (no central lab, limited number of testing labs, no ISO certification) | √ | √ | √ | | |
| | Limited technical specialists | √ | √ | √ | | |
| | Limited capacity in risk analysis | √ | √ | √ | | √ |
| | Insufficient ICT systems | | | | | √ |
| | Delays in harmonization and adoption of food safety standards | | | | | √ |
| | No independent consumer organization | | | | | √ |
| | Insufficient support from universities and research institutes | | | | √ | |
| | Lack of inter-ministerial coordination addressing food safety issues | | √ | | | |
| | No food safety database | | √ | | | |

√ = presence of bottlenecks, GMS = Greater Mekong Subregion, ICT = information and communication technology, ISO = International Standards Organization, Lao PDR = Lao People's Democratic Republic.

Source: Authors' consultations with the Mekong Institute, 2016.

Appendix 2.4: Food Safety Initiatives in GMS Countries, 2011–2017 (supporting sources in parentheses)

| GMS Economy | Initiative | Brief Description |
|----------------|--|--|
| All GMS | Towards a Non-Toxic Environment in South-East Asia (Sweden–FAO) | Project develops sustainable pest and pesticide management policies, strengthens the regulatory framework for controlling the distribution and use of pesticides, and enhances the capacity for implementing these policies and enforcing pesticide legislation. |
| CLMV | Mekong Institute Food Safety Project (NZAP) | The goal is for policymakers in CLMV responsible for developing and implementing food safety regulations to create an enabling food regulatory environment connected to the private sector, their needs, and the market. |
| | Capacity Building and International Food Safety Standards in ASEAN (Japan–FAO) | Project focuses on strengthening national capacity to develop national food safety standards in line with Codex Alimentarius standards, implementing standards, and contributing to international standards setting process. |
| | Pesticide Risk Reduction by Policy and Capacity Building (Sweden–FAO) | Overall objective is to promote sustainable, safe, profitable, and environmentally-sound intensification of agricultural production by developing, promoting, and practicing integrated pest management. |

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Appendix 2.4 continued

| GMS Economy | Initiative | Brief Description |
|--------------------|---|---|
| CLM | Food Safety Control Measures in Developing Asian Countries (GIZ) | This project strengthens the food safety standards in order to protect and promote consumer health by controlling the entire food chain and strengthens the role of COs in monitoring and carrying out market surveillance. |
| CLV | Improving Food Safety Management in CLV (NZAP) | Project provides trainings to small and medium-sized enterprises, food handlers, and market places about basic food hygiene, food regulations and quality assurance systems such as GAP, GHP, GMP, and HACCP. |
| | Regional: Trade Facilitation: Improved Sanitary and Phytosanitary (SPS) Handling in GMS Trade (ADB) | Project conducts due diligence in the following aspects: (1) The capacities pursued and methods introduced need to be compliant with principles/ obligations under the WTO and ASEAN. They need also to be tailored to the needs of individual countries as identified in national SPS Action Plans and ADB's own analysis. (2) Financial and economic viability will be assessed for the project investment, in particular cost-benefit, least cost, and alternative analysis. Fiscal impacts of the investments and recurrent costs will be assessed to ensure that the developing member countries (DMCs) can sustain the project operation. (3) Public financial management, procurement, policy, legal, and institutional issues that are important for project implementation and cost-effectiveness of SPS services will be examined. (4) Poverty and social impacts assessments will be done. (5) Detailed project implementation will be done. |
| | ASEAN-EU Programme for Regional Integration Support – Phase II (APRIS II) | Objective is to provide training on and to audit the implementation of HACCP methods, GMP, GHP, and risk analysis and management among SMEs in the agro-based sector in three selected ASEAN Member States—CLV. |
| CL | Standards in South-East Asian Food Trade (GIZ) | Project improves the food standards to benefit the health of people and boost food supply to regional or international markets. |
| Cambodia | Structured Program to Achieve Food Safety Excellence in Cambodia (SAFE Cambodia) (ASSIST, TÜV Rhineland, DEG) | This PPP project helps local SMEs adopt international standards to help them reduce operational inefficiencies and increase business opportunities on a larger scale. By collaborating on implementing the internationally approved practices, SMEs will be able to share their knowledge and create a valuable network to guarantee long-term success. |
| | Demonstration Company Project on Modern Food Safety Management Systems in Cambodia (APO) | A demonstration company project aimed at establishing sophisticated FSMSs such as HACCP or ISO 22000 in food-processing companies that introduced GMP in previous projects. The project also educates NPCC staff to develop their consultancy ability on FSMS. Modern food FSMS will be promoted in the entire Cambodian food industry. |

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Appendix 2.4 continued

| GMS Economy | Initiative | Brief Description |
|------------------------------------|--|---|
| China, People's Republic of | China Food Safety Initiative (UCLA School of Law) | Initiative to enhance food governance in the PRC, with the ultimate aim of ensuring safe and healthy food for consumers. Through events and research development, the initiative facilitates discussion among leaders in the PRC on addressing food safety challenges. |
| | 13th Five-Year Plan on Food Safety (State Council) | The Plan sets forth the following primary objectives: enhance sample testing to cover all types of food; assure effective governance of resource contamination; reinforce on-site inspections; establish a professional inspector team and standardized enforcement procedures and documentation; and align PRC food safety standards with international standards. |
| | China National Center for Food Safety Risk Assessment (CFSA) | CFSA, established in Oct 2011, is a public health organization and national technical institution in charge of food safety risk assessment in the entire food chain; advises government on risk management matters; provides public information and science-based education on food safety issues for all stakeholders; addresses scientific needs of innovative industries. |
| | National Food Safety Standards Project | The Ministry of Health processes 83 national food safety standards in four categories: 4 basic standards, 45 food additives standards, 7 good production practice standards, and 27 method of inspection standards. |
| | Asia-Pacific Smart Agriculture & Food Safety Industry Demonstration Zone (UNOPS) | Assists the Government of Changchun to establish a 10-square-kilometer zone that showcases smart and sustainable agriculture, food safety innovation, and health management. |
| | EU-China Trade Project II | The project supports the PRC government's trade and investment reform agenda by working under the EU-PRC economic and trade dialogues to promote fair competition and value for consumers; facilitate harmonization with international standards and promote safe products; improve food safety and quality; modernize customs; encourage a more transparent legal environment, and work toward transparency, good governance, and equitable trade and investment policies. |
| | National Institute of Nutrition and Food Safety | The Institute conducts studies on health-related nutrition and food hygiene problems and trains nutrition and food hygiene specialists. The ultimate goal is to improve nutritional status, prevent foodborne diseases, and strengthen the physical fitness of the people. |
| | China-Jilin Food Safety Project (World Bank). | Project improves the legal and regulatory environment and the institutional capacity in the private and public sectors to manage agriculture product safety and quality in Jilin Province. |
| | GLOBALG.A.P. Farm Assurer Capacity Building Program GLOBALG.A.P. | Project establishes the GLOBALG.A.P. Farm Assurer as a universally recognized brand that communicates a high level of competence and integrity. |

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Appendix 2.4 continued

| GMS Economy | Initiative | Brief Description |
|--------------------|--|--|
| | Walmart Food Safety Collaboration Center | Walmart Foundation funded three projects. An initiative with CCTF focused on educating children and parents across the PRC by increasing knowledge of safe handling of food in the household. It is a collaborative research project bringing together US and PRC academics and PRC poultry producers to study safety in poultry supply chains; and a collaborative research project bringing together the Massachusetts Institute of Technology, Zhejiang University, and Tsinghua University that will use supply chain analytics and state-of-the-art technology to rapidly predict and detect the areas of greatest vulnerability for food adulteration in food supply chains. |
| Lao PDR | Technical assistance to strengthen emergency preparedness for highly pathogenic avian influenza (FAO) | Purpose of the project is to reduce the spread of H5N1 in poultry in the country, thus minimizing the risk of contagion to other mammals (including humans) and the possibility of a pandemic. |
| | Lao Organic Agriculture Promotion Project (JICA) | Project builds knowledge and human resource capacity to ensure organic agriculture systems are fully functional. |
| | Laos Pilot Program (LPP) for Narrowing the Development Gap Towards ASEAN Integration (ASEAN Secretariat, JICA) | LPP aims to balance development growth with environmental conservation, to harmonize development. LPP has an agriculture component to introduce GAP for safe and quality agricultural production promotion. |
| | National Nutrition Strategy to 2025 and Plan of Action 2016–2020 | Project employs a multisectoral convergent approach with common focus points, goals, and time frames while boosting resources and increasing support from development partners and the relevant stakeholders to the greatest extent possible to reduce all forms of malnutrition among women, children, and disadvantaged groups, to achieve success, and meet the set targets. |
| Myanmar | Improving Food Safety Compliance with SPS to Increase Export in Oilseeds (WTO STDF) | Project improves food safety and compliance with SPS measures for market access to increase export revenues of farmers, processors, and exporters along the oilseed value chain. |
| | Food Safety Regulation & Enforcement (NY Wagner; New York University) | Project identifies the main challenges in food safety, regulations, and enforcement. |
| | Strengthening National Quality Infrastructure for trade (NORAD) | Project strengthens Myanmar's national capacity to provide internationally recognized laboratory testing services to food producers and exporters. |
| | Enhancing of Food Safety (Japan Grassroots) | Project aims to enhance the quality of local agro-products and protect Myanmar people from food contaminated with excessive use of harmful chemicals. |

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Appendix 2.4 continued

| GMS Economy | Initiative | Brief Description |
|-----------------|---|---|
| Thailand | | Huge investment in hard and soft infrastructure to develop modern and world-class FSMSs for domestic market and export engagements to fuel rapid economic growth, with the food industry contributing 23% to GDP, \$27 billion in exports, and more than 20 million people employed. |
| Viet Nam | Livestock Competitiveness and Food Safety Project (World Bank) | Project aims to increase the production efficiency of household-based livestock producers; reduce the environmental impact of livestock production, processing, and marketing; and improve food safety in livestock product supply chains (mainly meat) in selected provinces. |
| | Canada funds food safety project in Viet Nam | Canada to provide an aid package of about Can\$15 million (\$11.3 million) for a food safety project in Viet Nam. |
| | Strengthening Vietnamese SPS Capacities for Trade—Improving safety and quality of fresh vegetables through the value chain approach (FAO) | Project develops vegetable value chains, a GAP training manual, a pilot model with VietGAP, information exchange web service forum, and linkages between growers and vendors |
| | Outbreak Mechanisms and Development of a Surveillance Model for Multi-Drug Resistant Bacteria | Project establishes the mechanism of multi-drug resistant bacteria, develops a comprehensive monitoring system for antibiotics residue and antibiotic resistant bacteria in the process from food production to intake, and trains researchers and technical staff related to food safety monitoring. |
| | Strengthening International Health Regulations Core Capacity on Food Safety (WHO) | Project reviews MOH legislation documents (food safety law); strengthens national capacity for foodborne disease surveillance and response; and strengthens national and international network and collaboration/ coordination to respond to foodborne hazards (e.g., develop an emergency response plan and active participation in the platform). |
| | Veterinary Intervention for Anti-microbial Reductions in Chicken Production (ViParc) | Project develops diagnostics for poultry diseases, investigates antimicrobial resistance, and conducts cost-benefit analyses. |
| | Supporting Small-Scale Pig Production in Viet Nam through Reducing Disease Risk, Enhancing Productivity, and Upgrading Value Chains (ACIAR) | Project improves livelihoods of rural and urban poor through improved opportunities and incomes from pig value chains as a result of reduced risks associated with pork-borne diseases. |

ACIAR = Australian Centre for International Agricultural Research; ADB = Asian Development Bank; APO = Asian Productivity Organization; ASEAN = Association of Southeast Asian Nations; ASSIST = Asia Society for Social Improvement and Sustainable Transformation; CCTF = [the People's Republic of] China Children and Teenagers' Fund; CL = Cambodia and the Lao PDR; CLM = Cambodia, the Lao PDR, and Myanmar; CLMV = Cambodia, the Lao PDR, Myanmar, and Viet Nam; CLV = Cambodia, the Lao PDR, and Viet Nam; DEG = Deutsche Investitions-und Entwicklungsgesellschaft mbH; DMC = developing member country of the Asian Development Bank; EU = European Union; FAO = Food and Agriculture Organization of the United Nations; FSMS = food safety management system; GAP = good agricultural practices; GDP = gross domestic product; GHP = good hygiene practice; GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit, GmbH; GMP = good manufacturing practice; GMS = Greater Mekong Subregion; HACCP = hazard analysis critical control

point; ISO = International Standard Organization; JICA = Japan International Cooperation Agency; Lao PDR = Lao People's Democratic Republic; LPP = Laos Pilot Program; NORAD = Norwegian Agency for Development Cooperation; NPCC = National Productivity and Competitiveness Council; NZAP = New Zealand Aid Programme; PPP = public-private partnership; PRC = People's Republic of China; SPS = sanitary and phytosanitary; SME = small and medium-sized enterprises; STDF = Standards and Trade Development Facility; UCLA = University of California, Los Angeles; UN = United Nations; UNOPS = United Nations Office for Project Services; US = United States; WHO = World Health Organization; WTO = World Trade Organization.

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Appendix 2.5: Sanitary and Phytosanitary and Codex Alimentarius Initiatives in the GMS

| Cambodia | China, People's Republic of | Lao PDR | Myanmar | Thailand | Viet Nam |
|---|--|---|--|---|--|
| Capacity Building and International Food Safety Standards in the ASEAN (Japan and FAO) | National Food Safety Standards Project | Capacity Building and International Food Safety Standards in the ASEAN (Japan and FAO) | Capacity Building and International Food Safety Standards in the ASEAN (Japan and FAO) | Amended its Codex system in 2004 by a ministerial decree | Capacity Building and International Food Safety Standards in the ASEAN (Japan and FAO) |
| Regional: Trade Facilitation: Improved Sanitary and Phytosanitary (SPS) Handling in GMS Trade (ADB) | 13th Five-Year Plan on Food Safety (State Council) | Regional: Trade Facilitation: Improved Sanitary and Phytosanitary (SPS) Handling in GMS Trade (ADB) | Food Safety Control Measures in Developing Asian Countries (GIZ) | Continuing strengthening of standards (e.g., Quality GAP and ThaiGAP) to conform with international standards | Regional: Trade Facilitation; Improved Sanitary and Phytosanitary (SPS) Handling in GMS Trade (ADB) |
| Food Safety Control Measures in Developing Asian Countries (GIZ) | | Food Safety Control Measures in Developing Asian Countries (GIZ) | Improving Food Safety Compliance with SPS to Increase Export in Oilseeds (WTO STDF) | | Strengthening Vietnamese SPS Capacities for Trade—Improving safety and quality of fresh vegetable through the value chain approach (FAO) |
| Developing SPS action plan for Cambodia. ADB-SPS Standards Management Systems Phase 2 | | Technical Assistance for Further Development of SPS-related Legal Framework in the Lao PDR (FAO) | | | |
| Standards in South-East Asian Food Trade (GIZ) | | Standards in South-East Asian Food Trade (GIZ) | | | |

ADB = Asian Development Bank; ASEAN = Association of Southeast Asian Nations; CODEX = Codex Alimentarius (Food Code); FAO = Food and Agriculture Organization of the United Nations; GAP = good agricultural practices; GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit, GmbH; GMS = Greater Mekong Subregion; Lao PDR = Lao People's Democratic Republic; SPS = sanitary and phytosanitary; STDF = Standards and Trade Development Facility; WTO = World Trade Organization.

Sources: Sources gathered and consolidated by the Mekong Institute.

Appendix 2.6: Private-Sector-Driven Initiatives in Food Safety in GMS Countries

| Initiative | Cambodia | China, People's Republic of | Lao PDR | Myanmar | Thailand | Viet Nam |
|------------|---|---|---|--|--|---|
| PGS | <ul style="list-style-type: none"> • Started in 2014 • 13 PGS groups • >180 farmers • Agencies involved: GDA, CEDAC, Caritas, COD, NAV • Pilots operating effectively • Products now at markets; restaurants are interested; farmers felt ownership and proud to be part of PGS <p>Next steps: prepare national logo; complete the national organic standard; adopt PGS for national standard/certification system; increase number of PGS groups; capacity building; national campaign; form “green show network”</p> | <ul style="list-style-type: none"> • 2 PGS groups (rice and vegetables); Guangxi Zhuang Autonomous Region • >125 farmers, mostly female • Agencies involved: Farmers Seed Network, OXFAM HK • Marketing thru local and farmer's markets, consumer associations, online thru rural e-commerce (set up by Alibaba). • Branded as PGS; PRC regulation does not allow products to be called organic <p>Next steps: conduct national PGS workshop to strengthen with govt representation; up-scaling; lobbying; awareness raising; market strengthening; target PGS recognition at central level by 2020</p> | <ul style="list-style-type: none"> • Started in 2015 • 3 PGS groups • >250 farmers • Agencies involved: DOA, GRET, SAEDA • PGS as certification tool and option in DOA program • PGS can be used for organic or GAP certification (separate standards & labels) • National/local structures set • No govt funding; local initiatives supported by NGOs (GRET, SAEDA) <p>Next steps: organize workshops to improve the system; establish national platform/task force that works on the action plan and national guidelines</p> | <ul style="list-style-type: none"> • Started in 2014 • 9 PGS groups • >100 farmers • Agency involved: MOGPA • PGS is already known • First certificates soon to be issued for 8 groups • Govt shows positive attitude but resources limited • Main communication channel is Facebook • At domestic market, organic tea and coffee are available (PGS and 3rd party), rice, fruits, mushrooms, and vegetables are starting now <p>Next steps: provide technical support; collaborate with govt; capacity building; develop a national PGS network and market linkage; info campaign</p> | <ul style="list-style-type: none"> • 16 PGS groups • >1,500 farmers • Agencies involved: Earth Net, Lemon Farm, TOAF, POAA • Govt supports PGS as a development tool • Lemon Farm is the success model from private sector-led PGS with strong market facilitation (14 shops in Bangkok) • Main-stream markets: Tops supermarket <p>Next steps: consolidate PGS movement; create platform for exchange and networking “Thai PGS Movement”</p> | <ul style="list-style-type: none"> • Started in 2008 • 5 PGS groups • >350 farmers • Agencies involved: ADDA, VOAA • Now more resilient with strong links to Ha Noi markets • No regulation or recognition • Relevant govt agencies now interested • Build the PGS bottom-up with strong market links <p>Next steps: continue policy lobbying for govt adoption of PGS guidelines and standards; capacity building; upscaling and awareness raising; improve traceability (smart-phone/apps)</p> |

Continued next page

Appendix 2.6 continued

| Initiative | Cambodia | China, People's Republic of | Lao PDR | Myanmar | Thailand | Viet Nam |
|------------|--|--|---|---|--|--|
| | | | Small-Scale Farmer Inclusion in Organic Agriculture thru PGS, addresses certification and marketing issues through PGS and raising awareness on benefits of organic agriculture and PGS for environment, health, and livelihoods in rural areas | | | Scaling up PGS among smallholder farmers, consumers, and private actors in Viet Nam (VECO) The project supports the PGS groups to strengthen their production, marketing, and management skills |
| GI | <ul style="list-style-type: none"> • 2 GI products (Kampot pepper and Kampong Speu palm sugar) • 3 GIs pending in EU • Promotion of Rural Development through Development of GI at Regional Level in Asia: CLVT (FAO) | <ul style="list-style-type: none"> • 2,984 GIs with 83 foreign GIs • Agencies involved: State Administration for Industry and Commerce, Trademark Office, General Admin of Quality Supervision, Inspection and Quarantine, Ministry of Agriculture • EU-PRC GI-10 plus 10 project • Protection of 10 famous EU food names in the PRC with GI. In parallel, EC examined and registered 10 PRC food names with GI status | <ul style="list-style-type: none"> • No GI product • Promotion of Rural Development thru Development of GI at Regional Level in Asia-CLVT (FAO) • Implementing GI under the Intellectual Property Law Oct 2016 • Establishment of Trademark and GI Division, Ministry of Science and Technology to coordinate GI registration | <ul style="list-style-type: none"> • 1 foreign GI product • GI protection under Trademark Law, Sept 2014 • Formulation of a GI regulatory framework • GI training • Awareness raising events • Plan to enact GI law | <ul style="list-style-type: none"> • 61 GI products with 5 in EU (3 pending), 1 in Viet Nam • 11 foreign GI products • Promotion of Rural Devt thru Devt of GI at Regional Level in Asia—CLVT (FAO) | <ul style="list-style-type: none"> • 48 GI products with 39 in EU and 2 pending in Thailand • 4 foreign GI products • 169 GI from EU protected with FTA • Promotion of Rural Devt thru Devt of GI at Regional Level in Asia—CLVT (FAO) |

Continued next page

Appendix 2.6 continued

| Initiative | Cambodia | China, People's Republic of | Lao PDR | Myanmar | Thailand | Viet Nam |
|------------------------|---|---|-----------------|---|---|--------------------------|
| GI | <ul style="list-style-type: none"> • Law on GI in Cambodia | <ul style="list-style-type: none"> • EU-PRC Trade Project II providing support to ongoing bilateral negotiations on GI | | <ul style="list-style-type: none"> • 1st GI product Ywangan Coffee for processing in 2017 | <ul style="list-style-type: none"> • GI products: Khao Hom Mali Thung Kula Rong (2013 EU registered), Isan Indigenous Silk Yarn (2014 Viet Nam registered); 3 EU applications Kafae Doi Chaang (coffee), Kafae Doi Tung (coffee), and Khao Sungyod Muang Phattalung (rice) | |
| Private Company | <ul style="list-style-type: none"> • Natural Garden Safe and Organic produce • Green-O Farm chemical free produce • Amarak Veggie Store • Happy Farm • Aliment Organic Foods | | Lao Fresh Meats | <ul style="list-style-type: none"> • Myanmar Food Processors and Exporters Association—lab testing; training on food quality • Myanmar Consumer Union—awareness raising, advocacy, consumer seminars • Shan Maw Myae—form and promote organic groups | Public-Private Collaborative Committee: New Sustainable Growth Path 2016-“Community Product to Modern Trade” standardizes cash crop production under “Thai GAP” and “Primary GAP” | Binh Dinh Safe Vegetable |

ADDA = Agricultural Development Denmark Asia; CEDAC = Cambodian Center for Study and Development in Agriculture; COD = Center for Organic Development; CLTV = Cambodia, the Lao PDR, Thailand, and Viet Nam; DOA = Department of Agriculture; EC = European Community; EU = European Union; FAO = Food and Agriculture Organization of the United Nations; FTA = Free Trade Agreement; GAP = good agricultural practices; GDA = General Directorate of Agriculture; GI = Geographical Indication; GRET = Groupe de Recherches et d'Echanges Technologiques; MOGPA = Myanmar Organic Grower and Producer Association; NAV = Natural Agricultural Village; NGO = nongovernment organization; PGS = participatory guarantee system; POAA = Participatory Organic Agriculture Association; SAEDA = Sustainable Agriculture & Environment Development Association; TOAF = Thai Organic Agriculture Foundation; VEVO = Vredes Eilanden Country Office; VOAA = Vietnam Organic Agriculture Association.

Source: Sources gathered and consolidated by the Mekong Institute.

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Chapter 3

Increasing the Safety and Quality of Food Products from the Greater Mekong Subregion

Chapter 3 was prepared by Thomas R. D. Weaver with support from Maria Theresa S. Medialdia of the Mekong Institute, Anthony Zola of the Mekong Environment and Resources Institute, and Lourdes S. Adriano. The chapter consolidates the discussions from the Greater Mekong Subregion issues on food safety and quality assurance during the Policy Forums held in THAIFEX 2017, Bangkok, Thailand, from 30 May to 1 June 2017.

3.1. Introduction

Improving food safety and increasing market access for food and agriculture products are national priorities for each of the Greater Mekong Subregion (GMS) countries. Inducing the development of improved food control systems and the control of hazards of importance to trade is essential to meet rising consumer and buyer requirements, to achieve public health objectives, and to unlock potentially lucrative export markets for the subregion's produce. At the same time, improving the effectiveness of risk management systems can protect and support rural livelihoods and contribute to national economic development. These activities can contribute to the achievement of the Sustainable Development Goals (SDGs), specifically:

- SDG2 (zero hunger), by enhancing food security and improving nutrition; and
- SDG17 (partnerships for the SDGs), by strengthening and deepening partnerships for promoting the development of sustainable agriculture.

Given the nature of the GMS—notably its' porous land borders and high volumes of intraregional trade in food and agriculture products—strategic and coordinated policies and investments are needed at national and subregional levels. This can better protect consumers and industries and will serve to build trust in food products sourced in the GMS in an inclusive and sustainable manner.

The political will to address the challenges of food safety and non-foodborne hazards in agriculture in the GMS is strong. In addition, the GMS Economic Cooperation

Program and the high volume of intra-GMS trade provide firm bases for GMS-level coordination and cooperation in addressing these issues. More broadly, the advent of the ASEAN¹ Economic Community (AEC) will facilitate further increases in intraregional trade, and the ASEAN Economic Community Blueprint 2025 includes specific reference to improving food safety, meeting international food safety and quality standards, and promoting the ASEAN as a supplier of organic food (ASEAN Secretariat 2015).

Developing robust food and broader agricultural hazard control systems is complex and requires a continuous iterative process of improvements. However, strategic initiatives can catalyze progress.

Building on extensive secondary data review, this chapter presents a synopsis of the key points and discussions from the GMS food safety events at the THAIFEX 2017 in Bangkok, Thailand. The events brought together diverse food and agriculture stakeholders from the private sector, public authorities, development partners, and research institutions from across the GMS. This chapter outlines some of the high-priority issues related to both foodborne and non-foodborne (i.e., other agricultural) hazards of importance to public health, agricultural production, and trade that can best be addressed collectively by the GMS countries. The chapter then recommends an approach and proposes feasible and politically attractive initiatives to address key issues.

The chapter has been developed within the ambit of the Core Agriculture Support Program, Phase II (CASP2). The program's vision is for the GMS to become a leading producer of safe and environment-friendly agriculture products. This chapter is closely aligned with, and strongly endorses, the GMS Strategy and Action Plan for Promoting Safe and Environment-Friendly Agro-based Value Chains 2018–2022, developed by the GMS Working Group on Agriculture and endorsed by the GMS ministers of agriculture.

3.2. The Key Issues

Historically, food safety has primarily been the concern of exporters in the GMS. However, with increasing consumer awareness and demand, changing supply chain and retail mechanisms, and recognition of the economic costs of breakdowns in food safety, food safety in domestic markets is increasingly being prioritized. Aside from frequent outbreaks of foodborne diseases, individual GMS countries have suffered

¹ ASEAN = Association of Southeast Asian Nations.

from specific food safety failures—such as melamine in the People’s Republic of China and antibiotic and hormone residues in livestock and fishery products in Myanmar, Thailand, and Viet Nam—to name but a few.

The nature of GMS agriculture is such that hazards in one country threaten the subregion as a whole. This is exemplified by the frequent transboundary disease outbreaks. Key foodborne hazards in the GMS include a wide variety of pathogens and chemical residues, such as antimicrobials, synthetic growth hormones, pesticides, and heavy metals. In addition, various non-foodborne zoonoses, infectious diseases of animals, pests, and residue levels limit market access for GMS products. The GMS countries recognize that they must strive to increase food quality assurances in line with domestic and international demand and market requirements. However, addressing food safety and hazard management must be prioritized as the foundation for improving the quality assurance systems: “food quality is food safety plus more” (Annovazzi-Jakab 2017).

Although much has been achieved through the establishment of food safety laws and supporting policies and regulations in the GMS countries, gaps remain and there are considerable disparities within and between countries. Many areas of the GMS are hampered by limited infrastructure and human and institutional capacity—leadership, technical, and operational—to operate effective food control systems that protect consumers, suppliers, and buyers. Moreover, consumer trust in current systems is generally low due to frequent scandals and reports of food safety failures implicating various certified products.

Establishing robust food control systems is inherently complex due to the nature of the products and the numerous actors and processes typically involved in supply chains. Therefore, food control systems must be continually adapted in response to the many influencing factors: for example, changing hazards and populations at risk—including the (re)emergence of hazards, hazard presence and prevalence, potential for exposure and susceptibility of populations; scientific advances; consumer demand and buyer requirements; and political priorities. This complexity means that the establishment of reliable, robust food control systems that earn trust requires considerable technical capability, substantial financial resources, strong decision-making processes, and systems able to adapt to changing circumstances. Experiences internationally show that food systems that reliably deliver safe and quality assured products must develop through ongoing improvement built on effective feedback loops and the sharing of data and best practices. The opportunity to catalyze the development of such systems in the GMS through strategic actions and investments is addressed in subsequent pages.

Limited Risk Analysis Capacity

Risk-based approaches that address value chains holistically are needed to ensure product safety and to meet the requirements of current and potential export markets in accordance with the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement). However, the capacity to effectively implement risk analysis for hazards of importance to food safety, production, and trade varies considerably across the GMS. The institutional capacity to implement effective and efficient systems is often hampered by limitations in leadership; availability of capable risk assessors, risk managers, and risk communication specialists; access to and quality of infrastructure; and availability of resources for the day-to-day operation of essential activities. This leaves current systems some way from demonstrating equivalence between GMS countries, let alone in wider international markets.

Broad disparities in capacity to adequately assess risk associated with specific hazards exist both within and between GMS countries. Hazard lists have not been developed universally across the subregion, even in relation to major global commodities such as pest lists for rice. For example, (1) surveillance systems vary in design, implementation, and reliability; and (2) the use of information and communication technology (ICT)-based/e-commerce systems employing barcoding and, potentially, radio-frequency identification (RFID) technologies, and other track and trace systems is increasing but they are optimally employed in only the most advanced settings. Technical constraints are commonly amplified by a lack of managerial capacity and operational budget.

The ability to identify outbreaks and outbreak strains is limited by surveillance system capacity. Furthermore, much of the GMS suffers from nonexistent or embryonic traceability systems, severely limiting capacity to conduct source attribution investigations. This hampers implementation of effective controls, such as establishing and enforcing movement bans, vaccinations, destruction campaigns, and product recalls. At present, emergency response plans for food safety hazards, zoonoses, and other infectious diseases are varied in their level of elaboration and capacity to be effectively implemented.

Current approaches to the communication of risk information to the public, policymakers, suppliers, and current and potential trading partners are limited in all but the most advanced areas of the GMS. This impacts the effectiveness of risk mitigation messaging and risk management activities. Moreover, nonexistent or inconsistent messaging harms trust among consumers, retailers, and trading partners, thus affecting market preferences, demand, and access.

Trust Issues and Disparities in Standards

Numerous scandals have engulfed various certifications related to food safety in the GMS, whereby supposedly certified produce has been proven to be unsafe. This has damaged perceptions and reduced trust among consumers, retailers, and wider stakeholders. Building or rebuilding trust is likely to require greater coordination of certification systems within and between countries. Benchmarking and sharing of best practices within the region could help the establishment and enforcement of trustworthy risk-based guidelines and standards that are related to food safety and that minimize the risk of food safety failures. This might include standards such as national, regional, and global good agricultural practices. The process would facilitate addressing other needs and concerns in future, such as food quality standards, standards specifically related to environmental protection, animal welfare, and so forth.

The variability in technical requirements in national standards relating to food safety and quality and in their implementation and enforcement hampers demonstration and recognition of equivalence between suppliers and across GMS borders. Moreover, the feasibility of employing recognized certifying bodies varies considerably between countries and types of supplier. Many smaller suppliers, especially in the less-developed GMS countries, are often incapable of receiving certifications due to a combination of lack of awareness, difficulties in physically accessing certifying bodies, and the associated costs of certification.

Internationally recognized process control systems, such as good management practices and hazard analysis and critical control points, are generally confined to larger processors or export-oriented suppliers. Greater coordination with universities and research institutes is needed to develop fair, GMS-appropriate, harmonized, and robust standards for food safety.

Ensuring the safety of produce at the retail (consumer) level requires controls throughout the supply chain. Therefore, standards and transparency must be improved from inputs through to retail. At present, considerable quantities of inputs used in the GMS are of uncertain provenance and composition. Inputs present a potential source of hazard contamination in production while input quality issues may hamper productivity and present risks to users' health. Limited transparency also leads to inappropriate input use, which can promote the pathogens' and pests' development of tolerance of and/or resistance to inputs.

Facilitating Trade across GMS Borders and Improving the Environment for Business

The requirements for export/import of produce within the GMS and to markets beyond the GMS have been notably reduced, yet there is room for further improvements, particularly among the less-developed GMS countries. Reducing the direct costs and opportunity costs of fees, red tape, and times in transit can help sustain the current growth in the trade of GMS agriculture products. It can also support improvements in risk management of important hazards at borders, thereby reducing risks to consumers and suppliers and reassuring current and potential trading partners. Other issues that could occur in cross-border areas, though not uniquely, include intentional human failures, fraud, informal payments, and rent seeking behavior by any number of stakeholders including suppliers, retailers, regulators, and border personnel.

Creating more enabling terms and conditions for business in the agro-food sector can encourage investment and drive progress in food safety. By setting the right institutional and regulatory framework, governments can help increase the competitiveness of farmers and agricultural entrepreneurs, enabling them to integrate into regional and global markets and reduce risk for potential investors. At present, opaque systems and contradictory and/or unnecessary regulations and laws impede the ease of doing business in the agriculture sector in many areas of the GMS. Businesses are often affected by high transaction and opportunity costs, rent seeking behavior, and lack of clarity in corporate and personal liability, with subsequent effects on investment risk.

3.3. Recommendations

The GMS countries are diverse in their stages of development, populations, and capacity to implement food safety systems. Therefore, while the ultimate goal is the same for each country, it must be recognized that a step-by-step process must occur based on national context. The iterative process of developing food and agricultural hazard control systems can be accelerated by establishing GMS-wide approaches; prioritizing entry point products and locations (such as key border points and economic corridors); and sharing knowledge, best practices, skills, data, services, and capacity between countries.

GMS-wide agreement on applying risk-based approaches based on international best practice is required. Addressing domestic markets and cross-border trade are essential entry points for developing optimal systems. Approaches must address supply chains holistically and be in line with global norms.

Risk-Based Approaches

Adoption of improved risk-based approaches can upgrade GMS food safety and broader agricultural hazard management systems cost-efficiently. Effective implementation will increase transparency and accountability of food safety measures, which can increase trust between customers and suppliers. Moreover, risk-based approaches form the basis of the SPS Agreement and are essential to maintaining and increasing international market access for GMS products.

Whole Chain Approaches

“Whole chain” approaches are essential to improve the sensitivity of surveillance systems; to better mitigate and manage risk; and to respond effectively to food safety breakdowns, disease outbreaks, and related events. It is in every player’s interest that issues are identified early and dealt with fairly, efficiently, and effectively. Yet at present, smallholders and small and medium-scale enterprises are too often excluded. All stakeholders have a role to play in developing locally appropriate approaches to assessing, mitigating, and managing risk in food supply and identifying hazards and risky behavior.

Domestic Markets and Cross-Border Trade as Entry Points

The GMS has made exceptional advances in terms of food availability and security in recent decades. However, the economic costs of food safety failures are high and increasingly well-recognized. Consumer awareness of foodborne hazards and demand for assurances are also increasing quickly. Therefore, the political and economic drivers for investment in improved food control systems for domestic markets are well established. Additionally, the value of cross-border trade in food and agricultural raw materials in the GMS is high and increasing. Cross-border sourcing typically increases the length and complexity of supply chains, which typically increases risks related to foodborne hazards and hazards of importance to trade and introduces the risks associated with the reliability of food control systems in neighboring countries.

Addressing cross-border trade, therefore, lends itself easily to establishing greater coordination and cooperation between GMS countries on the basis of protecting domestic interests. Targeting key border points can help to build constructive working relationships and facilitate sharing of data and expertise and mutual recognition of systems among GMS member countries. This can also help to increase transparency

and accountability, which might reduce unethical and illegal practices. Moreover, the development of effective systems in domestic markets and at borders will support the demonstration of equivalence to current and potential trading partners.

Policies and Investments

Investment and policy support is needed throughout the length of supply chains. Input supply safety and quality assurances need to be made more transparent through legal and regulatory requirements and better enforcement. Investment in on-farm surveillance systems and communication of best practices and risk mitigation and risk management strategies are needed. Post-farm-gate, process control systems are in their infancy in much of the GMS and vary widely between supply chains of different scales. Ease of transport and reduction of losses is often impeded by variable access to adequate storage facilities and the availability and quality of cold chains; movement is further impeded by unnecessary border requirements and inefficient mechanisms. Investments in expediting consignment movement by reducing red tape and investing in transport hub services and improved access to deep-sea ports can reduce losses in transit and minimize the likelihood of contamination and/or multiplication of hazards in or on product. Retailers' food handling may be improved by communication of better practices and risks. Promoting safer consumer steps in the handling and preparation of foods is also needed. Finally, systems for identifying a problem early and addressing it via alerts to all stakeholders, product recalls, movement bans, vaccination campaigns, culling, and the like, are required.

CASP2 presents a platform on which to establish a collegial approach to addressing hazards in food supply within the subregion. The GMS countries with more advanced risk analysis systems, in terms of technical capacity and infrastructure, can help to develop the systems in neighboring countries for mutual benefit. To this end, a comprehensive review of laws, regulations, and capacity related to food safety is needed to identify gaps. Systems need to ensure adequate protection without overburdening suppliers in terms of direct and/or opportunity costs. Greater transparency, accountability, and predictability in enforcement can reduce risk to businesses and encourage further private investment. Moreover, excessive regulatory burdens can push players toward the informal economy, hampering the development of transparent and accountable systems. Poorly designed regulations may impose overly high transaction costs and reduce productivity and interest from investors.

Based on the above analysis, the GMS countries are well positioned to share resources, capacity, facilities, and services related to food safety and broader risk analysis. In

particular, encouraging the establishment and accreditation of sustainable, accessible certification bodies, and facilitating access to accredited laboratories across the subregion is needed. Standard operating procedures (SOPs) that make explicit the chains of custody, ownership of samples and strains, intellectual property rights, confidentiality, and roles and responsibilities will need to be developed and established. Data sharing and risk communication within and between GMS countries can be quickly and effectively improved, through mutual agreement and SOPs. Government-to-government sharing of surveillance data can raise the speed of responses to the benefit of all GMS countries—the quicker an outbreak is identified, the more cost-efficient and effective the responses are likely to be. This is essential for establishing a rapid alert system at the level of the GMS, which would provide efficacy and efficiency advantages. There are also opportunities to increase business-to-government and government-to-business data sharing on hazards and risks, with the added benefit of bolstering collaboration between the public and private sectors. This can rapidly improve the quality of risk assessments and the effectiveness of risk management and risk communication strategies.

Joint emergency simulation exercises can form the basis of future coordination, cooperation, and knowledge sharing between countries. Effectively run joint simulations present an opportunity to improve emergency response plans; to build leadership; and to test and strengthen decision-making processes, response strategies, operations, and communications, while learning from and contributing to other systems. Simulation exercises present a good opportunity to (1) strengthen collaboration between regional stakeholders through sharing of knowledge, technical expertise, and data; and (2) harmonize systems. Such exercises provide benefits to all and a step toward mutual recognition of equivalence in risk management between countries.

Coordinated and unambiguous national and regional risk communication messaging is needed to mitigate risk, build trust, and reassure export markets. To be effective, awareness-raising initiatives about high-priority hazards, risks, and best practices must be dynamic, timely, and targeted at consumers, retailers, and all other supply chain stakeholders.

Greater coordination and harmonization of food safety standards among the GMS countries, and potentially other food-related standards in future, can drive progress. Variation in national standards and enforcement hampers mutual recognition and implementation. Mutual recognition within the subregion will help to build trust and increase bargaining power for suppliers in both domestic and export markets. Harmonizing current standards through benchmarking can facilitate demonstration of equivalence. Research institutes and the private sector should be engaged in

establishing standards, guidelines, policies, and regulatory systems, for them to be effective and appropriately targeted to maximize effectiveness without creating unnecessary burdens on suppliers. Such institutions also have essential roles to play in providing technical expertise for risk assessment and the design and implementation of risk management systems.

Improving the terms and conditions for business and facilitating trade within and beyond the GMS countries will save industries billions of dollars through cost reductions. Moreover, the costs to health systems, of lost labor and of tourism dollars, are likely staggering in terms of national economic growth. Building trust among consumers, retailers, and potential trading partners is essential to remain competitive in the modern global food market, where competition is high, differentiating products can be challenging, and margins are generally very low. A supportive and transparent policy environment will reduce investment risk and encourage better practices.

ICT-based systems can support functioning of effective food safety systems that build trust. The adoption of ICT-based/e-commerce systems employing barcodes/RFID—“smart” trade supporting “smart” food safety—is increasing and should continue to be promoted. The benefits of ICT-based systems will be substantial in terms of consumer and buyer trust, speed in transit, efficient supply chain management, traceability, and ability to target responses efficiently and effectively. Moreover, ICT-based systems lend themselves to data sharing in business-to-government, business-to-business, and government-to-government arrangements, which is of great value to risk assessment and the development of optimal risk management strategies.

Food testing laboratories and related transport and logistics infrastructure are typical infrastructural gaps. The GMS has few food testing laboratories and those that exist often lack accreditation by relevant international bodies. Some GMS countries do not have laboratories that meet international standards for detecting key hazards, meaning suppliers remain uncertified or must export samples at considerable costs in time and resources.

Transport and trade infrastructure such as road quality, transport hubs, storage facilities, and cold chains can mitigate risk, particularly in perishable products, but are often inadequate. Disease control infrastructure, such as quarantine facilities, is also inadequate in much of the GMS. Investment in risk management infrastructure can begin at key high-volume border points with investment in product handling facilities, quarantine stations, and broader infrastructure needed to improve surveillance and risk management. Adequate budget and cost recovery mechanisms for operating and maintaining systems are also essential.

Investment in institutional and human capacity is equally if not more pressing. Leadership and mentoring from more advanced systems are needed in areas with less-developed systems. Aside from the need to invest in technical expertise—in epidemiology, risk analysis, laboratory proficiency, and so forth—leadership, management, and operational skill sets are essential and often inadequately accounted for.

Establishing effective, dynamic, and sustainable food safety and broader risk analysis systems will require that both the public and private sectors invest resources in physical and human capacity. There are strong incentives for both sectors to build lasting partnerships that benefit consumers and businesses, in domestic and export markets. These arrangements must be inclusive and draw in smaller players. Identification of public and private sector “champions” can drive the development of these mechanisms for management, decision-making, and cost coverage.

3.4. Proposed Initiatives

First and foremost, it is essential that each GMS country produces and shares a candid and objective, science-based national food safety status assessment, based on a common approach and methodology. This assessment must describe chains of command and roles and responsibilities in relation to foodborne hazards and hazards of importance to trade. The document must candidly describe relevant legislation, regulations, and policy; national standards, trust marks, logos, and labeling; testing facility accreditations and capacity; and surveillance system design and capacity. The document must provide a frank assessment of national capacity to support, implement, monitor, and certify safe food standards and respond to emergencies.

The GMS countries should jointly seek to address three hazard categories of importance to domestic consumers and industries and to market access under the terms of the SPS Agreement:

- foodborne hazards, including pathogens and toxic residues;
- pathogens of importance to production and trade; and
- pests of importance to production and trade.

To this end, three key issues in GMS food control systems that will best be addressed through coordinated efforts have been identified.

- (1) Establish mutually agreed GMS-wide approaches and entry points—in terms of products, locations, and flashpoints in supply chains—for improving food control systems.

- (2) Establish greater coordination and cooperation between the GMS countries toward harmonization and mutual recognition of equivalence in food control systems; legislation, regulation, and policy; knowledge and data sharing; and capacity sharing and building.
- (3) Prioritize investments in human and institutional capacity building and key infrastructure at the GMS level.

To address these issues, the following initiatives are proposed:

- (1) Agree to promote the adoption of locally, nationally, and subregionally appropriate and rigorous risk-based systems that address high-priority hazards across the length of supply chains. Specifically, agree to address issues of domestic markets and cross-border areas as entry points to strengthening systems across the subregion.
- (2) Agree to a time-based plan to increase coordination and cooperation toward harmonization of systems and mutual recognition of equivalence, which will be initiated by:
 - (a) developing and sharing candid national food safety status assessments;
 - (b) establishing mechanisms for joint review of current national legislation, regulations, and standards and a road map to mutual recognition of equivalence;
 - (c) establishing mechanisms for sharing laboratory capacity within the GMS Agreement by jointly drafting the SOPs relating to chains of custody, roles and responsibilities, confidentiality, and intellectual property rights;
 - (d) developing joint emergency response simulation exercises, focused initially on priority land borders and economic corridors within the GMS; and
 - (e) promoting adoption of ICT-based/e-commerce specifically in relation to cross-border trade.
- (3) In alignment with the GMS Strategy and Action Plan for Promoting Safe and Environment-friendly Agro-based Value Chains 2018–2022, jointly develop a subregional investment plan for increasing GMS food control system capacity. The plan should include prioritizing institutional and infrastructural investments and the development of coordinated national food safety pilot projects.

Three actions have been identified for immediate implementation to kick-start achievement of the foregoing proposals.

- (1) Establish food safety data sharing and risk communication through the Agriculture Information Network System (AINS) version 2.0—led by CASP2 technical assistance. Because this activity relies on CASP2 staff, it is immediately actionable. The system can be used as a platform for building

and strengthening food safety at domestic levels through open sharing of information from around the subregion and as a mouthpiece for risk communication. A pilot case of applying AINS to food safety data sharing and messaging in one cross-border area can commence immediately. Priority information includes sharing of hazard lists for key commodities; sharing of best practices on food safety and quality; and communication of risk information to the public, policymakers, suppliers, retailers, and current and potential trading partners.

- (2) Establish collaboration between GS1 and the GMS Working Group on Agriculture on facilitation of trade in food and agriculture products, initially focusing on piloting barcode/RFID code-based traceability systems and broader data collection systems in cross-border food trade situations.
- (3) Pursue further public-private dialogue on capacity building for increased food safety, commencing with the Food Industry Asia, Global Food Safety Initiative, and other GMS@THAIFEX 2017 participants. A broader public-private dialogue was hosted during the GMS Second Agriculture Ministers meeting in September 2017, which engaged a wide group of public, private, and civil society interests.

3.5. Conclusions

Each of the GMS member countries recognizes the need to address current deficiencies in food safety control systems and the management of hazards of importance to trade in food products. The GMS countries also appreciate that a focus on food safety in domestic markets must first be prioritized and that protecting domestic consumers and suppliers is essential and will, in turn, support future access to export markets. Moreover, the GMS countries recognize the potential advantages of acting collectively to address hazards in food and agricultural systems, due primarily to the close ties between the GMS countries, the porous borders, and the high and increasing volumes of cross-border food supply within the subregion. Therefore, it is essential that cross-border areas be considered a priority for protecting domestic and subregional consumers and suppliers.

The increased adoption and improved implementation of consistent risk-based approaches across the GMS is needed to mitigate and better manage food-related threats. Effective design and implementation of risk-based systems can increase efficiency, mitigate risk to consumers and suppliers, and facilitate recognition of equivalence between GMS countries, regional neighbors, and wider global markets. However, current GMS food control and risk analysis systems are highly varied in their technical, leadership, and operational capacities. Furthermore, investment in key

infrastructure, such as accredited laboratories, trade infrastructure, and data sharing and risk communication platforms, is often inadequate. To address these constraints and to catalyze the improvement of food systems across the GMS, better coordination, collaboration, and harmonization of GMS systems is needed.

In the medium term, the GMS countries can

- openly assess their current systems and identify gaps,
- facilitate the free movement of samples within the subregion by developing SOPs,
- plan investment in cross-border areas and pilot track and trace systems bilaterally/collectively,
- establish mentoring and technical capacity-building programs,
- run joint emergency response simulations, and
- harmonize systems and standards toward recognition of equivalence.

To stimulate achievement of these goals, the immediate action will be to leverage the AINS platform to facilitate data sharing and risk communication among food stakeholders, including consumers, across the GMS. The platform can be leveraged immediately. The activities will also facilitate public–private dialogue on food safety and the development of pilot initiatives, which are currently being discussed with program partners.

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Chapter 4

Supporting Food Safety: Participatory Guarantee Systems— Issues to Be Considered for Up-Scaling in the Greater Mekong Subregion

Chapter 4 is authored by Christopher May, affiliated with IFOAM Organics International.

4.1. Introduction

Under the Core Agricultural Support Program, Phase 2 (CASP2), countries of the Greater Mekong Subregion (GMS) aim to be recognized as leading producers of safe food, using climate-friendly agricultural practices and being integrated into global markets through regional economic corridors. This vision has been supported by three strategic pillars: (1) food safety and trade modernization, (2) climate-friendly agriculture, and (3) bioenergy and biomass management.

The Participatory Guarantee System Capacity Building in the GMS project supports CASP2's pillars 1 (food safety and trade modernization) and 2 (climate-friendly agriculture) by pilot testing participatory guarantee systems (PGSs) in each GMS country—Cambodia, the People's Republic of China (PRC), the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam. The aim is to demonstrate the potential of and understand the challenges to be addressed in scaling-up PGS. This was made possible through letters of agreement between ADB and the governments of Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam.

The PGS is a community-orientated certification system that encourages climate-friendly agri-produce stakeholders to form a network of producers, consumers, and other stakeholders for building a credible certification system. Conceived as an alternative to third-party certification, a PGS builds farm-level capacity in agri-food certification and food traceability for smallholder farmers. An aim is to reduce the

certification costs, which have kept smallholders from integrating into modern value chains and broadening their market reach.

The experience gained from implementing PGSs demonstrates that they are effective in linking smallholders to new markets and can capture the confidence of consumers. Thus, the PGS provides governments with another tool—in addition to the Association of Southeast Asian Nations (ASEAN)¹ Good Agricultural Practices (GAP) standards (for safe fruits and vegetables) and third-party organic certification—to help them achieve their wider food safety goals and help create a competitive agriculture sector in the GMS.

The project's goal of initiating at least two PGS pilots in each country was exceeded overall: in Cambodia (3), the Lao PDR (3), Myanmar (2), Thailand (7), and Viet Nam (3). The project clearly demonstrated the benefits of well-structured and commercially focused farmer groups, with farmers linking with new markets and finding new sources of income. At the government level, an initial generally negative view toward the PGS methodology has been replaced by a positive one. The success of the pioneering PGS pilots has sparked a number of new PGS initiatives supported by nongovernment organizations (NGOs) and the private sector. With support from ADB, another round of PGS activities is planned. The PGS' potential as a credible and effective certification option has been established, and, as noted by Cambodia's Under Secretary of State San Vanty, the question is now "how best to up-scale PGS."²

The PGS can provide a quality assurance option along with GAP-certified products and those certified by third parties as organic. GAP-certified products are often described as "safe products," meaning they are grown with controlled use of pesticides and chemical fertilizers and minimizing the risk of contamination from chemical residues or pathogens from animals or unclean water. Third-party certification of organic products is mostly used for exports, with accredited bodies certifying that the products meet regulatory requirements of various markets. The PGS follows similar organic standards for production and sale to local markets. Their compliance procedures are oriented to internal monitoring systems, employing a structured peer review approach and engaging other stakeholders to help endorse compliance.

Together, GAP, third-party certification, and the PGS are part of a quality management landscape and contribute to the institutionalization of a "quality mindset" at all levels. The development of this process takes time and requires governments to commit resources to establish robust systems underpinned with a high level of accountability.

1 ASEAN = Association of Southeast Asian Nations.

2 At the Working Group on Agriculture's 14th Annual Meeting, Siem Reap, July 2017.

Key issues to be addressed in up-scaling PGS include

- securing PGS recognition in government policies and regulations,
- confirming the definition of PGS quality assurance,
- harmonizing standards domestically and across all GMS countries to facilitate cross-border trade,
- coordinating PGSs at the national level,
- developing models for government engagement with the private sector,
- ensuring that PGSs comply with government food safety regulations, and
- promoting the PGS to consumers.

Organic and PGS regulations need to be shaped by policies that are inclusive rather than exclusive of different certification options.

4.2. Situation Overview

To help address food safety challenges GMS countries face, the “GMS as One” Policy Forum³ highlighted the need for each country to adopt global food safety standards and common internal control systems referencing regional standards such as the ASEAN GAP and ASEAN Region Organic Standard. The “GMS as One” policy forum participants stressed the importance of focusing collective resources of government and the private sector to develop pilot initiatives in their domestic markets as their focal point for implementing food safety strategies, and referenced PGS as an important tool to help support this process.

The PGS provides a certification option that can be used to promote the growth of the agriculture sector as well as job creation and livelihood improvements in the wider agricultural community. The advantage of PGSs is that they have been designed specifically to meet the needs of smallholder producers supplying local markets. As a result, costly bureaucratic procedures associated with export certification are not required.

Another advantage of a PGS is that it requires the smallholders to be actively engaged in supporting the process. This manifests in knowledge exchange, trust building, and opportunities to invest in and structure postharvest and supply chain improvements that contribute to strengthening the marketing opportunities for the farmer groups. Other stakeholders are also expected to become involved in supporting a PGS. This involvement varies according to each situation—it may mean involving local agencies

³ GMS as One: Unified Regional Approaches to Food Safety and Market Access Policy Forum, World of Food Safety Conference, THAIFEX—World of Food Asia, 31 May–4 June 2017, Muang Thong Thani, Nonthaburi, Thailand.

in providing technical or cultural support or retailers and consumers participating in on-farm peer reviews with farmers.

The PGS is a grassroots initiative that is open to adopting local cultural norms to strengthen the compliance process. In this way, communities are able to demonstrate compliance in diverse ways while still aligning with PGS quality assurance requirements as described in the International Federation of Organic Agricultural Movements–Organic International (IFOAM) *PGS Guidelines*. To provide consumers with confidence in PGS certification, governance of the certification should be coordinated at the national level, ideally by a multi-stakeholder body supported by the responsible government agency.

IFOAM is a global organization formed in 1972. It has memberships from 84 countries worldwide. IFOAM's functions include advising policymakers, national organic movements, NGOs, and others on strategies to develop sustainable and credible organic sectors. IFOAM maintains the Organic Guarantee System, a global nonprofit independent evaluation program that helps to provide an understanding of which organic labels can be trusted. IFOAM promotes both third-party and PGSS as complimentary organic guarantee systems. The form and functions of PGS are described in the IFOAM *PGS Guidelines* document.⁴ Organic standards are listed in the IFOAM Family of Standards document (this list includes the Viet Nam PGS organic standard).⁵

Cambodia

Since the PGS concept was first introduced in a national PGS workshop in 2015, the government and private sector have collaborated to quickly advance PGS at both the governance and production levels. PGS pilots were initiated in 2015 with two NGOs and a CASP2-supported program, implemented by the General Department of Agriculture (GDA).

The GDA implemented PGS pilots with provincial departments of agriculture in Kandal, Prey Veng, and Tbong Khmom provinces and established an organic standard (CAMORG) with a logo and Cambodia PGS with a logo. The rules for how the Cambodia PGS logo can be used are to be developed by October 2017.

One PGS pilot was initiated by CARITAS (an NGO), with two groups in Battambang producing vegetables for the local market, and another by the Natural Agricultural

⁴ Available at www.ifoam.bio/sites/default/files/page/files/pgs_guidelines_en_web.pdf

⁵ Available at www.ifoam.bio/en/ifoam-family-standards-o

Village (NAV, a social enterprise) in Kampong producing vegetables for its own NAV retail outlet and to supply supermarkets in Phnom Penh. The marketing success of NAV has been well noted by the GDA, with both parties collaborating on various levels to promote PGS and exchange expertise.

The collaboration between the GDA and NGOs has been a significant and positive feature of the open approach that the GDA has taken in supporting the PGS development process in Cambodia. This approach is reflected in the national coordinating body, where there is representation and active engagement from the private sector.

In the GMS (including Cambodia), the scale of the food safety issues is significant, with numerous smallholder farmers growing vegetables on small plots of land and applying pesticides randomly. Due to poor postharvest handling, contamination from pathogens occurs along the whole supply chain.

Orienting government support and technical resources toward the development of domestic markets is critical. To help solve the smallholder's dilemma of small volumes, low quality, and weak market links, PGS certification must address not only on-farm production but must also aim to secure the integrity of product from field to plate. Because the supply chain issues extend beyond the farm gate and are usually out of the farmer's control, all the supply chain actors must be engaged to ensure consumers can buy safe organic food.

Actions that are in process include

- completing the policy statements and process for PGS recognition in national regulation,
- developing national PGS technical guidelines,
- consolidating the roles and functions of the national coordination body,
- building capacity to strengthen the internal management of PGSs, and
- training specialist trainers for government officers and new private sector actors who want to implement PGS.

Recommendations to support further PGS development include that the GDA should include the PGS under the umbrella of its food safety program for pesticide and pathogen residue monitoring and testing. Covering the PGS under an independent testing program with published results would go a long way toward building consumer confidence in safe and organic food brands.

The People's Republic of China

The way forward for the PGS as an organic certification option in the PRC is unclear because current regulations do not include allowing PGS products to be labeled as certified organic. This constraint delayed the introduction of the PGS to Yunnan and Guangxi.

Under CASP2, a national PGS workshop was held in Kunming, Yunnan Province in 2015. Subsequently, two PGS pilots in Guangxi Zhuang Autonomous Region, in cooperation with OXFAM Hong Kong, China and the Center for Chinese Agriculture Policy and Chinese Academy of Sciences, Nanning, received a workshop supported by an IFOAM PGS specialist.

Pilot groups were established in Mashan County (Guzhoi Village) where there is a long history of saving corn seeds for planting in the next season, and breeding local (black) pigs, and in Du'an County (Nonglv Village) based around saving and commercially producing traditional rice varieties. Both groups market their products at a weekend market in Nanning. They applied the PRC's National Organic Standard and the IFOAM PGS Guidelines. OXFAM is continuing to support both groups to strengthen their PGSs and their supply chains are continuing to operate.

The PRC has had national organic standards since 2005. The standards encompass organic production, processing, distribution, and retailing. To sell organic products legally in the PRC, all products (whether of domestic or international origin) are required to have PRC organic certification from the Certification and Accreditation Administration. The standards were primarily set up to facilitate the export of organic products and are achievable for large organizations supporting contract farming. However, smallholders who are not engaged in contract farming cannot label PGS products as certified organic.

There have been no reported proposals by PGS groups in Nanning requesting a review of the government regulation to include the PGS.

There is no legal constraint on using PGS as a certification methodology, but products with such certification cannot claim to have organic certification or labeling. In the United States, the PGS certification body has avoided the same legal constraint imposed by the United States Department of Agriculture by not referring to organic specifically in their labeling, and in France, the PGS Nature in Progress has taken a similar approach to avoiding the same constraint imposed by the European Union.

In the PRC, Community Supported Agriculture (CSA), similar to Teike in Japan, provides an alternative way for farmers to engage with consumers. The CSA allows city residents direct access to high-quality, fresh produce grown locally by regional farmers. Consumer-members of a CSA purchase a share of vegetables produced by a farmer. The consumers who visit the farms (and sometimes work on them) determine if they can trust the farmer to produce the crops ethically. Increasingly, though, it is reported that consumers in the PRC would like to see CSA farms certified and the PGS is proposed as a suitable methodology. However, for the PGS to be recognized in the PRC's national regulations as complimentary to third-party certification for domestic markets is likely to take some time.

The Lao People's Democratic Republic

The PGS in the Lao PDR has developed differently from that in other GMS countries. When the PGS was first introduced in 2014, the Department of Agriculture (DOA) Accreditation and Certification Division immediately took control of the process and included PGS under the umbrella of its certification program. This program includes an organic third-party certification system and Lao GAP certification, which is aligned with the ASEAN GAP. The DOA is responsible (via regulation) for managing the Lao Organic Standard, registering and certifying PGS, and issuing the Lao Organic/PGS Logo.

The strength of the Lao PDR system supporting the PGS is that government fully endorses the process and manages PGSSs. The DOA has successfully worked with three PGS groups in different locations, leading to their certification and entitling them to use the Lao PGS/Organic logo.

A challenge to the development of PGSSs in the Lao PDR is that the demand for quality certified product is limited. Private sector support for organic products is weak and is not actively engaged with the DOA in supporting the national coordination and management of the PGS. Ideally, as the private sector expands and becomes more active in the production and marketing of organic food, a more inclusive approach will evolve. In the interim, the DOA could consider inviting the NGOs such as the Sustainable Agriculture Environment Association (SAEDA) and GRET (Groupe de recherche et d'échanges technologiques, an international NGO) that are supporting the PGS to become part of a national PGS coordinating body.

Three PGS groups are now certified by the DOA, all supported by CASP2.

- The Savannakhet Organic Farmer Group has 25 households producing 5 tons of vegetables annually for sale in Savannakhet markets.
- The Xieng Khoang Organic Farmer Association has 75 households producing about 12 tons of vegetables each year, sold in the local market at Xieng Khoang.
- The Huaphan Bamboo group is of particular interest because they are applying PGS for the sustainable management of 588 hectares of communal bamboo forest. They harvest bamboo shoots and use improved processing and drying techniques to produce a quality product that is sold to an organic retail chain (Bac Tom), based in Ha Noi, that accepts PGS certification. The returns to the farmers are better than what can be had on the local market. However, to secure supply, Bac Tom is required by the provincial agriculture forestry office to coordinate the trading process with the Huaphan Trading Enterprise. This arrangement carries some risk in terms of upfront investment to facilitate the trade but also provides an approved pathway for future opportunities for cross-border trade between Huaphan Province and Viet Nam.

Up-scaling PGS presents challenges for the DOA due to the weak private sector in the Lao PDR. There are numerous opportunities for PGSs but the lack of demand from the markets driven by the private sector means that NGOs become the catalyst for PGS development. Where NGO projects support an inclusive value chain approach, their success is high as they are addressing the market demand and building smallholder capacity to supply the demand.

The inclusive value chain approach is well demonstrated by the SNV⁶ model in the southern Lao PDR, where rice millers, collectors, and farmers, facilitated by SNV, came together to increase yields by using improved rice varieties and improving quality management throughout the supply chain, resulting in better returns to all the stakeholders and proving that value addition is possible through an inclusive approach to supply chain management. The successful application of an inclusive value chain approach requires the active engagement of key stakeholder groups working together to achieve the same objective. For NGOs, the inclusive value chain approach serves as an effective mechanism for strengthening supply while building market demand for smallholder production.

⁶ SNV Netherlands Development Organisation is a nonprofit, international development organization, established in the Netherlands in 1965.

Myanmar

The PGS in Myanmar is less developed and has less direct government support than is the case in GMS neighbors, mostly due to the relatively recent introduction of PGS and the early developmental stage of the country's food safety agenda.

PGS pilots were initiated in 2015 with two NGOs supported by CASP2 and Myanmar's Department of Agriculture (DOA). The catalyst for introducing the PGS into Myanmar has been the Myanmar Organic Growers and Producers Association (MOGPA), an organization set up to promote organic agriculture and certification. MOGPA facilitated the introductory PGS workshops supported by CASP2 and follow-up training.

MOGPA applied its own organic standard, adapted from the IFOAM Basic Standard and the IFOAM PGS Guidelines. The DOA, for its PGS program, applied the same IFOAM Standard⁷ and DOA staff working in their PGS program received initial training from MOGPA and a CASP2-supported IFOAM PGS specialist.

MOGPA provided technical support for the development of several PGS groups including a mushroom producers group in Yangon, a vegetable producers group in Hmawbi close to Yangon, and a coffee producer group in Ywa Ngan. MOGPA has also worked with the DOA to support PGS initiatives in Mandalay (rice) and Pi Uu Lwin (strawberries). The DOA has provided support for two PGS vegetable producing groups in Nay Pi Daw neither of which is certified because they are unable to fully comply with the organic standard. This issue highlights the lack of specialist knowledge for organic production within both government staff and MOGPA. Specialist knowledge is required to support the hands-on commercial production of organic vegetable crops.

The potential for PGS in Myanmar, with its many smallholders, is significant but Myanmar must address challenges that include

- developing the specialist technical knowledge required to commercially produce organic food;
- developing a cohesive government policy supporting organic and PGS certification (ideally following the Cambodia example); and
- addressing food safety issues in general, especially relating to postharvest and supply chain contamination—there are reports of up to 70% postharvest crop loss.

⁷ Available at www.ifoam.bio/en/ifoam-standard

For PGS to contribute to the overall improvement of food safety in Myanmar requires government support for PGS through policies and regulation. Government needs commitment and resources to support national coordination and develop the level of technical expertise necessary for pest and disease management.

To help achieve this objective, government leadership is required. Ideally, government will appoint a high-profile “champion” for the PGS among the DOA staff, creating a key contact point and beginning the process of building capacity to support PGS within the government departments.

Recommended actions include

- appointing a senior government staff member to champion the development of PGSs,
- developing the policy statements supporting the PGS (through multi-stakeholder engagement) and mapping out a process for PGS recognition in national regulation,
- developing national PGS technical guidelines based on the IFOAM *PGS Guidelines*,
- developing a multi-stakeholder national coordination body with prescribed roles and functions,
- continuing to build the MOGPA and DOA PGS groups’ capacity to strengthen the PGS pilots’ internal management, and
- drawing on international expertise to help prepare specialist training for government officers and new private sector actors who want to implement PGS and produce organic products.

Thailand

Thailand’s organic market is growing rapidly, at close to 20% per year. In 2014 sales were B2.331 billion, of which B514 million is domestic sales. The growth in the Thai organic market presents an opportunity for organic producers from other GMS countries to participate. Consumers in Thailand, including supermarkets and specialist stores such as those of the Lemon Farm and farmer markets such as Sampran Riverside weekend market, recognize both third-party organically certified and PGS-certified products.

Since 2014, under CASP2 at least 10 PGSs have been established, either by the Thailand Organic Agriculture Foundation (TOAF) or the Lemon Farm (shop and restaurant in Bangkok). Lemon Farm Organic and Natural Foods, supported by CASP2 and investment from its own resources, has developed several PGSs. The first pilot

group was in Mae Hong Sorn, Chiang Mai, producing avocados and plums. Building on their initial success the Lemon Farm established another seven PGS groups, producing rice, herbs, vegetables, and eggs to supply the Lemon Farm restaurants and stores. As of 2017, the Lemon Farm had established 11 PGS groups in eight provinces.

The TOAF has been actively working with more than 450 farm households in five locations across Thailand, one of the more publicly recognized being with the Sookjai Organic PGS in Nakhon Pathom. This group produces a diverse range of TOAF PGS-certified products supplying the expanding Sampran Riverside weekend market at the Sampran Riverside Resort. This market has played an important role in linking farmers with consumers and thereby helping to establish the credibility of the TOAF PGS.

Both the Lemon Farm and TOAF have followed the IFOAM *PGS Guidelines*. For organic production, the TOAF has promoted the domestic Thai Agricultural Standard TAS 900-2003, Production, Processing, Labelling and Marketing of Organic Agriculture (developed by the Ministry of Cooperatives) and Lemon Farm uses the standards of Organic Agricultural Certification Thailand (a private third-party certification body accredited by IFOAM).

A range of other PGSs has also been established across Thailand. A private sector initiative has created a PGS coordinating body, the Thai Organic+, which offers private registration and a logo. The Lemon Farm and other PGS groups have aligned with Thai Organic+ and use the Thai Organic+ logo on some of their product labels.

To effectively up-scale the PGS in Thailand so that it remains a credible certification system that consumers recognize and have confidence in, the key stakeholder groups need to agree on how the PGS is coordinated at the national level. Currently, however, the TOAF and other key PGS-supporting bodies do not agree on how this should happen. While the basics of following the IFOAM *PGS Guidelines* are agreed, the challenge is for each key party to agree on where it would sit under a national umbrella or coordinating body.

Ideally, the national coordinating body would be a multi-stakeholder body serving as an umbrella for the whole organic sector where both government and private sector stakeholders collaborate for the national coordination of PGSs. The roles of this body could include managing or endorsing a PGS registration system, maintaining a PGS data base, providing guidelines to new PGSs, managing a national PGS logo, approving farm inputs, and auditing PGSs that want to register with the national PGS program. The TOAF and the other PGS bodies would sit under this umbrella.

Viet Nam

The first PGSs in the GMS were developed in 2008 and 2009 and involved producer groups, consumers, supporting NGOs, and organic traders that now successfully produce and market large quantities of PGS-certified products daily. As PGS pioneers, Viet Nam developed its own production standard based on the National Basic Standards for Organic Products in Viet Nam issued by the Ministry of Agriculture and Rural Development. Their PGS standard is now recognized in the IFOAM Family of Standards.⁸

New PGSs have been initiated by Action for the City⁹ in conjunction with the Economics Division of Hoi An City and supported by ADB technical assistance to establish PGS in Hoi An. The PGSs are coordinated by the Economics Division of Hoi An City and the Cam Thanh's Peoples Committee and they follow Viet Nam's PGS organic standard and compliance arrangements adopted from the IFOAM PGS Guidelines. The Hoi An PGSs demonstrate the diverse potential of PGS as they certify production and catalyze agro-tourism—the Thanh Dong group receives more than 1,000 paying visitors annually.

Through the ongoing work of the Organic PGS Viet Nam, the country has established well-tested systems and procedures supporting the development and operation of PGSs. PGSs have also been tested by VECO¹⁰ (with support from PGS Viet Nam) in the vegetables subsector, supporting farmer organizations to set up PGSs to monitor and certify compliance with either a food safety standard (Basic GAP)¹¹ or an organic standard (PGS Viet Nam). The application of PGSs to safe vegetable certification has widened the appeal and opportunity for the PGS to facilitate pro-poor development.

The potential benefits of the PGS as a mechanism for improving food safety are now well demonstrated. Reaching this stage in the development of PGS in Viet Nam has been NGO-driven with support from the private sector. However, to up-scale PGS at the national level requires support and engagement from government, ideally following a collaborative approach engaging with the private sector and agencies that have already developed expertise and systems for PGS management.

Various agencies, including PGS Viet Nam and the Vietnam Organic Agriculture Association have pointed out to the government's Ministry of Agriculture and Rural Development the huge interest in the PGS from various parties and they fear that

8 Available at www.ifoam.bio/en/organic-landmarks/ifoam-family-standards

9 The Action Center for City Development is an NGO promoting innovation to help "green" urban communities.

10 VECO Vietnam is a member of Vredeseilanden, an international NGO with headquarters in Leuven, Belgium.

11 Basic GAP (24 steps) is a reduced VietGAP standard (65 steps).

the integrity of the existing PGS brand will be undermined if new PGSs sprout up in an uncoordinated way, highlighting the urgent need for government to support the development of PGS

- policy and regulation; and
- coordination supporting the development of a management body that shares responsibilities for national management and coordination between government and competent organizations such as the PGS Viet Nam and the Vietnam Organic Agriculture Association.

4.3. Analysis of the Issues

The primary PGS issues are fragmented supply chains with few opportunities to add value. A large majority of producers continue to operate subsistence farms or produce only small volumes of seasonal products and are often only weakly connected to market networks. In this cycle, debt is common, product quality is low, and the farmers are price takers supplying collectors who often amalgamate the products from an area and sell them on to wet markets or wholesalers.

In such situations, the PGS can provide a structure for organizing and coordinating the production base, enhancing product quality through improved postharvest handling systems, certifying the product, and attracting buyers wanting reliable sources of quality product. In many cases where new buyers understand the potential of PGS, they become involved in supporting the development of the whole process.

In the past, when decisions have been made relating to policy and regulatory control of organic production and certification, the process has been modeled on regulatory arrangements of export markets rather than the needs of local markets. Where regulations do not recognize alternative organic certification approaches such as the PGS, they risk excluding the opportunity for PGS certification to be used as a tool in pro-poor development. When a regulation has been set, changing it takes time and can be complex process. This issue can be addressed by each country aligning PGS regulation with global (IFOAM *PGS Guidelines*) and regional standards (such as the ASEAN Regional Organic Standard).

Current opportunities for cross-border trade in PGS products between GMS countries are very limited because production is focused on local markets. However, there are opportunities for cross-border trade in quality PGS products, as demonstrated by the export of good quality dried bamboo shoots from Huaphan in the Lao PDR to Ha Noi. The adoption of common GMS PGS standards would help reduce barriers to

cross-border trade and enhance the credibility of PGS certified products. In the case of the dried bamboo shoots both the Lao PGS and Viet Nam PGS demonstrated, on a basic level, how this process can work. They both apply and recognize the IFOAM PGS *Guidelines*, making it easy for the buyer in Viet Nam to understand and have confidence in the integrity of the Laotian certification process.

Although GMS countries are at different stages of regulatory development for organic food, PGS, and food safety in general, there are common GMS issues relating to up-scaling food safety strategies that the PGS could help to address. To be effective at the national and regional level, food safety quality assurance programs must be recognized by government policies and supported via regulations. It is possible for the GMS to have voluntary standards and certification options, but compliance with both national and GMS standards would provide an effective mechanism for helping to ensure that minimum food safety standards are being met at both levels.

In this context, the PGS should be recognized alongside other certifications such as GAP or organic third-party certification by governments in their national policy and regulation. To facilitate cross-border trade and build consumer confidence in PGSs within the GMS countries, the definition (standard) of PGS should be recognized as the IFOAM *PGS Guidelines*, and for organic production, the ASEAN Organic Regional Standard or a recognized national standard should be used.

Coordination of PGS at the National Level

The credibility of PGS certification could be eroded by uncoordinated proliferation of PGSs using different standards and confusing the market. Thus, there is a strong case for coordinating the PGS at the national and GMS level, but the question is: “How should coordination be structured?” Government cannot do it alone, as it is not the input supplier, farmer, processor, trader, and retailer.

The consensus among stakeholders is that government should take the lead role by developing supporting policy and regulation and facilitating the establishment of PGS national coordination bodies with multi-stakeholder representation. The bodies should have defined roles for government in order to not overextend its resources and capacity to deliver.

A key function of the coordinating body could be managing a national PGS logo, maintaining a registration system (similar to the IFOAM PGS registration model

and approval system),¹² maintaining a national PGS database, providing PGS documentation to new PGSs, promoting PGSs, and providing overall governance of PGSs.

A public–private–community partnership structure might be used for the national coordinating body, with the roles and responsibilities allocated accordingly. The four stakeholder groups in the value chain are government, producers, the private sector, and consumers. An option for government is to simplify its management responsibilities and “contract” the daily coordination of PGSs to an established entity, which would serve as the intermediary linking the farmers and consumers. For example, in Viet Nam this role could be undertaken by the PGS Viet Nam. Government would maintain governance responsibilities and ownership of a national logo but the day-to-day PGS management would be carried out by the entity.

The bulk of the agricultural production in the GMS continues to be consumed locally. Fresh vegetables dominate this market, are sold daily in numerous outlets, and present the most food safety risks to consumers. Contamination can occur on–farm but also at many points along the supply chain. Thus, PGS certification must align with the other food safety certifications and aim to provide security over the whole supply chain.

The PGS structure strengthens the opportunity for farmers to organize their postharvest handling systems by establishing collection points where produce and product can be graded and packaged securely before it is sent to market. Collection points must address food safety standards. Traceability is now a foundation requirement of all credible food safety programs. Collection points provide the opportunity for supervised record keeping and product labeling.

Standardizing product quality can help to add value and secure markets.

Up-Scaling: Which Model Works Best?

Models to establish PGSs have been both market-led, where a private sector operator or an NGO (with its own retail outlets) has provided the capital investment and impetus to work with groups of farmers to establish a PGS, and project-led, mostly by government agriculture departments (notably in Cambodia, the Lao PDR, and Myanmar).

¹² www.ifoam.org/pgs

The most successful models have had a strong private sector involvement providing a market, such as in Thailand, the Lemon Farm or Sampran Riverside Resort; in Viet Nam, where the PGS Viet Nam has facilitated the engagement of the organic retail sector; and in Cambodia, with the NAV PGS.

For PGS certification to be credible, the system should be legitimized at the national and regional levels and should provide clear benefits to all the key supply chain stakeholders.

For PGS to be effective, its development requires multi-stakeholder involvement with a clear understanding that the purpose of setting up a PGS goes well beyond creating groups of farmers. The purpose is to create opportunities for farmers to become organized so they can confidently engage in markets they could not access on their own. The PGS provides a tool that can facilitate this process.

4.4. Policy Directions

Recommendations to assist governments to effectively improve food safety from the farm to the table include the following:

- Promote the ASEAN Regional Organic Standard as the minimum standard required for producing organic products in the GMS.
- Recognize PGS alongside other organic certification systems as a certification for produce and products sold in domestic and potentially other GMS markets.
- Base the definition of PGS and any legal approval requirements on the PGS definition, key features, key elements, and characteristics elaborated in the IFOAM *PGS Guidelines*.
- Particularly for markets with emerging organic products, consider promoting the PGS as voluntary (within the national regulations), where operators have the right to use an official national organic logo and to access markets. Operators who are not certified as PGS under the regulations may still be able to make organic claims, but may not use the official PGS logo or statements (such as “certified in accordance with the national organic PGS regulation”) to do so.

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- Establish a national PGS coordinating body that actively engages government and private sector stakeholders in the national coordination of PGSs. Roles of this body could include managing a PGS registration system, maintaining a PGS data base, providing standards and guidelines to new PGSs, managing a PGS logo, approving farm inputs, issuing certificates, and auditing PGSs that want to register with the national PGS program.
 - Support and encourage the promotion of the PGS to retailers, traders, and consumers in local markets.
 - Include PGS-certified products in the government's food safety sampling and residue testing program.
 - Engage with other GMS countries to facilitate cross-border trade in PGS-certified products.

Theme 2

**Inclusive and Sustainable,
Safe and Environment-
Friendly Agriculture Products**

Chapter 5

Green Water Management and Nitrogen Use Efficiency in the Greater Mekong Subregion—Promoting Synergy between Sustainable Agriculture and Food Safety

Chapter 5 was prepared by Anthony G. McDonald and Lourdes S. Adriano.

5.1. Introduction

The Core Agriculture Support Program Phase II (CASP2) is committed to achieving the vision to make the Greater Mekong Subregion (GMS) internationally recognized as a hub for safe and environment-friendly agro-food products (SEAPs). In the last 2 decades, the GMS economies were growing rapidly—and they continue to do so (ADB 2017). Their present population of over 330 million is becoming larger, richer, and more urbanized. This growth is occurring within the context of very tangible social and physical changes occurring across the GMS; change in the characteristics of the market and the intentions of consumer demand; more integration of sectors (e.g., food–energy–water) and stakeholders (farmers, traders, food manufacturers, hoteliers, supermarkets); changes in climate conditions, which include an increase in uncharacteristic weather events; and of course the steady change in population numbers, which generates a need for a greater volume of food production.

These changes also create a great opportunity for the GMS to be a major supplier of SEAP both domestically and increasingly elsewhere. From an export perspective, the GMS is strategically located next to the PRC market, the Indian subcontinent, and the major transport corridors linking the Association of Southeast Asian Nations (ASEAN) to Central Asia and South Asia, as well as the Pacific Ocean and the Indian Ocean. The continuity of the GMS landmass, rapid development of its economic corridors, and diversity of its agroecological environment uniquely place the GMS within the ASEAN to accelerate the path toward recognition of a region that proudly produces SEAP.

This chapter will summarize the importance of addressing the physical environmental drivers of change in order to achieve the CASP2 vision. It

- highlights the need for change in approaches to land and water management;
- introduces a conceptual approach that summarizes a cycle of trust and web of connections necessary to build market confidence for SEAP;
- looks at the state of play and current situation of the letter of agreement (LOA) activities pursued under CASP2 and the contribution that they are making; and
- identifies policy directions, including investments and institutional reforms that are needed to respond appropriately.

The chapter is divided into five sections. Section 5.2 provides the socioeconomic context and the drivers of environmental transformations accompanying the growth pathway. Section 5.3 posits the physical environmental dimensions of the situation, and the holistic approach required when looking at the development of safe and environment-friendly agro-based value chains in the subregion. This is consistent with the ensuing 5-year GMS Strategy and the Siem Reap Action Plan that was endorsed by the GMS Agriculture Ministers on 6–8 September 2017 at the second Agriculture Ministers' Meeting. Section 5.4 focuses on climate smart agriculture measures that are being test cased in the GMS through the LOA arrangement between the Asian Development Bank and the GMS agriculture ministries. Two specific areas of “on-the-ground” activity are highlighted—examples of innovations that benefit production and resource management—the Green Water Management (GWM) and the Nitrogen Use Efficiency (NUE) initiatives. At the same time, the holistic context into which the GWM and NUE fit will be emphasized and the early findings from the LOAs discussed by using Cambodia as a case study. The fifth section suggests the way forward with policy recommendations and additional potential actions, and the last section concludes.

5.2. Setting Up the Context

Historic Agricultural Advantages

For about a century, the GMS possessed a natural advantage in agriculture and rice production, compared to its neighboring island economies of Malaysia, Indonesia, and the Philippines (Dawe 2013). The GMS economies share common natural endowments suitable for agriculture production, a contiguous arable landmass with

porous borders, and good river systems such as the Mekong and the Ayeyarwady rivers that also serve for transport between and among the GMS economies. Through more business-friendly policies in terms of foreign direct investments, trade, and connectivity of agro-based supply chains, these natural advantages have been transformed into a comparative edge in agriculture production, spearheaded by more advanced economies such as the PRC, Thailand, and Viet Nam. The less-advanced agriculture-based economies (Cambodia, the Lao PDR, and Myanmar) are catching up so that, overall, the GMS economies have become net suppliers and exporters, particularly of rice and many agriculture products.

Growth in the agriculture sector has contributed to steadfast and strong expansion of the GMS economies in the last 2 decades, resulting in a decline in the share of agriculture's gross value added and a rise of that of the services and industrial sectors. Economic growth has averaged 7.5% per capita annually since 1992 and is characterized by rising intra-trade in the GMS. Poverty has declined significantly in Cambodia and the Lao PDR largely because of the dynamic expansion of agriculture and rice production—63% of Cambodia's poverty reduction was linked to the robust growth of its rice subsector and the liberal trade that boosted its rice export potential, and about 44% of the Lao PDR's poverty reduction was due to the growth of its agriculture sector (World Bank and IFC 2016). Incomes have risen, resulting in the emergence of the more affluent middle and urban residents, with the urbanization growth rate averaging 3% yearly.

Cost of an Agro-Industrial-Compromised Environment

Agriculture growth in the GMS has been attributed to the efforts of the “Green Revolution,” wherein dramatic increases in food production were accelerated through an intensive model of agricultural inputs, introduction of new varieties from research and development (R&D), availability of synthetic fertilizers and pesticides, increased availability of formalized irrigation schemes, and greater focus on agricultural extension services. While the supply has not entirely matched the demand, with surplus in some areas and seasonal to chronic food insecurity in some undeveloped regions, the achievements of the Green Revolution are outstanding, resulting in higher staple productivity and more stable food prices (FAO 2004).

While the Green Revolution pathway has successfully achieved an astonishing turnaround in food production and productivity globally and in the GMS, it has come at a high price. The major challenges concern equating sustainable resource use with greater productivity. The negative result of high-input agriculture has included

impacts on the biology of waterways, degradation of arable land, serious degradation of groundwater quality, and threats to human health.

Rice production is also the second-largest emitter of greenhouse gases (GHGs) from agriculture, contributing about 10% of GHG emissions, with more than 90% coming from Asian agriculture. Mitigation and adaptation measures are urgently required to abate the adverse environmental effects of climate change.

The predominant smallholder farming methods in the GMS present a case in point of the unsustainable pathway of production. Existing smallholder farming systems are commonly based on a very rudimentary approach to intensive cultivation, routinely growing a limited range of species, having incomplete or limited knowledge of soil nutrient cycles and plant requirements, requiring very labor-intensive methods when delivering supplementary irrigation, and generally lacking knowledge about safe and appropriate pesticide and herbicide usage (often promoted by unscrupulous traders). The combined negative impacts of the predominant cultivation practice are profound, most particularly on soils through excess nitrogen dispersal, which ultimately leaches into water bodies and the atmosphere. In addition, providing supplementary irrigation on cropping areas can absorb up to 3 hours a day for smallholders, a labor requirement that increasingly falls upon women.

Out-migration from rural areas to larger urban areas is increasing, particularly of younger men chasing more lucrative employment. This has also included leaving for employment in other countries. The ripple effect of this change has seen a diminishing supply of male labor in rural areas. This has cast more responsibility onto the shoulders of women, who, more than ever before, carry the burden of the agricultural cycle. As a result, the need for labor saving initiatives that are also gender sensitive is critical.

Weak Links for Small-Scale Farmers

Small-scale farmers, especially in the less-developed GMS economies (Cambodia, the Lao PDR, and Myanmar), are weakly linked to the end markets, resulting in their receiving lower shares of the agro-based value addition. The lack of cooperatives, which could combine small production quantities into larger volumes, also prevents farmers from reaping the benefits of successfully intersecting with the market and operating sustainably.

Sustainability of SEAP supply equally hinges on the profitability of small-scale farmers and small and medium-sized enterprises that handle the post farm activities. More

efficient and effective value chain links that enable farmers to respond to the changing consumer preferences will be instrumental. Effective partnerships of the public and private sectors as well as bilateral agreements with the advanced GMS economies may be strategic for building these value chain links, especially in R&D for sustainable production branding and marketing, and food safety.

The synergy between food safety and sustainable management of natural resources for agriculture is becoming increasingly pronounced. The Southeast Asia Region is second to the African Region in death rates, including among children under the age of 5 years, from unsafe food produced by a combination of overuse of fertilizers, pesticides, and herbicides, and poor water quality (Aktar et al. 2009).

The Value of a Shift to SEAP

Shifting to high-value, safe, good quality, and environment-friendly agriculture products may be a good strategic move for the GMS economies, especially for the less-developed ones. The envisaged 5-year GMS Strategy and Siem Reap Action Plan's focus on value chain development, food safety and quality, and climate-friendly supply chains is in the right direction. Trade and value chains of the less-advanced economies are increasing their ties with the more advanced PRC, Thailand, and Viet Nam and are paving the way for stronger economic connectivity. The regional and global demand from fast urbanizing and industrializing economies for safe, good quality, and sustainably produced agriculture food products is rising phenomenally, offering opportunities for locally produced and "no-frill" agro-based products.

5.3. A Holistic Approach to Sustainable SEAP

Sustainable Agriculture, Climate Smart Agriculture, and Food Safety

There is a large body of literature regarding sustainable agriculture and how to achieve and maintain it. From the physical perspective, answers to the core questions revolve around themes of resource stewardship and a balance of inputs to outputs. However, the overwhelming common element in successful practice of sustainable agriculture is farmers working in groups, sharing knowledge, adopting new practices, and maximizing postharvest benefits (Pretty 2007; Leach et al. 2012; Scoones 2009).

The negative effects of high-input agriculture can place unsustainable pressure on resources. To achieve the CASP2 vision for SEAP, there is clearly a need to explore alternative approaches to farm production, ones that (1) maximize production of limited resources; (2) combine to prioritize and facilitate inclusion and greater opportunities for poor families, and, at the same time (3) improve land and water management and assist in nurturing greater climate resilience. The array of sustainable practices should aim to contribute within a holist cross-cutting landscape approach—one that includes environmental, economic, and social dimensions. Focus is needed on resource conservation and stewardship and the implications that can impact the whole environment. This includes the physical and the social issues associated with agriculture, geographic and biologic diversity, gender inclusion, and the growing niche markets generated by (for example) ecotourism.

A sustainable agriculture strategy that tackles sustainable food security within the context of climate change is termed “climate-smart agriculture” (CSA). CSA aims to tackle three main objectives: (1) sustainably increasing agricultural productivity and incomes; (2) adapting and building resilience to climate change; and (3) reducing and/or removing GHG emissions, where possible.

CSA activities include good agricultural practices (GAP), which promote specific ways to produce food for consumers that is safe and wholesome. GAP addresses environmental, economic, and social sustainability for on-farm processes. The objectives of GAP codes, standards, and regulations (Chan 2016; FAO 2011) include

- ensuring the safety and quality of produce in the food chain;
- capturing new market advantages by modifying supply chain governance;
- improving natural resource use, workers’ health, and working conditions; and
- creating new market opportunities for farmers and exporters in developing countries.

GAP is supported by “Good Handling Practices,” which are voluntary audits that verify that fruits and vegetables are produced, packed, handled, and stored as safely as possible to minimize risks of microbial food safety hazards (FAO 2008). In addition, rolling out a participatory guarantee system (PGS) provides members with a mechanism to voluntarily agree on a set of standards, a process that eclipses the expensive and time-intensive steps of gaining organic certification.

Sustainability Tools

The GWM and NUE technologies and practices are key tools for sustainable agriculture that are CSA compatible, and have been test-cased under the CASP2.

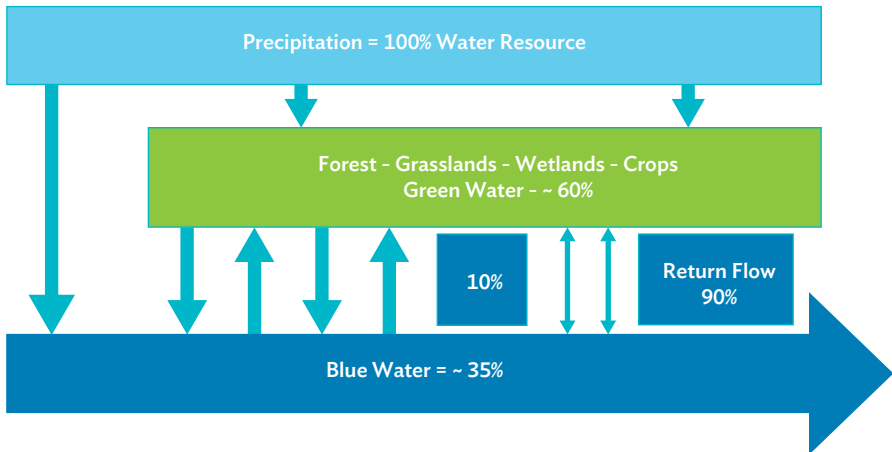
Soils contain a combination of four components: mineral matter, which makes up the largest proportion; water and air, which are present in roughly equal volume; and organic matter, the smallest but most dynamic soil component (Roychowdhury et al. 2013). The CASP2 activities placed a large importance on the relationship between mineral matter, water, and organic matter (GWM) and the components that deliver nutrients through minerals and organic and inorganic matter (NUE). Water, nutrients, organic matter, and minerals service a considerable amount of plant requirements. Maintaining soil health, as with any resource, requires regular monitoring and maintenance, particularly when the annual cycle of production is an exercise in extraction. Where nutrients and moisture are constantly being used, they need to be replenished, and sustainable farming practices aim to do this.

The interrelationship between GWM and NUE and their combined potential impact on sustainable agriculture can be expressed from a number of perspectives:

- promoting the prism of soil health and its importance for sustainable agricultural output throughout the GMS, most particularly for rainfed agriculture;
- the threat that overuse of nitrogen has as a GHG, as well as on people's health;
- the relationship of agriculture and its contribution to global concerns of climate change; and
- for maximum impact, farmers benefit from working in groups (such as the PGS).

Green Water Management

GWM encompasses practices that improve stewardship of a critical resource in all farming systems, but most particularly in rainfed ones. Globally, rainfed agriculture constitutes over 80% of the world's agricultural area and produces 62% of staple foods. It is estimated that food from rainfed areas will need to meet 75% of the global increase in food production required to avert hunger. Water scarcity faces nearly 60% of humanity and, with demand for water fast outstripping its supply, efficient and effective water management technologies and practices are needed to ensure that present and future generations have sufficient water (Mekonnen and Hoekstra 2016).

Figure 5.1: Green and Blue Water and their Links

Source: Based on Fallenmark and Rockstrom (2010).

Conceptually, green water constitutes 65% and blue water 35% of freshwater resources. Figure 5.1 illustrates the link of the two types of water. The green water rainfall footprint provides essential moisture, which is stored in the root zone of the soil and is evaporated, transpired, or incorporated by plants. It is particularly relevant for agricultural, horticultural, and forestry products. Green water also performs critical “environmental services” across all landscapes. The blue water footprint is water that has been sourced from surface (rivers, lakes) or groundwater resources and is taken from one body of water and returned to another.

The amount of green water available and the efficiency of its use is a product of two things: (1) the occurrence of rain events and the capacity of soil to capture and store that rain, and (2) appropriate farming practices that can optimize this precious resource. Green water plays the role of replenishing soil moisture from precipitation and is used by plants via transpiration. To understand the importance and potential of GWM, compare it conceptually against blue water management, which overwhelmingly receives the greatest share of attention. Table 5.1 summarizes the major differences between the two at a resource planning and design level.

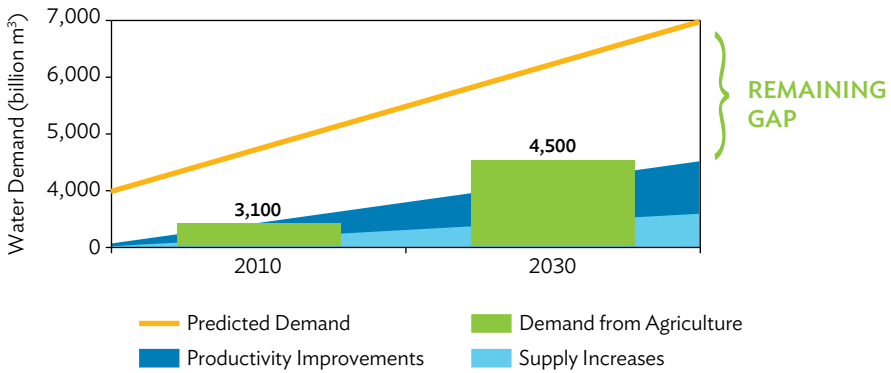
Table 5.1: Conceptual Differences between Blue and Green Water Management

| | Conventional Blue Water Management | Green Water Management |
|------------------------------|---|---|
| Resource Planning and Design | Macro-scale plans and optimization at a broad river basin level. | Micro-scale focus at the local farm level, from river basin and catchment to the farm unit. |
| | Large-scale integrated water resource management. | Small-scale optimization of land and water resource management |
| | Macro resources: water in rivers and aquifers and crop efficiency maximized with permanent water. | Micro resources: opportunistic harvesting of rainfall, micro reticulation, and agronomic enhancements. |
| | Planning focus on water allocations for irrigation, industry, and domestic water supply. | Basic extension of management options from rainfed to supplementary irrigated agriculture. Emphasis on small rice/vegetable production enterprises. |
| | Institutionally managed supply to multiple farmers. | Single-farm driven utilization of harvested water for multiple uses. |
| | Design requires high-level engineering for impounding and controlling water flows | Design and implementation are farm-based; a convenient harvest pond and distribution system. |
| | Constant supply, on demand as per agency. | Initiating greater seasonal opportunity through supplementary irrigation. |
| | Labor required to access supply. Supply extends period and amount of water availability. | Major labor saving compared with previous methods; however, no water, no crop in dry season |
| | Estimated share of farm production using brown water management across the region is 25%. | Estimated share of farm production using green water management across region is 75%. |

Source: Anthony G. McDonald.

The gap between the amount of water available and the demands for its use has been growing, and as population continues to rise the demands on water will increase. Globally, water scarcity currently affects over 2.7 billion people for at least 1 month each year, and projections using current trends without changes indicate that the gap between supply and demand will be a global challenge (Hoekstra and Makonnen 2011). Figure 5.2 illustrates the aggregated growth and water deficits that can be expected up to year 2030 compared to 2010. This deficit can only be made up by more astute use of existing resources. GWM aims to do that.

The water footprint over production and harvest areas is a credible indicator on which to assess water use efficiency, and GWM aims to make more efficient use of that rainfall. Due to the large rainfed character of the farming system in the GMS, the subregion can be considered to have a very efficient footprint where the soil productivity is generated by green water. The techniques promoted as part of the GWM initiative offer a broad spectrum of measures that can be applied to address this anticipated deficit.

Figure 5.2: Projected Water Deficits Based on Current Demands

m³ = cubic meter.

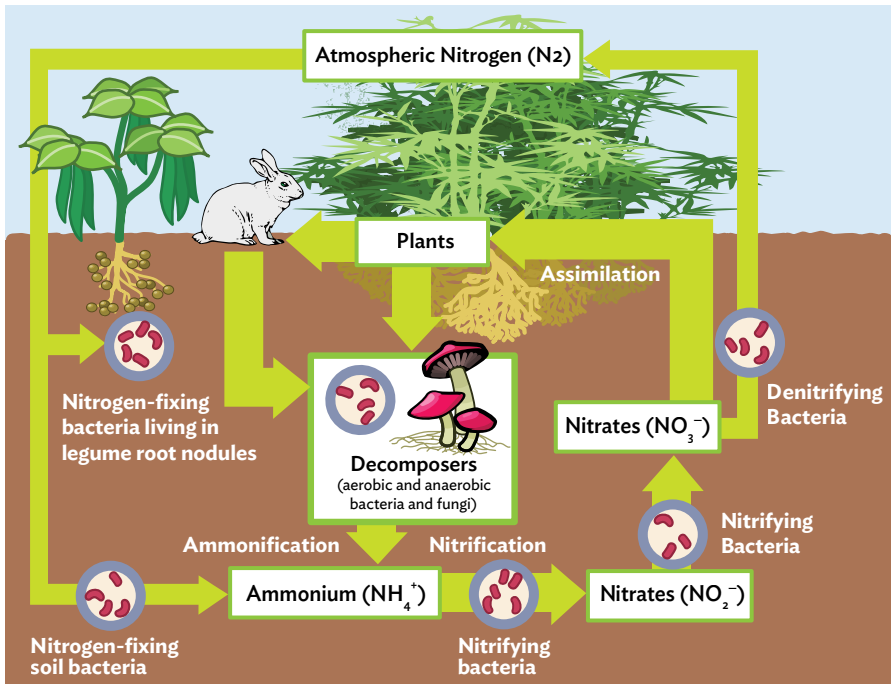
Source: Based on Farming First. Sustainable Development Goals Toolkit. https://farmingfirst.org/sdg-toolkit#section_2

Nitrogen Use Efficiency

NUE provides an additional platform of actions that can contribute to improving the production of SEAP. The accelerated use of artificial nitrogen fertilizer in the GMS has greatly increased food production. Increased use of inorganic nitrogen fertilizers can take credit for reductions in starvation and famine in many parts of the world, especially in Asia in the last decade; indeed, nitrogen fertilizers have bridged the gap between malnutrition and adequate diet (Roy et al. 2006). Nitrogen is a component of chlorophyll, the compound plants use to convert sunlight energy to produce sugars from water and carbon dioxide, and thus complete the important process of photosynthesis. The nitrogen compounds cycle through the air, the aquatic systems, and soil, and globally the nitrogen cycles have been altered more than any other basic element cycle. Efficient use of nitrogen is generally site-specific and can vary by soil type, cropping regime, climatic conditions, incidental weather events, and localized ecology. The natural nitrogen cycle and its compounds are interconverted in the environment and in living organisms. Knowing the baseline soil status along with the specific crop need is important. Plant requirements and benefits derived from inputs of nitrogen follow a bell curve, and overuse can have detrimental effect on soils, water bodies, and human health.

The nitrogen cycle is one of the most important nutrient cycles found in terrestrial ecosystems. Figure 5.3 illustrates the complexity of the nitrogen cycle, and the important function it performs. Living organisms use nitrogen to produce a number of complex organic molecules such as amino acids, proteins, and nucleic acids.

Figure 5.3: The Complexity of the Nitrogen Cycle



Source: Johann Dréou. 2006. (User:Nojhan), translated by Joanjoc from Image:Cycle azote fr.svg. https://commons.wikimedia.org/wiki/File:Cicle_del_nitrogen_ca.svg

When any element is altered at rates above ecological or agronomic needs, the result can become an environmental concern, leading to a host of problems, ranging in this case from eutrophication of terrestrial and aquatic systems to soil acidification (Vitousek et al. 1997). Excessive nitrogen use will manifest quickly in the basic aquatic food chain or ecosystem. In addition, high nitrate concentrations accumulate in the edible parts of leafy vegetables, particularly if excessive nitrogen fertilizer has been applied (Science Daily 2008). Consuming such crops can harm human health (Liu et al. 2014). Such impacts are the result of nitrogen being used at the wrong time, at the wrong rate, and put in the wrong place or in the wrong form.

NUE aims to be a workable indicator to assess and monitor sound fertilizer use and can be described as the fraction of fertilizer nutrient removed from the field through the crop harvest. The goal is to optimize nitrogen's beneficial role in sustainable food production and minimize nitrogen's negative effects on the environment. Successfully addressing NUE contributes to SEAP and value addition manifesting as improved farmer income.

The provision and delivery of SEAP to end markets can be vastly enhanced by combination of (1) GWM and NUE approaches, (2) enhanced by PGS as a means of consolidating farmers producing environment-friendly agriculture products, and (3) the tools coupled with the tools that ensure food safety from production (GAP, PGS, and Good Handling Practices) to midstream value chain segments of agro-based value chains.

Toward a Holistic Landscape

Growth in Demand for “Clean and Green.” Continued economic growth across the GMS and the emerging greater numbers in the middle classes have led to changes in the market demand for food, particularly for fruit and vegetables with “clean and green” characteristics. This includes demand for items that may be “organic” by certification; free from overuse of or contamination by herbicides or pesticides; and, in a highly subjective way, considered in the market place to be more flavorful. The growth in market demand for “clean and green” across the GMS is currently anticipated at 12.5% yearly, and as household incomes increase, the drivers of the growth will only increase in profile and number (Far Eastern Agriculture 2017).

This demand is being driven by families in their homes, in restaurants, and in hotel kitchens across the subregion. The demand assumes that farmers will be committed to responsible production of food, where the physical resources and the output are treated with business acumen combined with the aforementioned stewardship.

Food production therefore has to increase to meet the demand of a growing population as well as the change in the market expectations. In light of high energy costs and finite resources, future agricultural systems have to be more productive, and adoption of practices such as GWM and NUE will contribute to this. The question that can therefore be posed is: How can we improve resource management while maintaining productivity within what is seen as a highly dynamic set of variables?

A Holistic Landscape—Value Chain as a Cycle of Trust

To increase the availability of SEAPs there is a clear need to address both the supply and demand sides of the entire agro-food equation, as well as to promote efforts that place practical importance on achieving environmental sustainability goals. It is clear that clean and safe produce will come from environments that are agriculturally and environmentally sustainable. To achieve both, a holist approach is

necessary: at one end of the spectrum, soil health is an indicator; at the other end, it is sustainable markets. The CASP2 approach has targeted understanding and improving both the supply of and demand for SEAPs, while contributing to improved farmer livelihoods. The conceptual approach being put forward is one of an interactive web of relationships, where the value chain is underwritten with the important link of trust and confidence among all the players in a cycle. It assumes a sharing of knowledge as well as an appreciation of the contribution of other players in the cycle.

Linking All the Variables in the Cycle

Figure 5.4 aims to illustrate both the simplicity and the complexity of the food cycle from farm to consumer plate and assumes sustainable land-use practices by farmers whereby they produce SEAPs and deliver them to consumers who appreciate the importance of “clean and green” food. This further assumes an understanding at the farm level that changing consumer demands present farmers with an opportunity to be rewarded for embracing change, as well as a scenario of “continuous improvement.” Figure 5.4 is not so much a value chain, but a values cycle—where all the key four nodal points have an influence and a relationship with each other: (1) food production, (2) postharvest logistics, (3) market demand, and (4) consumer confidence.

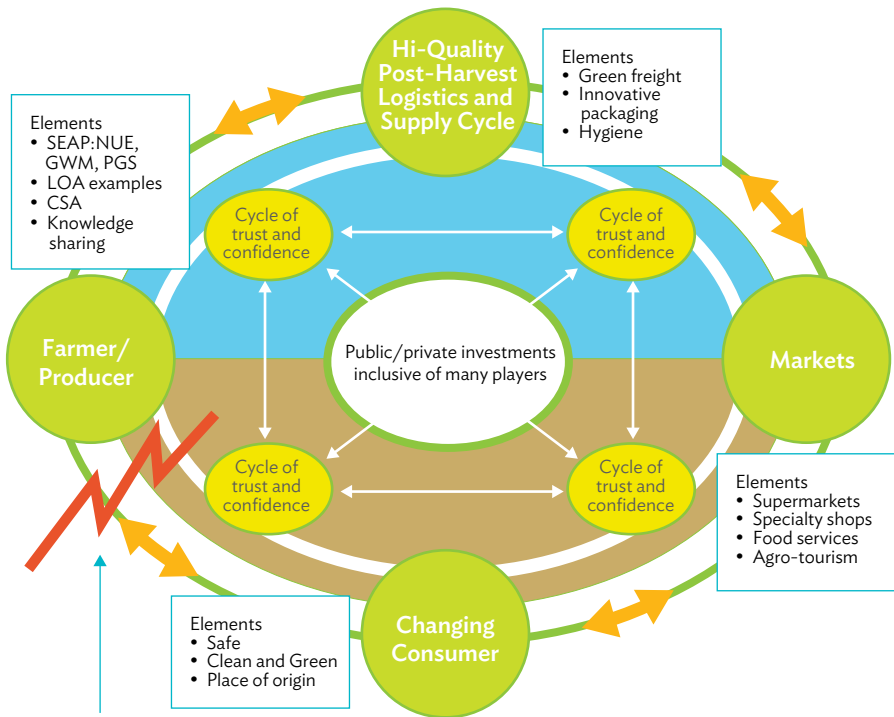
Figure 5.4 emphasizes the importance of linking all the variables, and presents this as a process, a cycle where each step, to be successful, requires a firm degree of trust and confidence in the players in the cycle, and where, increasingly, the link between consumers and farmers, although not as well established as the other links, could have a large impact on the production and supply of SEAPs, most particularly where farmers achieve a growing demand and greater return for their efforts. The red lightning bolt aims to illustrate a current gap in the link between consumers and farmers, a gap that when bridged has increasingly been acknowledged in European and North American markets as a driver of change at the farm level. To successfully facilitate and strengthen this highly dynamic and interrelated cycle requires that all the players involved have a role, including of course the public and private sectors.

The market, which wants to respond appropriately to the growing change in consumer demand, must have trust and confidence in the on-farm efforts to produce high-quality, safe food for consumption. The market will recognize this effort with a greater demand for a product and will potentially pay a higher unit price.

The conceptual roles of each player in the cycle are logical. What has become increasingly apparent is that effective linkages and partnerships between private and public players can very quickly foster and facilitate opportunities for greater SEAPs. An

additional significant factor—and one considered to be growing with huge potential—is associated with tourism and the role it plays in the food values cycle. Apart from the simple increase in arriving tourists who need food, the cycle recognizes that many travelers want to engage in cultural experiences such as, for example, the growing number of visitors interested in an authentic culinary experience, or wanting to “give back” to local communities, a phenomenon increasingly referred to as agro-tourism where people visit or stay in a rural/farming community and become familiar with the production cycle.

Figure 5.4: From Farm to Plate and Back to Farm



The existing farmer-consumer link is tenuous but will emerge as a solid influence and stimulant for ongoing change at farm level

CSA = community supported agriculture, GWM = green water management, LOA = letter of agreement, NUE = nitrogen use efficiency, PGS = participatory guarantee system, SEAP = safe and environment-friendly agro-food product.

Source: Anthony G. McDonald.

5.4. Green Water Management and Nitrogen Use Efficiency Experiences

State of Play

Agriculture in the GMS is the cornerstone of many families' livelihoods; however, agricultural intensification, large-scale monoculture cropping, and the inappropriate use of agrochemicals have incurred a high environmental cost, especially land degradation, without significantly reducing rural poverty (ADB 2015). Agricultural production is also a climate change contributor, and in turn is directly affected by it through higher temperatures, seasonal shifts in rainfall, and rising sea levels, among other things. Given the growing population of the GMS and the associated increased demand for land and water for urban and industrial development, the subregion faces a high risk of increased food insecurity, and the loss of potentially being seen as a food safety hub. Future agricultural systems will need to be flexible and diverse to withstand and respond to climate change; water shortage; low soil fertility; and other environmental, social, and economic drivers.

Water and Agriculture in the GMS

Using water efficiently is the key to future food security and food safety. Agriculture is by far the largest consumer of water in all GMS countries, estimated to account for 68% of total withdrawals in the PRC and Viet Nam and 98% in Cambodia (IWMI and Worldfish Center 2010). Despite this, the proportion of irrigated land used for agriculture in GMS countries is relatively low by world standards, ranging from 7% of total cropland in Cambodia to 31% in Viet Nam (World Bank 2009), and approximately of 75% production is rainfed. Agriculture in the GMS is thus particularly vulnerable to climate change, with significant risk from floods and droughts even under current climate conditions. Safeguarding production will require improved water management in both rainfed and irrigated systems (IWMI 2010).

In many areas, introducing formalized irrigation is not technically or economically feasible, so improving on-farm water management is essential. Using conservation farming or climate-friendly techniques, plus harvesting and storing run-off on farms can achieve this (IWMI 2010). As outlined in the previous section, the practice of harvesting rainwater, using the stored water for crop irrigation with water saving techniques, and subsequent improvement of soil properties to increase water absorption, retention, and nutrient availability are among activities that cumulatively contribute to what is called GWM.

Soil Fertility Management

Nearly 65% of the soils in the GMS have physical and/or chemical limitations on their agronomic use for crop production. The important soil constraints include shallowness, poor structure and high incidence of stones and rocks, low fertility, acidic pH, and low availability of phosphorus. About 25% of the GMS soils comprise the region's key agricultural soils. The inherent fertility of these soils varies from low to moderate in most cases (ICEM 2015).

People and governments in the GMS are working to develop agricultural practices that simultaneously conserve land and water resources, mitigate environmental impacts, increase resilience to climate change impacts, and increase the productivity and profitability of agriculture, particularly for small-scale farmers. There is an urgent need to manage soil fertility if food production is to meet the increasing demand for safe and environment-friendly product. Annual cropping regimes such as rice deplete soils of nutrients, and thus there is a need to replace them as a part of the growing cycle. Nitrogen is an essential element and improving the efficiency of its use to increase economic return and help mitigate climate change has a critical role to play in SEAP production.

Testing Sustainable and Climate-Smart Agriculture Innovations

Beginning in 2015, CASP2 introduced the first round of LOAs for delivering CASP2's Output 3, the adoption of gender-responsive SEAP. This first round was implemented by the GMS governments between mid-2015 and the end of 2016. The following has been achieved:

- (1) 162 demonstration and pilot sites were set up, comprising good agronomic practices on climate-friendly agriculture and PGSs;
- (2) more than 80 training activities were held at regional, national, and local levels, coupled with field visits for farmer-to-farmer learning, with over 6,000 farmer participants (35% of them women) being trained in CSA practices;
- (3) simple sheds in some of Myanmar's demonstration farms served as multipurpose meeting places for capacity building activities; and
- (4) extension-related communication materials and visuals were produced.

A set of subprojects under the LOAs included piloting the use of the PGS as a mechanism for quality certification of smallholders' organic products and linking them to new market opportunities. About 16 PGS pilots were developed with technical assistance support through IFOAM, the internationally known organization on PGS.¹

¹ The International Federation of Organic Agriculture Movements (IFOAM Organics International).

Progress reports on the subprojects recorded some positive economic impacts, including reduced farm production costs (especially from reduced agrochemical use) increased turnaround of farm produce, and improved incomes. Environmental benefits included improved soil nutrient levels and physical conditions, improved pest resistance, and more efficient water use.

The outcomes reported come from a very short period of time. Because of the nature of agriculture and the variables involved, a little more than a 1-year implementation period is not sufficient for claiming a rigorous method and findings, or objectively determining if the demonstrated experiences provide justification for scaling them up or replicating them. While there are no agreed criteria for identifying whether the activities are suitable for up-scaling and replication, and the specific roles of government, private sector, and other institutions could vary by country and crop, certainly all signs indicate support for scaling up.

GAPs gleaned from the pilot trials pertain to

- reduced use of agrochemicals (including synthetic or chemical fertilizers, pesticides, and fungicides);
- enriched soil fertility by applying compost (including bokachi compost, biochar mixed with animal manure and compost, and vermiculture compost);
- application of liquid biofertilizer (including fish amino acids, fermented fruit juice, and liquid from vermiculture);
- application of liquid biopesticides to control insect pests (including biopesticides made from ginger, chili, tobacco, and neem);
- application of beneficial fungi to control fungal disease (including *Trichoderma* fungi to improve seedling resistance to disease);
- promotion of multiculture (including crop rotation, integrated farming with crop and livestock or fisheries) to replace monoculture; and
- lessening of soil erosion from rain and improvement of soil moisture retention (e.g., through mulching, increasing soil organic matter by applying compost, and planting wind breaks such as bamboo).

Green Water Management and Nitrogen Use Efficiency

Following the assessment of the first trials, which identified lessons and developed recommendations, the way forward was identified. LOAs for Cambodia, the Lao PDR, Myanmar, and Viet Nam have been amended to initiate GWM practices, and additional funds were earmarked for the three countries to undertake NUE activities.

Associated with these two initiatives has been the promotion of biochar use for soil enhancement and carbon sequestration and promotion of organic farming. An important step has been the successful formation of PGS groups, which have strengthened farmer group engagement. There are numerous overlaps and reinforcing commonalities between these initiatives, which can all combine to achieve the SEAP vision. Tables 5.2 and 5.3 summarize the specific GWM and NUE activities.

As identified in Table 5.2, GWM activities have included construction of on-farm rainwater harvesting structures, introduction of water saving irrigation facilities, and innovations to minimize water loss through evaporation by using windbreaks (Mayaud et al. 2017). Plants that improve water surface cover and soil surface transpiration (mulching) were also promoted. In addition, GWM includes climate-friendly practices learned from the earlier work, such as applying biochar and biopesticides, using PGSs, and facilitating market linkages.

Table 5.2: Green Water Management Practices

| GWM Practices | Cambodia | Lao PDR | Myanmar | Viet Nam |
|--|---|-------------------|------------------|-------------------|
| Farm Pond to Harvest Rainwater | ✓ | ✓ | ✓ | ✓ |
| Drip Irrigation | ✓ | Some | ✓ | Some |
| Windbreak Plants/Trees | ✓ | ✓ | ✓ | ✓ |
| Surface Water Cover to Minimize Evaporation Loss | Some water surfaces planted with water lily and morning glory | Not yet initiated | Under experiment | Not yet initiated |
| Fish Raising in Farm Pond | ✓ | ✓ | ✓ | ✓ |
| Diversified Farming with Crops, Livestock | ✓ | ✓ | ✓ | ✓ |
| Biochar Application | ✓ | ✓ | ✓ | ✓ |
| Compost Application | ✓ | ✓ | ✓ | ✓ |
| Biopesticide Application | ✓ | ✓ | ✓ | ✓ |
| Mulching | ✓ | ✓ | ✓ | ✓ |
| Participatory Guarantee Systems | ✓ | No | ✓ | No |
| Market Linkage Facilitation | ✓ | ✓ | ✓ | ✓ |
| Conduct Policy Study and Recommend Policy Directions | ✓ | ✓ | ✓ | ✓ |

GWM = green water management, Lao PDR = Lao People's Democratic Republic.

Source: Anthony G. McDonald.

Some innovations that are still being trialed, such as techniques to minimize evaporation loss (conducted in Myanmar) and growing water plants in ponds (conducted in Cambodia) will be useful for other countries, such as the Lao PDR and Viet Nam. The policy study on GWM will also enhance policy development to support the up-scaling of practices on a wider scale.

The NUE subprojects (Table 5.3) aim to identify innovations that can help reduce application of chemical fertilizer without affecting cash crop yields, while mitigating GHG emissions. Myanmar has proposed more detailed studies on GHG measurement and the effectiveness of applying neem cake to retard GHG emission. Neem cake is naturally made from the neem tree (*Azadirachta indica*); and was developed by Myanmar's Department of Agriculture, Ministry of Agriculture, Livestock and Irrigation (MOALI).

Table 5.3: Nitrogen Use Efficiency Practices

| NUE Practices | Cambodia | Lao PDR | Myanmar |
|---|----------|---------|---------|
| Crop: Rice | ✓ | ✓ | ✓ |
| Another Crop: Vegetable | ✓ | ✓ | No |
| Another Crop: Corn | No | No | ✓ |
| Split Application of N Fertilizer as Needed (vs. one-time application) | ✓ | ✓ | ✓ |
| Reduced N Fertilizer but Added Biochar | ✓ | ✓ | ✓ |
| Reduced N Fertilizer but Added Biochar and Manure | ✓ | ✓ | ✓ |
| Application of Neem Cake to Minimize N ₂ O Emissions | No | No | ✓ |
| Plan to Measure CH ₄ and N ₂ O Emissions from Different NUE Practices | No | No | ✓ |
| Conduct Policy Study and Recommend Policy Directions | ✓ | ✓ | ✓ |
| Market Linkage Facilitation | ✓ | ✓ | ✓ |

CH₄ = methane, Lao PDR = Lao People's Democratic Republic, N = nitrogen, N₂O = nitrous oxide, NUE = nitrogen use efficiency.

Sources: Letters of Agreement project proposals for implementing the Nitrogen Use Efficiency initiatives in Cambodia, the Lao PDR, and Myanmar as part of the Core Agriculture Support Program Phase II (ADB 2012).

To enhance up-scaling of good practices in NUE, a policy study with recommendations is being carried out in all participating countries.

In addition, and based on the experience from the first trials, there have been regional initiatives to promote regional knowledge and resource sharing across the GMS, facilitated by the Working Group on Agriculture Secretariat.

- (1) A regional NUE training workshop was held in Guangxi, PRC, for 25 participants—five each from Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam.
- (2) A regional GWM training workshop was held in Kunming, PRC, for 15 participants—three each from Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam.
- (3) Regional training on biofertilizer and soil management was provided in Bangkok for senior government officials in the six GMS countries, for approximately 20 participants.
- (4) A regional training-of-trainer course on biofertilizer making and application was held in Bangkok for 60 participants from the six GMS countries.

Additional bilateral initiatives by individual countries include the Thai Department of Land Development providing

- (1) exchange of knowledge and experience for soil doctors in the Lao PDR, and
- (2) technical assistance in the development of a soil museum for Myanmar participants.

Additional Findings

Despite the limited samples, CASP2 has demonstrated appropriate pathways to support more sustainable farm production practices, especially for high-value crops such as fruits and vegetables. While some countries have been observed to adopt the practices quickly, others have done so more slowly. Not all member countries have been embarking on the same activities. The more agriculturally advanced economies such as the PRC and Thailand have shared learning with and supported the other economies. This effective cross-border knowledge facilitation for expanding SEAP practices is critical and ongoing. A brief summary of activities follows.

The PRC Workshop in Nanning gave 26 representatives an intensive discourse on efficient fertilizer use; the cycle of major and minor elements; improved utilization rate of chemical fertilizer and pesticides through R&D; application of biological fertilizers and pesticides; the importance of fertigation, composting, and management of soil and water conservation; and the importance of the “4Rs practices” of nitrogen management—right product, right rate, right time, and right place—and techniques to measure GHG in the field, and integrated management of nitrogen and ways to measure it in rice growing regimes. The messages of this NUE seminar included the need to promote

- climate-friendly agriculture through a market-based strategy to ensure food security, while rewarding farmers for their ecosystem services;
- a harmonized certification system for food produced across the GMS; and
- agriculture as a leader in providing clean renewable rural energy through efficient use of biomass for bioenergy, while ensuring food security.

In Viet Nam, the Institute for Agricultural Environment applied different mitigation techniques in pilot farm trials including (1) recycling crop residues to reduce fertilizer use, and (2) identifying appropriate farming techniques to sustain yields and rice incomes while improving soil fertility and reducing GHG emissions. The Institute for Agricultural Environment also trained rice farmers to shift from conventional rice production dependent on agrochemicals to use of biofertilizer (including biochar) from recycled crop residues. The key findings generated from the research-cum-extension work were that

- rice farmers currently use large to excessive amounts of fertilizers, mainly urea, and a compound fertilizer of nitrogen, phosphorus, and potassium, (NPK);
- a majority of farmers were aware of biochar and composting but few used them;
- farmers were aware of climate change—the increased frequency of flooding, drought, and salt intrusion in farmland;
- farmers were not knowledgeable regarding the contribution that an appropriate mix of synthetic and biofertilizers could offer their farming practices;
- application of biochar and compost increased plant yield by 2.7%–14.5% over the conventional approach of intensive agrochemical use in rice cultivation; and compost mixed with 75% NPK yielded the highest productivity rise, followed by biochar mixed with compost and NPK;
- among the four treatments examined, combined composting and biochar increased yield significantly over the conventional rice production method using only NPK; and
- GHG emissions declined significantly when biochar was mixed with 75% NPK, followed by the composting and biochar method.

Thailand has supported volunteer soil doctors in the Lao PDR by training the volunteers with a specific focus on improving vegetable and rice production. Laotian farmers were trained with hands-on practical sessions and returned to their communities to assist fellow farmers to adopt the practices they had learned. Establishing and maintaining soil health requires baseline data and knowledge of what farmers should be aiming. This may be accomplished through assistance such as from the Volunteer Soil Doctor program, and should be a high priority in member countries serious about sustainable agriculture goals.

The Lao PDR and Myanmar have both been active participants in the program. Myanmar has adopted some solar energy for pumping, an initiative that has applications elsewhere.

The Agricultural Information Network Services (AINS) is a knowledge platform supported by CASP2. Information on AINS can be freely accessed by all participants in the values cycle. AINS can provide farmers with a source of agronomic and market information and can link farmers directly to consumers. AINS can help disseminate the benefits from the trials and information about the steps taken and the practices adopted. The service has to be relevant and accessible to farmers, and the next iteration of AINS aims at that.

Institutional Issues and Legislation—public agencies in the GMS are committed to expanding good agronomic practices and the value chains of safe and environment-friendly agro-based products. Some countries (the PRC and the Lao PDR) have national policies to encourage promotion of biofertilizer and regular organic markets in urban areas. In other countries, legislation for organic and reduced agrochemical farm production is being prepared, including disseminating the potential of promoting the PGS nationwide. If the GMS wishes to emerge as a SEAP producer, GMS governments need to develop appropriate policy, legislation, and ways to facilitate change using public–private partnerships. Having safe places of production applying sustainable agricultural models is one starting point.

Cambodia as a Case Study

To communicate the range of issues found and the early findings and achievements of the trials, activities observed in Cambodia are presented as a case study. Cambodia's office of the National Secretariat Specialist responded promptly to the LOA requests, and thus implementation has progressed well in the country. As Tables 5.2 and 5.3 indicate (pp. 143–144), Cambodia has been pilot testing almost the entire range of activities. The successful expediting of implementation is attributed to clear presence of strong and enthusiastic ownership by government agencies at national, provincial, and district levels; careful selection of farmers with whom to collaborate; and the attentive and vigorous approach taken by the National Secretariat Specialist's officer.

Although the timelines have been short, the innovations introduced by the LOA pilot subproject have resulted in positive outcomes, with increased yield and lower economic costs for farmer inputs. Activities that are still at early stages demonstrate all the initial signs of success as well. The activities have targeted predominantly poor smallholders, who have benefited from positive economic and social outcomes through the introduction of a variety of climate-friendly and gender-sensitive agronomic practices, and to that end the trials have been successful.

The observations and findings that follow (1) describe and present the GWM and NUE outcomes, (2) discuss the postharvest issues associated with “clean and green” qualities that SEAPs aim for, and (3) outline some marketing issues identified by traders interested in SEAPs and the role that PGS has played in addressing the issues.

Green Water Management

As previously noted, the GWM activities combine improved water harvesting, water storage in on-farm ponds, and strategic use of pumps, drip reticulation, and windbreaks, all of which combine to open a productivity and small enterprise window. For many smallholders, such a window was previously nonexistent, and, if used well, could improve the vigor and health of soils.

Improved GWM has been shown to provide smallholder farmers with the ability to store and reticulate water for supplementary irrigation using simple and highly effective drip technology. For a small investment of about \$500, farmers in Cambodia have been establishing farm ponds, dug by excavator and compacted and/or plastic lined. If deep enough (~5.0 meters) and well lined, the ponds can hold sufficient water for supplementary irrigation, providing an opportunity for additional dry season cropping. Farmers have achieved a dramatic increase in household incomes from an area as small as a 10x10 meter plot. The investment in micro-irrigation equipment is commonly paid back in the first year of its use (Charlesworth 2017).²

Farmers have been enthusiastic about adopting the technology supported by the project, and others have moved forward on their own initiatives. One farmer in Tboung Khmum explained that although he had not received funds from the project, he organized a deal with the company building a district road to dig his pond and take the spoil for the road. A farmer in Battambang, who is currently an enthusiastic contributor to the GWM initiatives, described how he took nearly 2.5 years to dig his pond by hand, and that, as a result, his farm of approximately 0.2 hectares has been well-placed to take advantage of the supply of tanks and drip irrigation componentry from the project.

Due to its farm-based activity level, the GWM program in Cambodia has worked well to improve farm output and has promoted alternative pesticide use; biodigesters to maximize recycling of animal manure for energy; and vermiculture, which has had major soil benefits elsewhere. As a result of the small investments at the farm level, some GWM participants in Cambodia report they have doubled their household food production. The increased growth is occurring with a 2-hour per day time saving on watering of horticultural crops, which is primarily done by women. The GWM promotes mulching mediums, which can cut down the evaporation of precious soil moisture and reduce the need for weeding. In time, it will contribute to improved soil structure and help ameliorate the impacts of heavy rain events. By cutting back on labor, these initiatives assist greatly in offsetting the impact of labor out-migration from rural

² Philip Charlesworth (phbcharlesworth@gmail.com), in personal communication with Anthony McDonald (tony.mc@gms-casp.org), August 2017.

communities. The labor-saving facet is highly attractive to rural communities, most particularly for women.

Nitrogen Use Efficiency

NUE subprojects have been producing positive results, if less pronounced than those of the GWM. Achieving the inherent benefits of biochar requires longer lead times, the beneficial results are less obvious, and more time is required to measure benefits. However, early indicators are that results are positive and integration of both NUE and GWM elements will be highly beneficial over time.

In both Svay Rieng and Tboung Khmum, the Cambodian Agricultural Research and Development Institute has conducted field trials to reduce nitrogen application on rice and vegetables. Complete analysis of this research is not yet available, but early findings have identified that

- application of a biochar formula (50% = 2.5 tons per hectare [t/ha]) mixed with slurry or compost or cow manure (50% = 2.5 t/ha) provided better yield than biochar alone (5 t/ha) and the control (farmer's practice); and
- rice husk vinegar, a product of the pyrolysis process by which biochar is made, has been fermented and enthusiastically adopted by farmers for use as a natural pesticide.

Findings from biochar work elsewhere include that yield and economic return vary by location and soil type. Time and careful R&D observation is required to identify the differences. Additional systematic research is needed to arrive at recommendations for site- and soil-specific biochar use. The current fieldwork by the Cambodian Agricultural Research and Development Institute supported by the CASP2 LOA projects, will contribute to this knowledge base.

The Cambodian work has revealed a difficulty in accessing sufficient rice husk for biochar production. This is because the larger rice mills are being approached by traders wanting to purchase large volumes of husk for export, particularly to Thailand. Thus, the value of this crop residue may be increasing with the emergence of businesses searching for inputs to produce ready-to-use organic/biofertilizer, and/or to use as co-fuels. The potentially greater availability of these products and natural/botanical pesticide by-products for selling to farmers should be evaluated. Cambodia would benefit from some support in this area.

Analysis of the entire country reveals hot spots that could benefit greatly from biochar use, and future work could look at this.

To conclude, the early assessment of the GWM activities is that they are collectively very cost efficient, most particularly for women farmers, offering greater efficiency in water use, productivity, and market opportunities. Adoption of both GWM and NUE can assist farmers to produce more and higher quality crops. Much of what has been piloted could be expanded to numerous other provinces, especially areas that are biochar hot spots, and for niche fruit and vegetable markets for tourism. The steps ahead for GWM and NUE include the needs to

- continue to promote the benefits of GWM and NUE practices in a combined way, linking the on-farm improvements for sustainability with greater opportunity to supply SEAPs; and
- explore and adopt approaches that successfully assist in up-scaling ideas and activities that enable change across the whole of the cycle of values.

The last observation concerning both GWM and NUE is that the promotion of farmers' ability to access both these activities has improved their productivity. The critical next step is to secure access to stable wholesale and retail markets that recognize the value of SEAPs and ensure a premium price for them. While some farmers have been supported and have secured greater market access, it is a challenge for smallholders to play a viable role in the daily supply of vegetables and fruit in Cambodia. A major gap for farmers is access to markets that value farm produce and connection with the growing consumer demand. The next section will look at this vital step.

Postharvest

Numerous postharvest issues are important for smallholders in Cambodia, including

- (1) improved produce care, transport, and selling arrangements;
- (2) product loss and wastage across the supply and value chain; and
- (3) indifference of others in the value chain to the plight of smallholder farmers.

These issues are common and require attention because farm produce has a diminishing value over time. The more efficient and hygienic the postharvest period is, the better the produce and the return to the farmer. An indicator of continuing success therefore will be to secure improvements in produce care and the logistics involved in moving farm produce.

A small group of wholesale and retail traders in Phnom Penh confirm that shifts in consumer focus are part of a revolution that is looking to a smaller food production footprint, with localized origins and of higher quality. The need for supply of SEAP produce has been a major issue in Cambodia where there has been a very strongly held perception, particularly among the increasingly emergent and predominantly urban middle classes, that farmers overuse agrochemicals (Alliance 2015).³

Recent research to understand more about this issue surveyed five commonly eaten market vegetables purchased from a variety of Phnom Penh markets. The limited survey revealed that 75% of vegetables and fruits sampled contained no detectable residues; the rest was found to be contaminated with residue that exceeded the international standards (Alliance 2015). Although the Alliance study findings are highly qualified, the dimensions of inferior practices are potentially of great concern, and findings like this contribute to fracturing the trust required in the value chain and are a public health concern (Neumeister 2015). A retailer supplying GAP and SEAP produce in the Cambodian capital says that consumers “need to be confident food is cultivated, produced, and cared for during transport and at markets, and that it will be nourishing to consume.”⁴ The current situation of contaminated produce cannot continue if the GMS is to be recognized for producing SEAPs.

The need for a shift in the quality of market produce has also been the subject of major capital investment. The PRC recently opened a \$10.0 million laboratory in Phnom Penh dedicated to elevating food quality standards and is training staff to operate the sophisticated equipment that has been supplied. The ultimate PRC intention is to export good quality produce from Cambodia to the PRC. It is vital that mechanisms to improve farmers’ postharvest and logistical practices, monitor standards, and communicate improvements across the value chains be put in place. This issue is important for all consumers, not only for export opportunity to the PRC but for the daily food supply of all Khmer people. Additional market demand is also coming from other niche groups in Cambodia, for example the emerging ecotourism market with visitors who are keen to experience farming practices and want to have confidence in the quality of the food that they eat.

Potential Role of the Participatory Guarantee System

While Cambodians supply some vegetables and fruits to local markets, particularly at the district level in rural areas, the overwhelming supply for the major markets is

³ Alliance 2016 is a network of 7 European nongovernment organizations.

⁴ Neak Tharen, owner, Naturan Garden Company, Phnom Penh, in an interview by Anthony McDonald.

imported. Over 150 tons of vegetables are imported each day from neighboring countries, the bulk of which is sold in the private and informal wholesale markets of Phnom Penh and then redistributed to outlets in the capital city as well as the major provincial markets.⁵

Cambodian smallholders appear to play a tiny role in this supply chain because individually they lack the capacity and resources to produce the volume required and to maintain consistent quality, and they have limited postharvest logistical abilities and capacity. Further, at the farm, village, and commune level, the experience is that traders give the producers a mediocre to nil dividend for improving their product, providing limited incentive to do so. And payments for the produce are very slow to arrive.

However, farmers have acknowledged that membership in PGS groups and adoption of the PGS practices can assist them to improve cultivating practices and market their produce through the support and combined energy the group provides, along with the combined trust and confidence that follows. The PGS trial initiative could prove to be a very strong mechanism to address the issues Cambodian smallholders face.

PGS groups led by motivated lead farmers have been valuable in giving farmers direction and confidence. There are also Cambodian examples of positive collaboration with provincial agriculture departments assisting PGS groups at district and provincial markets where farmers, particularly women, have confidence in the process and, for example, in receiving immediate cash from sales. In this situation, the PGS groups have also developed logos for placing on their food items, and in two cases where LOAs have subsidized and helped to organize support for market space, farmers have successfully been able to market their produce. PGS groups have been able to get their produce to a provincial market, with their own members cleaning, presenting, and selling it, and the near 50% increase in returns is in their pockets within days and sometimes hours of the sales. This change has been almost revolutionary for these smallholders, who as a result enjoy increased pride and confidence in their abilities.

Improved marketing is now required to help raise the profile of the PGS production groups and the significance they bring to market. Greater and more informative use of signage where PGS foods are marketed has been used on a very small scale and could be greatly increased. Produce raised using GWM and NUE processes could be promoted with signage at markets, to “tell the story.” Telling the story behind each shop, the process, the enterprise, and the varieties—such as providing information on where the produce is from, how it is being raised, why this is being done, when it

⁵ Neak Tharen, owner of Natural Garden Company, Phnom Penh, interview with Anthony McDonald.

started, and who is involved—can help convince the farmers themselves as well as the urban-based middle classes of the value of such produce.

While the PGS culture promotes trust in the farm production process, it can also provide farmers with some assurance that they will continue to get an appropriate return for their efforts and to link with key consumers in the urban areas who increasingly want to purchase SEAPs. At this stage, not all outlets, in particular the supermarket chains, understand or accept the significance of the PGS. To achieve this, PGS products need to penetrate larger commercial city markets and supermarkets. Successfully addressing this need presents a unique public–private partnership opportunity.

Summary of the Cambodia Case Study

Markets. The GWM and NUE have helped smallholders increase their production, but the singular greatest issue for farmers is selling the increased produce. Improving farmers’ marketing opportunities is now needed. Urban markets are commonly beyond the reach of smallholders, and few traders appear to place any priority on farmers’ interests. Some initiatives, such as the International Volunteer Yamagata (IVY) center in Svay Rieng, Cambodia, are offering farmers an important staging point for improved market access, and CASP2 LOA support for market space to sell PGS produce has shown positive results. Finding partners who could help to establish spaces similar to the IVY activity would be ideal, but there also needs to be recognition of the ability to achieve these standards and practices from within Cambodia.

Import Substitution. The volume of produce imported daily into Cambodia indicates the need for a strategy to address an imbalance. Although the subprojects have shown that Cambodian smallholders can and are willing to produce SEAPs, they currently play a limited role in the market.

Handling Produce. Inferior handling methods plus long time periods from farm to market contribute to the deterioration of produce when it finally reaches markets, with additional losses as produce is on-traded or retailed. The losses can and should be overcome with introduction of known, proven, and in many cases simple technologies. A simple technique at markets is keeping produce at waist/table height in crates and separated from contamination. Other techniques include introducing refrigerated/cool-chain movement and eliminating harmful chemical use. These are small, and in some cases expensive, initiatives but for the country to be confident it can produce SEAPs, these significant steps need to be adopted.

Dedicated Good Agricultural Practices Retailers. One consortium of GAP retailers in Phnom Penh has been exploring ways to join together to share products, adopt joint production plans, identify prices, use certificates (GAP and PGS labels), and cooperate with local distributors and wholesalers to bring GAP products to their customers. The focus is on quality with reasonable prices, affordable by the market and acceptable to farmers. This initiative is very similar to the IVY initiative and could benefit from further support where appropriate.

5.5. Policy Directions, Investments, and Institutional Reform

This section draws recommendations for consideration at the policy level that could involve the private sector, initiatives with public–private partnerships, and potential investments for the public sector to consider. The recommendations are intended to promote the broad SEAP agenda. The emphasis is on initiatives that are quick, doable, and practical.

For each issue, introductory discussion points are given, relevant public–private partnership aspects are noted, and the recommendations follow.

Sustainable Production at the Farm Level

Green Water Management. The total impact of the subprojects is yet to be assessed, however early findings are that they have had, and will continue to have a positive impact. Scaling them up is the next challenge. Improved GWM is essential for agriculture, particularly fostering increased resilience to stress factors of climate change. Initiatives in this area have been positive. There is a need to offer a clear and attainable vision and set of practices whereby other smallholders can increase their productivity through better management of their green water. The CASP LOAs have aspired to do this.

GWM inputs, e.g., excavators for ponds, plastic irrigation equipment, water tanks, simple water harvesting, and mechanized pumping are not capital intensive and the return on investment is positive and has provided farmers with highly beneficial outcomes. Smallholders should choose the options that would be best for them.

Public and Private Involvement. Numerous environmental, agricultural, water resource, health, and rural development ministries will be keen to see the benefits of

up-scaled GWM, and collaboration with nongovernment organizations could be an effective mechanism to assist. University research centers should also be encouraged to collaborate in the initiatives.

Recommendations.

- (1) Accelerate opportunities for farmers to implement GWM ponds on their farms. This can be achieved through a dynamic program of subsidy supported by microcredit, and delivered through collaboration with nongovernment organizations. Candidates for support should be selected in collaboration with target community members; farmers who are selected will readily adopt the method, agree to join a PGS group, and assist others in their community to adopt the practice.
- (2) Promote parallel R&D on up-scaling GWM with appropriate academic partners committed to improving understanding of water-use efficiency. Demonstrate this on AINS. R&D could, for example, include district case studies to analyze the maximum efficiency of using drip irrigation and other appropriate technology to support sustainable water management.
- (3) Strengthen and improve extension services and know-how regarding GWM and enhance capacity building.

Nitrogen Use Efficiency

Recap. There is room to introduce institutional innovations that encourage clustering of organic fertilizer production and logistics services for standardizing production and distributing these vital inputs. The PGS groups offer a vehicle to promote GWM and NUE on-farm practices.

Because biochar and compost production is labor-intensive, for farmers to adopt the practices they would need to see long-term tangible benefits, beyond the lower outlays for inputs.

Recommendations.

- (1) Maintain support for the ongoing trialing of NUE and communicate findings through AINS.
- (2) Consider promoting clustered organic fertilizer production to provide greater availability and access to it, given that this quality soil input medium is important in the SEAP equation.

Market Synergies—Participatory Guarantee Systems and Food Safety

Recap. Farmers need to market their surplus production. The single greatest factor for enabling improvements in sustainable farming practices is farmers working in groups. Combining the need to market with membership in a PGS is highly effective in defining the product farmers are producing and improving their marketing “position.”

The need for “clean and green” product is well established at the consumer point in the values cycle, but all involved in the agro-based food chain need to be engaged in the cycle of trust. The IVY initiative in Svay Rieng is a good model for replication, but requires considerable investment for buildings, vehicles, and farmer support. The model is very successful in delivering “trust and confidence,” which is important when trying to change production and market behavior.

Public and Private Involvement. The cycle of values is by definition inclusive of all the precursors of successful public–private partnerships. For the business to be successful, markets and entrepreneurs will want to respond positively.

Recommendations.

- (1) Develop an LOA for working in collaboration with the Pro-GAP “clean and green” outlets in Phnom Penh. Such an activity would promote “farm-to-plate” with consumers “knowing” the farming group from which they purchase. Consider buyer clubs and “office-to-farm” connections—food being grown for specific groups, with direct marketing. Enhance this using AINS and media to make the needs of the consumers clear to farmers while also promoting an understanding of the farmer challenges and perspectives.
- (2) Give a high priority to fostering opportunities for urban households to benefit from contracts with farmer groups, knowing where their produce comes from. Such an innovative move could assist confidence building for the important link between producer and consumer.
- (3) Start small, have small targets, and establish links between farmers and consumers whereby the “demand” for SEAP is successfully satisfied through an acknowledgment of the needs of all parties.
- (4) Acknowledge in a tangible way the achievements of farmers and farmer groups engaged in best practice “clean and green” in member countries.
- (5) Provincial and district agriculture departments, along with all the players involved, could consider a roundtable to find ways to secure a range of markets for farmers to sell their PGS produce. Find a way around bureaucratic “turf war” barriers.

Institutional Support

Benefit–Cost Analysis. Discussions of water productivity tend to focus on irrigation efficiency and crop productivity, summarized in the “more crop per drop” paradigm associated with “blue water” schemes. For farmers wanting to improve their livelihoods, techniques and practices that optimize available water use and minimize inputs are important, and GWM clearly will produce very positive returns on much lower levels of investment.

However, GWM schemes currently receive nearly no attention and negligible financing, despite being very cost-effective. GWM is an institutional “blind spot” that does not get enough attention at the policy or program development level.

Recommendations

- (1) Initiate one major GWM program in each GMS country to roll out simple initiatives that can make a huge difference in food security and livelihoods.
- (2) Dedicate an LOA to examining and developing relevant metrics and data, and use AINS to communicate the data.
- (3) Support farmer groups that are producing clean and green food by giving such food the highest priority at formal “state” functions, etc.
- (4) Explicitly support and overtly acknowledge R&D in promoting involvement of research institutes and universities in the GMS to engage with the issues highlighted, both the hard and soft sciences, to assist greater productivity with healthy foods and sustainable environments.
- (5) Explore import-substitution strategies in situations such as Cambodia’s, where smallholders are predominantly locked out of market dynamics by an imbalance in trade from neighboring countries.

5.6. Conclusion

Early signs are that greater adoption and implementation of the GWM practices in particular, but also the NUE, can make a very positive contribution to SEAP production. In addition, the PGS has been seen as an important tool to give smallholder farmers the leverage to engage with markets on their own terms and play an increased role in the food production cycle.

With the right approach and combined commitment, the GMS can confidently move toward achieving a vision whereby it is internationally recognized as a hub for SEAP production. The size and voracity of the potential market for SEAP, while not clearly

determined with hard numbers, shows promising signs of being a huge opportunity for all in the values cycle. The steps ahead will benefit from collaboration between all stakeholders and partners in the cycle of values, particularly securing greater links between consumers and farmers.

The importance of continuing R&D into the spectrum of issues associated with up-scaling an amalgam of good practice—GWM, NUE, and PGS—cannot be emphasized enough. Routinely the R&D should be both multidisciplinary as well as singular in discipline. At the same time, the R&D will benefit from being farmer, market, and consumer focused, grounded in the reality of both the importance and the efficacy of the approach.

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Chapter 6

Soil Mapping and Identification of Potential Biochar Hot Spots and Pilot Sites in the Greater Mekong Subregion

Prepared by Apichai Thirathon and Lourdes S. Adriano, Greater Mekong Subregion Working Group on Agriculture Secretariat. The full report can be downloaded from <http://icem.com.au/biochar/Soil Types and Biochar Land Application Suitability and Hot Spots>.

6.1. Introduction

In 2014, the Asian Development Bank funded technical assistance for implementing the Core Agriculture Support Program, Phase II (CASP2). Under CASP2, the study of biochar hot spots in the Greater Mekong Subregion (GMS) was conducted. The overriding purpose of the study was to evaluate the potential application of biochar technology in the GMS. The specific objectives were to

- (1) locate “biochar hot spots” by developing a spatial map of the soil types in the GMS that are appropriate for biochar feedstock or biomass, and
- (2) suggest appropriate pilot sites in the GMS as priority areas for future investment to promote safe and environment-friendly agro-based value chains.

This chapter summarizes the findings of the full report and updates the results with the actual experiences of the GMS pilot sites. The last section of the chapter puts forward some immediate and medium-term actions for up-scaling the application of the biochar technology to promote the production of safe and environment-friendly agriculture products in the GMS.

6.2. Biochar and Its Importance

Biochar is the carbon-rich product that results when biomass, such as wood, manure, and leaves, is heated with little or no available oxygen (Figure 6.1). The production and application of biochar can help store carbon and improve soils.

Figure 6.1: Biochar Production and Application

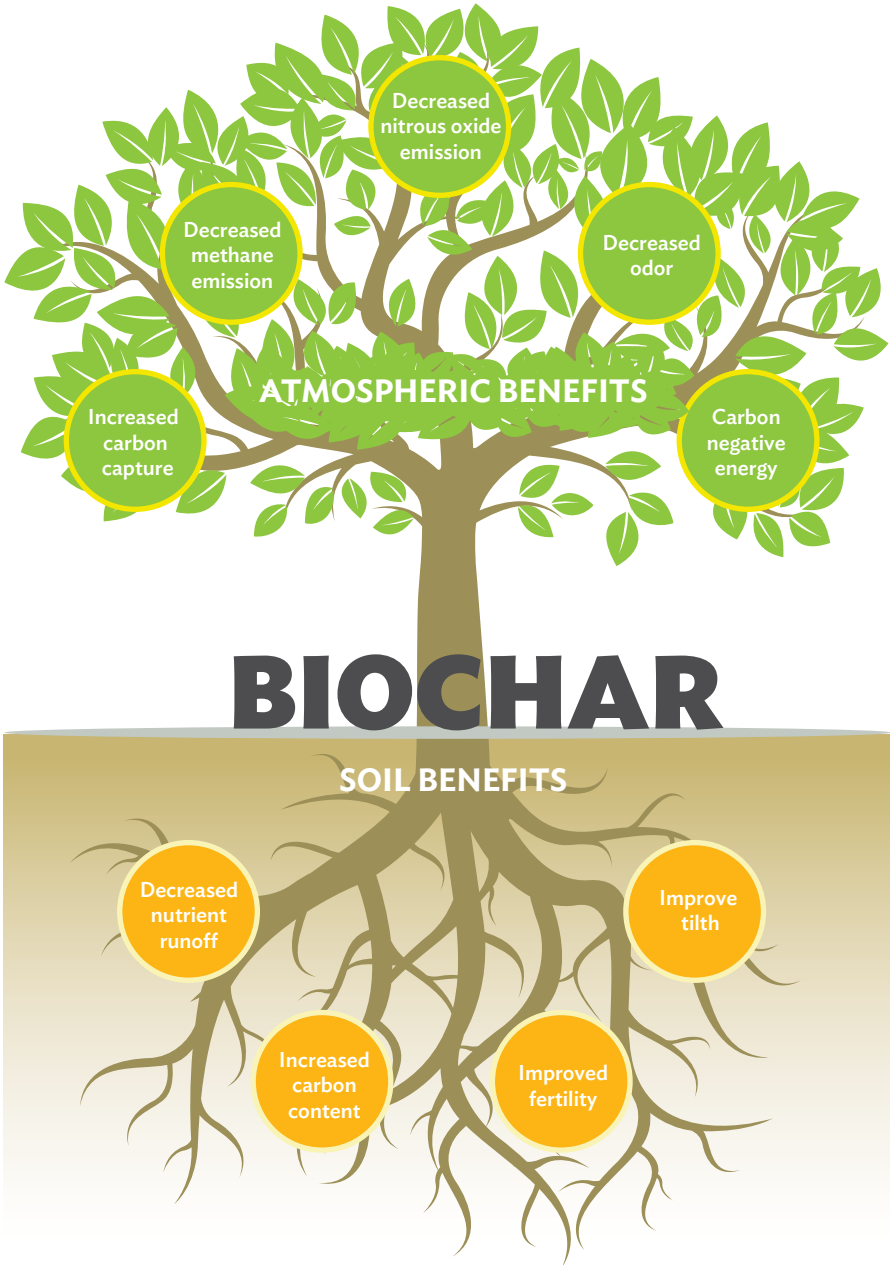


Note: Left: kilns for producing biochar; right: biochar spread on a field.
Source: ICEM (2016).

The production and application of biochar offer multiple potential benefits (Figure 6.2) as biochar provides a means to

- store organic carbon in the soil on a very long-term (millennial) scale, thus helping to mitigate climate change;
- significantly improve the soil by releasing nutrients, reducing nutrient leaching and gaseous losses, decreasing acidity, increasing water holding capacity, and regenerating the soil's microfauna and biological function;
- reduce input cost (especially the cost of using chemical fertilizer, by 25%–50%), improve nutrient use efficiency, increase crop yields, and consequently increase farmers' incomes;
- generate efficient and renewable energy;
- sustainably manage green wastes; and
- assist smallholder GMS farmers through a technology appropriate for them.

Figure 6.2: Benefits of Biochar



Source: International Biochar Initiative. <http://www.biochar-international.org/biochar> based on original artwork by Red Garner, redgarner@gmail.com use allowed under Creative Commons.

6.3. A Biochar Hot Spots Map

In developing the biochar hot spots map, a four-stage process was followed. The stages are discussed below.

Greater Mekong Subregion Soil Map

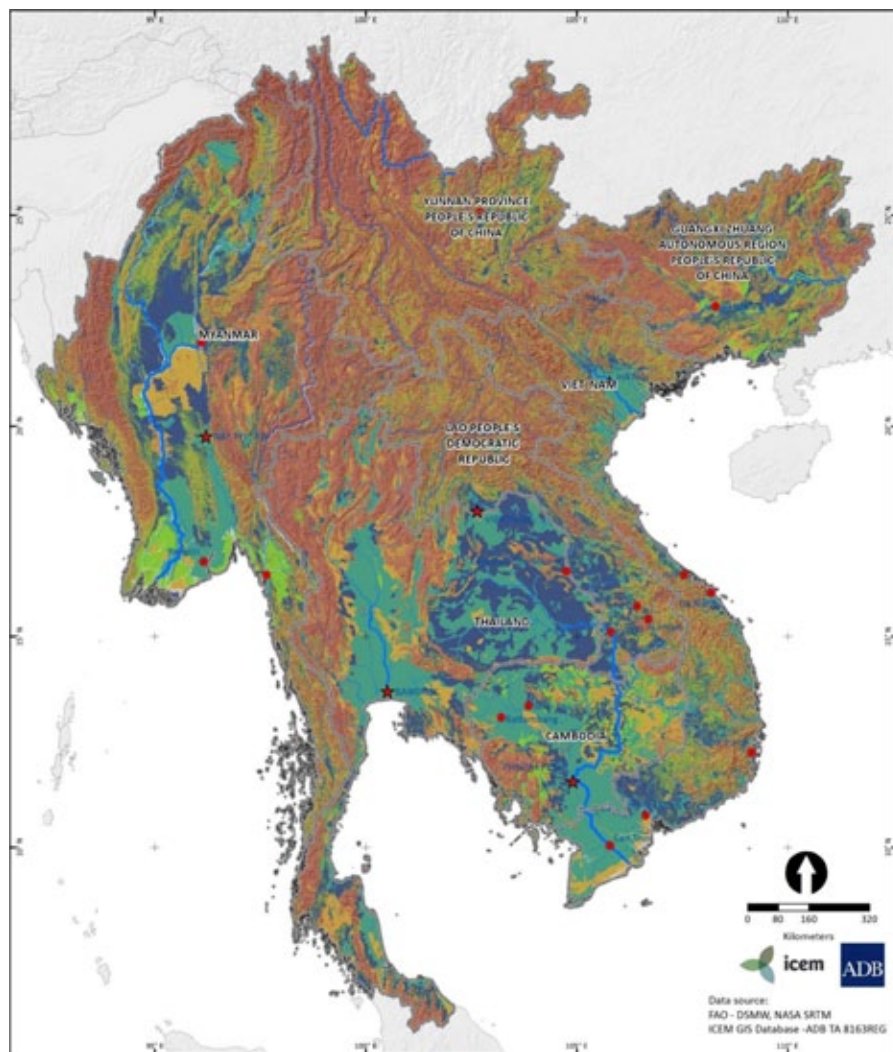
To identify the biochar hot spots in the GMS, a soil map was first constructed using available data on soil properties (Figure 6.3). For the GMS region, the suitability of soils for biochar was determined based on soil properties, specifically pH, percent base saturation, texture, depth, and slope steepness.

As can be gleaned from Figure 6.3, the GMS has diverse soils, with four key features.

- Nearly 65% of GMS soils are Acrisols, Ferralsols, and Leptosols. The majority of these soils have physical and/or chemical limitations on their use for crop production. The important soil constraints include shallowness, the presence of stones and rocks, low fertility, acidic pH, and insufficient phosphorus.
- About 25% of the remaining soils are mostly Cambisols, Fluvisols, Gleysols, and Luvisols. These are the GMS's key agricultural soils. The inherent fertility of these soils varies from low to moderate in most cases, although some of the Fluvisols and Gleysols may have moderate to high fertility qualities.
- Significant areas (over 3.34 million hectares [ha]) are acid sulfate soils (thionic Fluvisols and thionic Gleysols), which are extremely acidic and thus present severe limitations to cropping.
- The GMS has more than 2.84 million ha of sandy soils (Arenosols), which hold little water and have very low inherent capacity to supply and retain essential plant nutrients.

Soil Type and Topography

The second step was to identify the land suitability for biochar application. The soil type map was refined by juxtaposing on it information on topography or land slope. A biochar index was developed, incorporating soil types and land slope characteristics (Figure 6.4). By applying a geographic information system, a biochar suitability map was produced with five categories: (1) highly suitable (blue in Figure 6.4), (2) suitable (dark green), (3) may be suitable (lime green), (4) may not be suitable (gold), and (5) unsuitable (red).

Figure 6.4: Suitability of GMS Soil for Biochar**Biochar Index (Soil types x Slope)**

Notes: The boundaries, colors, denominations and any other information shown on this map do not imply on the part of the Asian Development Bank and the GMS Working Group in Agriculture or the governments of the countries shown any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries, colors, denominations, or information. Boundaries are not necessarily authoritative.

Sources: Produced by ICEM for the ADB Greater Mekong Subregion (GMS) Core Agriculture Support Project, Phase II <http://gms-wga.org> using data from the following: FAO Digital Soil Map of the World; NASA SRTM base data; ICEM GIS database.

Soil Type, Topography, and Land Use

The third step was to include land-use features (Figure 6.5), focused on the availability of agricultural and animal waste suitable for biochar production. More than 104 million tons per annum of agricultural residues can be sustainably removed from GMS agricultural land and used for biochar production. The agricultural residues are predominantly based on rice production. Waste from rice cropping varies from a midrange of 51% of crop residue to as much as 84%, especially in the major rice belt areas of GMS countries.

Animal wastes, when enriched with essential plant nutrients, could serve as feedstock and can be added to crop residues and used for biochar production. Based on the total livestock and poultry population in the GMS, approximately 294 million tons of dry animal waste can be generated annually.

Due to the scattered presence of both agricultural residues and animal wastes, the major challenge for biochar production would be collecting the wastes. There is also significant competition from other uses of both waste materials in the GMS, such as for biogas and bioenergy production. Thus, a comprehensive economic and environmental analysis of potentially competing uses is needed.

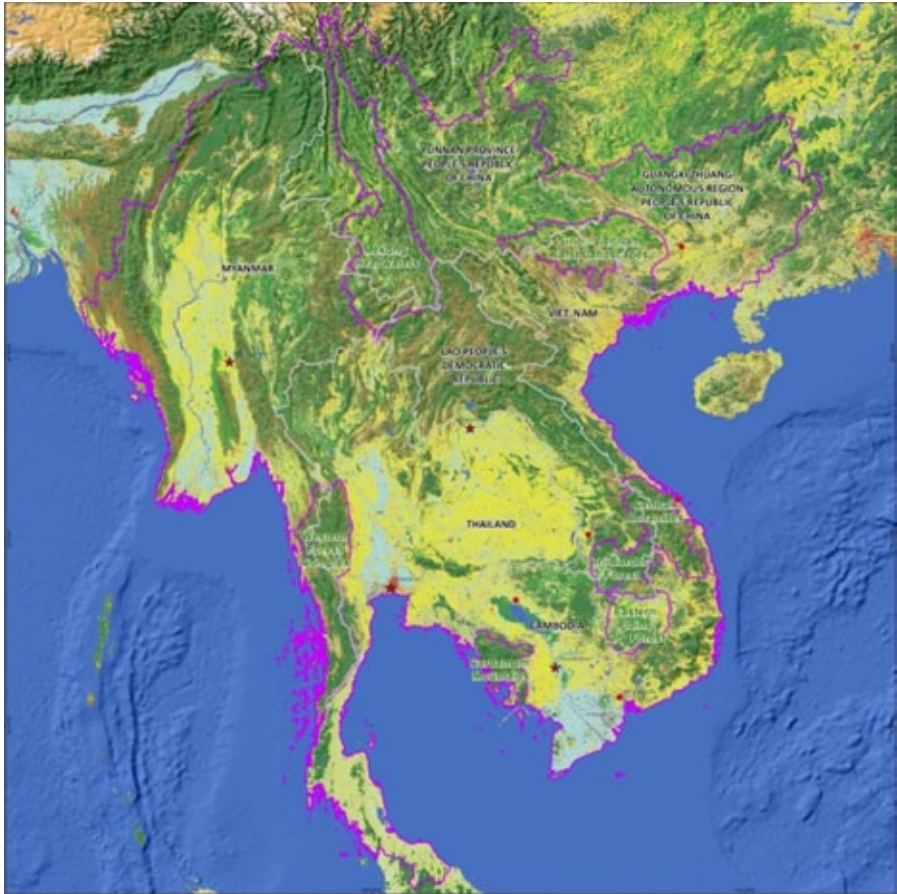
Biochar Hot Spots Map

The last step involved overlaying the defined landscape traits of the GMS with the information on the GMS economic corridors. Biochar areas that are near economic corridors could serve as supply centers for the production of safe and environment friendly agrobased products using reduced agrochemicals and replacing them with biochar. Such areas are the GMS “biochar hot spots” (Figure 6.6), which would be the most suitable areas for biochar production.

Based on suitability of the agricultural land to biochar production, potential biomass availability, and proximity to the economic corridors, about 2–4 biochar hot spots have been identified in each GMS country:

- Svay Rieng and Kampong Chhnang provinces in Cambodia;
- Luliang County in Qujing District in Yunnan Province and Gangbei, Xingbin, and Yongning districts in Guangxi Zhuang Autonomous Region in the People’s Republic of China;
- Nay Pyi Taw Council and Shwe Bo District in Saggaing Region in Myanmar;
- Savannakhet and Vientiane provinces in the Lao People’s Democratic Republic;

Figure 6.5: GMS Land-Use Map



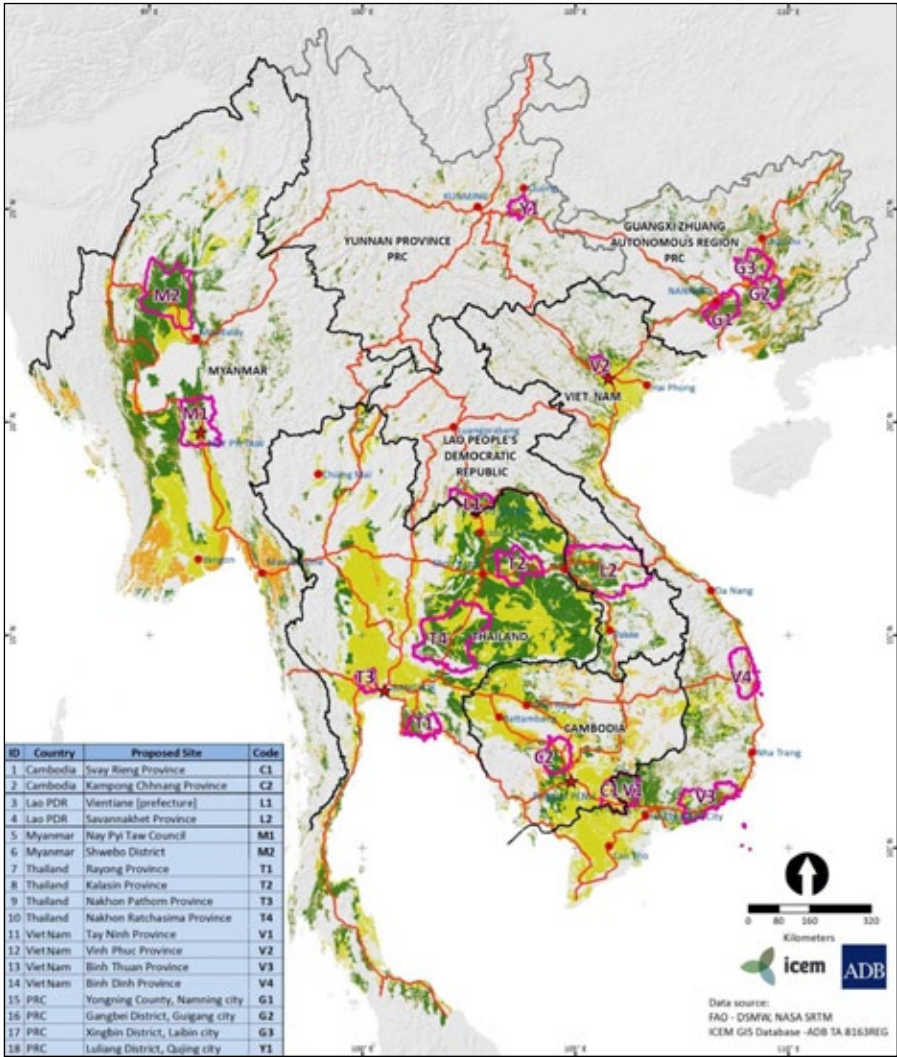
- | | |
|--|--|
| GMS border | 100; 110. Mosaic tree, shrub, herbaceous cover |
| TLs | 120; 121; 122. Shrubland |
| 10. Cropland, rainfed | 130. Grassland |
| 11. Herbaceous cover | 140. Lichens and mosses |
| 12. Tree or shrub cover | 150; 152; 153. Sparse vegetation |
| 20. Cropland, irrigated or post-flooding | 160; 170; 180. Tree cover, shrub or herbaceous |
| 30. Mosaic cropland & natural vegetation | 190. Urban areas |
| 40. Mosaic natural vegetation & cropland | 200. Bare areas |
| 50. Tree cover, broadleaved, evergreen | 201. Consolidated bare areas |
| 60; 61; 62. Tree cover, broadleaved, deciduous | 202. Unconsolidated bare areas |
| 70; 71; 72. Tree cover, needleleaved, evergreen | 210. Water bodies |
| 80; 81; 82. Tree cover, needleleaved, deciduous | |
| 90. Tree cover, mixed broadleaved & needleleaved | |



Notes: The boundaries, colors, denominations and any other information shown on this map do not imply on the part of the Asian Development Bank and the GMS Working Group in Agriculture or the governments of the countries shown any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries, colors, denominations, or information. Boundaries are not necessarily authoritative.

Sources: Produced by ICEM for the ADB Greater Mekong Subregion (GMS) Core Agriculture Support Project, Phase II <http://gms-wga.org> using data from the following: GMC EOS Interactive Atlas; FAO Digital Soil Map of the World; NASA SRTM base data; ICEM GIS database.

Figure 6.6: Proposed Hot Spot Sites for Biochar Production in the GMS



- Country border
 - Province border (in PRC)
 - Economic/Transport Corridors
 - ▭ Proposed Hot Spot of High Biochar Application
- Biochar Index (Soil types x Slope) on Existing Crop**
- ▭ Low Suitability (Index < 4,000)
 - ▭ Medium Suitability (4,000 < Index < 8,000)
 - ▭ High Suitability (Index > 8,000)

Notes: The boundaries, colors, denominations and any other information shown on this map do not imply on the part of the Asian Development Bank and the GMS Working Group in Agriculture or the governments of the countries shown any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries, colors, denominations, or information. Boundaries are not necessarily authoritative.

Sources: Produced by ICEM for the ADB Greater Mekong Subregion (GMS) Core Agriculture Support Project, Phase II <http://gms-wga.org> using data from the following: GMC EOS Interactive Atlas; FAO Digital Soil Map of the World; NASA SRTM base data; ICEM GIS database.

- Kalasin, Nakhon Pathom, Nakhon Ratchaima, and Rayong provinces in Thailand; and
- Binh Thuan, Binh Dinh, Tay Ninh, and Vinh Phuc provinces in Viet Nam.

6.4 Rice Husk and Straw for Biochar Production

Rice husk is perhaps the single most important agricultural waste that could be used as feedstock for biochar production. In addition, significant amounts of rice straw are burned in open fields, which has serious consequences for the local and regional air quality as high levels of particulate and toxic gaseous compounds are released into the atmosphere. Approximately 1.8 million tons of rice husk could be available annually for biochar production at the identified hot spots in the GMS. The conversion of rice husk into biochar could reduce the amount of carbon dioxide going into the atmosphere by over 1 million tons.

Additionally, rice husk biochar can reduce the consumption of potassium and phosphorus fertilizers by 20% and 100%, respectively. Rice husk biochar alone could reduce nitrogen fertilizers by only 4%, but this can be significantly increased if biochar is produced by mixing animal manure with rice husk.

Rice straw is being used for various purposes including animal feed, biofuel, organic fertilizer, and building material. Therefore, it is important to evaluate the economic and environmental viability of competing uses of rice straw (and other crop residues) in the GMS. This will provide the small-scale GMS farmers with information on what is the best use of their agriculture waste, other than environmentally damaging options such as open field burning.

The Pilot Tests

Through a letter of agreement between the Asian Development Bank and GMS ministries of agriculture, on-farm research and demonstrations of the multiple benefits of biochar application were carried out from early 2015 to the end of 2016. In the field studies on baby corn in Thailand, 6 tons–2 tons of biochar were applied per hectare. This helped to improve soil fertility as it reduced soil acidity, significantly increased the soil's organic matter content, and added important chemical elements such as phosphorus pentoxide, potassium oxide, calcium, and magnesium. The soil's physical properties were also improved, with an increase of moisture holding capacity, aeration, and aggregation. Biological functions were measured and populations of beneficial

microorganisms that accelerate the decomposition of agriculture residues, such as Actinomycetes, other bacteria, and fungi, increased. With improved soil fertility, the average yield of baby corn increased by approximately 11%.

Extension of biochar application in 48 farmers' fields in four Cambodian provinces (Battambang, Kampong Chhnang, Svay Rieng, and Takeo) also produced positive results. Trial and demonstration farms with rice and vegetables showed that the formula of applying 50% biochar and 50% slurry, compost, or cow manure at 2.5 tons/ha yielded the highest productivity vis-à-vis the conventional farmers' practice and the application solely of biochar. Tables 6.1 and 6.2 summarize these findings. With the same prices for rice and vegetables as those obtained from the conventional farmer's methods, the lower cost of production due to the use of biochar, and the higher yields, farmers' net incomes increased. Net revenues from the sale of vegetables that applied biochar were more than double those received by farmers who relied on synthetic agrochemicals. Women farmers were highly satisfied with the results, as a majority of vegetable farmers were women. However, more research is needed to reduce the amount of labor required to produce biochar.

Table 6.1: Average Rice Yield on the Demonstration Farms in Cambodia

| Province | Average Rice Yield (tons/hectare) | | |
|-----------------|-----------------------------------|---------------------------------|------------------------------------|
| | T1 (biochar 100%) | T2 (biochar 50%+ manure 50%) | Control (conventional practice) |
| Battambang | – | 4.95 | 3.38 |
| Kampong Chhnang | 3.50 | 3.87 | 2.83 |
| Svay Rieng | – | 2.56 | 2.37 |

– = no data, T = trial.

Source: Results from the vegetable trial farms on biochar use in Cambodia, under the Core Agriculture Support Program, Phase II (ADB 2016).

Table 6.2: Average Vegetable Yield on the Demonstration Farms in Cambodia

| Province | Average Vegetable Yield (tons/hectare) | | |
|-----------------|--|---------------------------------|------------------------------------|
| | T1 (biochar 100%) | T2 (biochar 50%+ manure 50%) | Control (conventional practice) |
| Battambang | 14.50 | 21.75 | 12.25 |
| Kampong Chhnang | 29.25 | 28.15 | 20.90 |
| Svay Rieng | 48.00 | 50.40 | 47.00 |
| Takeo | 17.00 | 23.50 | 17.75 |

T = trial.

Source: Results from the vegetable trial farms on biochar use in Cambodia, under the Core Agriculture Support Program, Phase II (ADB 2016).

Application of biochar to soil in rice and vegetable growing areas also helped reduce greenhouse gas emissions, and thus contributes to mitigating the adverse effects of

climate change. A study conducted by the Institute of Agricultural Environment in Viet Nam on rice grown in the summer and spring seasons of 2016 indicated that a 25% reduction of the use of nitrogen, phosphorus, and potassium (NPK) fertilizer and substituting biochar soil additions reduced the average methane from 496 kilograms per hectare (kg/ha) per season to 369 kg/ha/season, when compared with the normal (control) practice of NPK application. In addition, nitrous oxide emissions were reduced from 0.618 kg/ha/season to 0.482 kg/ha/season. This was equal to an average 26% reduction of carbon dioxide equivalent emissions, from 12.584 kg/ha/season to 9.360 kg/ha/season. Rice yields also improved, by at least 2% when compared to the conventional practice of applying NPK. This study concluded that biochar application not only helps reduce the use of chemical fertilizer while increasing yields, but also mitigates greenhouse gas emissions from agriculture fields.

Because the study's sample size is small, the positive economic and environmental results and the other perceived societal benefits should be validated in wider trials. The societal benefits include that

- (1) biochar technology is inclusive as it is tailored for easy and least-cost adoption by the small-scale farmers, the dominant actors in the agriculture sector;
- (2) promotion of biochar application (versus use of synthetic agrochemicals) produced health benefits—households that switched to biochar application noted that since they applied biochar, they had not experienced dizziness and illnesses became less frequent;
- (3) biochar use would reduce the import of synthetic agrochemicals, and thus contribute to foreign exchange earnings; and
- (4) the increase in farmers' incomes hinges on their effective links to markets, consumer awareness of the benefits of lower exposure to agrochemicals, and consumers' willingness and ability to pay a price premium for such health-related benefits.

More pilot trials are required to rigorously validate the medium- and long-term effects of biochar technology. This is especially important given the likely contribution to improved production of safe and environment- and gender-friendly agriculture products as well as enhancing the agro-based value chains for these products. On the basis of the study's results, there may be merit in scaling up the adoption of biochar at additional sites in the biochar hot spots, and conducting more research for maximizing the perceived benefits accruing from biochar application.

6.5. Recommendations

Given the economic, well-being, social, and environmental benefits observed in the trials using biochar, there may be merit in up-scaling the pilots in the identified biochar hot spots to study more options for biochar use and development and to validate more systematically the benefits and costs of biochar development. The end purpose is to provide farmers with a menu of options that can enable them to switch from excessive use of agrochemicals to approaches that benefit their incomes, health, and environments, as well as resulting in more climate-resilient and gender-responsive methods of farm production. Biochar development should also be considered as an option for paving the way for the GMS to be the ASEAN¹ hub for safe and environment-friendly agriculture products and value chains.

Immediate Actions

Expand the Farm Fields Using Biochar. Set up more demonstration trials in farmer's fields in the identified GMS hot spot areas. Use the trials for demonstration and training, and to optimize the biochar applications for rice and other crops. Biochar application could be encouraged in horticulture production for increased financial benefits and for developing sustainable production systems.

Update the Soil Map. The soil data will need to be updated and a revised soil map needs to be produced for the GMS. The revised map could benefit from the World Reference Base system, which is officially recommended as a sound source for soil type data by the International Union of Soil Sciences and is thus being adopted worldwide (IUSS 2014). A unified and consistent GMS soil map will be an important resource for monitoring soil parameters, for future planning, and for other environmental applications in the GMS. With the revised soil map and taking into account any emerging issues (such as policy or investment planning for promoting climate-friendly agriculture production), the biochar hot spots can be updated regularly and the information shared widely through the CASP2's Agriculture Information Network Services, which can also serve as basis for sharing knowledge and experiences on biochar application. Social media discussion forums will benefit both farmers and scientists such as agronomists in the subregion.

Capacity Building. In coordination with relevant national agencies, workshops and training programs should be organized to educate farmers and extension officials

¹ Association of Southeast Asian Nations.

about biochar production and its potential economic and environmental benefits. Farmers who apply biochar technology to produce safe and environment-friendly products can be assisted to form groups that apply the participatory guarantee system to monitor the quality and safety features of farm production.

Market Links. Farmers will need to be connected to markets, which is being tested in the CASP2 subprojects. Private sector collaboration will need to be strengthened to effectively link farmers to their consumer clients.

Investments in Research and Development

For wider scale use, biochar production will need to achieve scale economies that would keep pace with the growing population and increasing but changing agro-based food preferences. To increase the capacity of biochar to supply nutrients, animal wastes can be mixed with rice straw and other crop residues to produce biochar with better agronomic value. The appropriate mix for different soil types and farming conditions requires further research.

In the medium term, mangrove vegetation could be considered for sustainable biochar production.

More investments in sustainable approaches such as biochar development and biochar innovation laboratories will be needed. Investment funds can be joint ventures of the public and private sectors. Specific areas would be research and development for wider-scale biochar production and application that is less labor intensive as a majority of the farmers who produce and apply biochar are women.

Research and analytical capabilities for biochar and soil analyses in the GMS and particularly in Cambodia, the Lao People's Democratic Republic, and Myanmar are lacking and need to be addressed immediately.

Long-term field experiments (perhaps at experimental farms of national agencies and the private sector) comparing biochar with traditional fertilizer treatments should be established for monitoring agronomic and environmental benefits of biochar with the existing systems.

Policy Measures

Incubator Schemes. In the initial stages, adoption of biochar technology will require practical incentives from local and national governments to generate technologies that further improve yields from biochar, and technologies or equipment that lessen the labor used in the biochar production and application. This is especially relevant for women farmers. Incentives through start-up support or links with the private sector in the form of incubator programs could be established for developing local technology for the collection of crop residues and animal wastes.

Smart Subsidies. Smart subsidy schemes that encourage mechanization or mass production of biochar equipment and energy could be considered for biochar production in the hot spot areas identified in the study. The subsidies' implications for the fiscal situation of the country will need to be studied. The subsidy schemes will also have to be crafted so that they are transparent, time-bound, and highly accountable to remove the potential for illicit rents.

In some cases, reduced tariffs may also be needed, especially for inputs that are required for biochar production but are not available in the country in large quantities. Many of the inputs are produced and supplied by the larger and better-off GMS economies. Bilateral trade initiatives can be forged to facilitate reduced or zero tariff schemes in line with the ASEAN Economic Community principles. Trade facilitation measures will also have to be included in the initiatives to ensure smooth and least-cost transactions at the borders.

Inter-Trade Relations for Developing Cross-Border Biochar Value Chains. Access to inputs for decomposing agriculture wastes, contractual labor arrangements for production and application of biochar, rental services for kiln equipment, exchange programs for scientists, and development of research networks and centers of excellence on biochar, would all benefit from easier cross-border movement.

Framework. A regulatory framework could be developed for permitting the use of waste materials as a biochar feedstock, biochar production methods, and classification of biochar in the GMS. Such measures would increase consumer confidence in the uptake of biochar technology. For this to happen, a biochar value chain analysis will be needed.

Institutional Innovations

Biochar Network/Center. Establish a GMS biochar center of excellence and/or GMS biochar network to exchange and share knowledge and experience across the region. Countries such as Thailand are positioning themselves to serve as a knowledge hub for biochar. Public–private collaboration can participate in the promotion and development of biochar centers and networks.

Cluster Approach. Institutional arrangements that enable cluster production will be needed. Concentration of biochar production in the identified biochar hot spots can be an option to serve the numerous but scattered GMS small-scale farmers more efficiently and effectively. The clustered biochar centers will also need novel contractual arrangements for logistics, such as traders' delivery services. Additionally, invention of mobile kiln units that are practical and affordable for smallholder farmers needs research attention.

Media Connection. Media need to be informed about the production and supply of safe and environment-friendly agriculture products, so they can disseminate them. A communications plan that provides periodic dialogue with the GMS Working Group on Agriculture and the domestic print and social media networks could raise awareness of climate smart agriculture methods such as biochar and agro-based value chains. This could serve as an impetus for developing the GMS as an internationally recognized hub of safe and environment-friendly agriculture products.

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Chapter 7

Enhancing Rice Production and Lowering Greenhouse Gas Emissions by Recycling Crop Residues as Fertilizer

The content of Chapter 7 was developed by a research team from the Institute for Agricultural Environment, comprising Bui Thi Phuong Loan, Nguyen Hong Son, Mai Van Trinh, Nguyen Thu Thuy, and Dang Thi Phuong Lan. The research team's work resulted in a paper—Sustainable Paddy Production in Red River Delta through Recycling Crop Residues Toward Fertilizer Usage and Green-House Gases Emission Reduction. Highlights of the research work and their policy implications were written by Apichai Thirathon and Lourdes Adriano, Greater Mekong Subregion Working Group on Agriculture Secretariat.

7.1. Introduction

Since Doi Moi in 1986, agricultural productivity in Viet Nam has more than tripled, enabling the country to become the world's largest exporter of cashew and pepper; the second largest of coffee and cassava, and third largest of rice and fishery products. Viet Nam's export of rice has shifted from low-quality to fragrant rice. The country's rice exports averaged 2.5 million tons yearly in 2010–2012, contributing 40% of the country's total agriculture exports (World Bank and IFI 2016).

This remarkable growth in agriculture (and especially rice) contributed to Viet Nam's graduation to a lower-middle-income country. It also served as a major driver of poverty reduction—the poverty level has dropped from 64% in 1993 to about 8.4% in 2014 (World Bank and IFI 2016).

However, agriculture's growth has declined. Between 2008 and 2013 the average annual growth rate was a modest 3.2% compared with the gross domestic product (GDP) rate of 5.7%. Agriculture contributed about 19.4% of GDP during this period, a decrease from the high of 38.7% in 1990. Despite slower growth and a diminishing contribution to GDP, the sector plays a vital role in the country's socioeconomic development, providing employment for 48% of the labor force and the main livelihood source for two-thirds of the population.

For Viet Nam to move up from its present lower-middle-income status to the upper-middle rung, the country's agriculture sector, and in particular its rice subsector, will need to be reinvigorated. Agriculture growth has been attributed largely to expansion of the agricultural area and rice intensification. The sector's labor productivity has been low—lower than that of Indonesia, Thailand, and the Philippines. The key challenge is to develop an agriculture growth path that will foster more efficient, inclusive, and sustainable agro-based value chains. Four areas will need to be addressed (ADB 2017). The first relates to state dominance in key value chain segments, such as input supply, postharvest processing, and marketing. Second, rural infrastructure needs expansion and integration. The third involves the adoption of sustainable resource management. And fourth is the urgent need to address the worsening impacts of climate change on the agriculture sector.

The Ministry of Agriculture and Rural Development (MARD) is searching for measures that will ensure sustainable resource management and resilience to climate change in the rice economy. MARD encourages “climate-smart or -friendly agriculture” (CFA) measures that will perform multiple tasks: increase carbon sequestration in below- and above-ground biomass, strengthen the resilience of the sector to the vagaries of climate change, improve soil health, contribute to increasing productivity, and generate higher incomes for the small-scale rice farmers.

Small-scale rice farmers increasingly rely on agrochemical fertilizers to spur production. However, the overuse of agrochemicals is adversely affecting soil health and biodiversity in general. Water quality is also deteriorating due to pollution from agrochemical residues, exacerbated by crop residues that are dumped into the inland water systems. Inefficiencies in water use lower the quantity of this precious resource, especially as agriculture uses more than 80% of the available fresh water.

The problems of deteriorating resource quantity and quality in the rice subsector are exacerbated by climate change. Viet Nam is among the world's top 10 countries whose agriculture is most vulnerable to the vagaries of climate change, such as changing seasonal weather patterns, rising temperatures, increasing frequency and intensity of extreme weather events, and rising sea level. The impact of climate change has increased the vulnerability of the sector's natural resource base to natural calamities, which have disproportionate consequences on the incomes and lives of the poor. Moreover, agriculture and forestry contribute to climate change as they are the largest sources of greenhouse gas (GHG) emissions in Viet Nam.

The Institute of Agricultural Environment (IAE), a research arm of MARD, did a technical study of one of the CFA measures, specifically the conversion of rice crop residues into organic matter, and use of this matter to reduce agrochemical application.

The study involved testing a “menu” of fertilizer mixtures including chemicals and organic matter as key ingredients to rice production. The environmental, climate change, and economic impacts of the mixtures were assessed and compared. The study aimed to contribute to agriculture innovations that would (1) reduce the use of costly and environmentally damaging synthetic agrochemicals in the production of rice, (2) significantly enhance soil health, (3) reduce the subsector’s contribution to GHG emissions, and (4) improve rice farmers’ incomes. The study was financed in 2015 through a letter of agreement between the Asian Development Bank and MARD under a technical assistance project that supported the Greater Mekong Subregion (GMS) economies to implement their Core Agriculture Support Program, Phase II. The IAE subsequently produced the report, *Sustainable Paddy Production in Red River Delta through Recycling Crop Residues toward Fertilizer Usage and Green-House Gases Emission Reduction*.

This chapter summarizes the research. It describes the project site, and then discusses the IAE’s step-wise approach to identifying and selecting the most economically and environment-friendly methods to use biofertilizer. The results of the study are then summarized, lessons learned generated, and the research and development (R&D) agenda as well as the policy directions inferred by the research are discussed. The last section concludes with the way forward.

7.2. The Project

Agriculture, and especially intensive rice production, contributes significantly to GHG emissions due in part to poor crop residue management. Of the total crop residues generated in agricultural production in 2010, only 10% was used as input fuel in brick kilns and in home cooking; 5% (rice husk and bagasse) for heat generation in boilers and dryers; and 3% as feedstuff for cattle (IAE Survey in 2010, cited by IAE 2016). The bulk, or 80% of the total of crop residues, was either burned or dumped into nearby inland waters.

The IAE proposed that the residues could be converted into compost or biochar and used for soil enrichment, which would also reduce GHG emissions. Biochar application would also decrease the farmers’ expenses for fertilizer. Various research has shown the benefits of biochar application, which (1) improves the water holding capacity of sandy soil (Briggs et al. 2012); (2) increases the soil pH (Laird et al. 2010); (3) enhances the soil’s cation exchange capacity (Peng et al. 2011; Yamato et al. 2006); (4) reduces nutrient leaching (Lehmann et al. 2003; Major et al. 2009); and (5) lowers nitrous oxide (N₂O) and methane (CH₄) emissions by improving soil aggregation (Van Zwieten et al. 2009).

Moreover, compost produced from crop residues provides high-quality organic fertilizer. In Viet Nam, composting technologies using sugarcane waste, domestic waste, and waste from processing pineapples and cassava have been applied successfully. For example, the IAE has succeeded in producing microbial products (named “Compost Maker”) for making high-nutrient fertilizer and reducing GHG emissions. MARD has approved the application of the compost maker in the countryside.

The IAE’s proposal was to produce biochar and compost at the farm level and to examine combinations of fertilizer ingredients including mixtures that use biochar and compost through farm trial testing, scientific diagnostics using environmental and climate models, and benefit–cost analysis. The results of the study were disseminated to farmers and government extension workers to inform them about the inclusive, profitable, and sustainable merits of shifting from conventional rice production dependent on agrochemicals to farming techniques that reduce the use of agrochemicals and employ biofertilizers from recycled crop residues.

Project Site: Nam Dinh

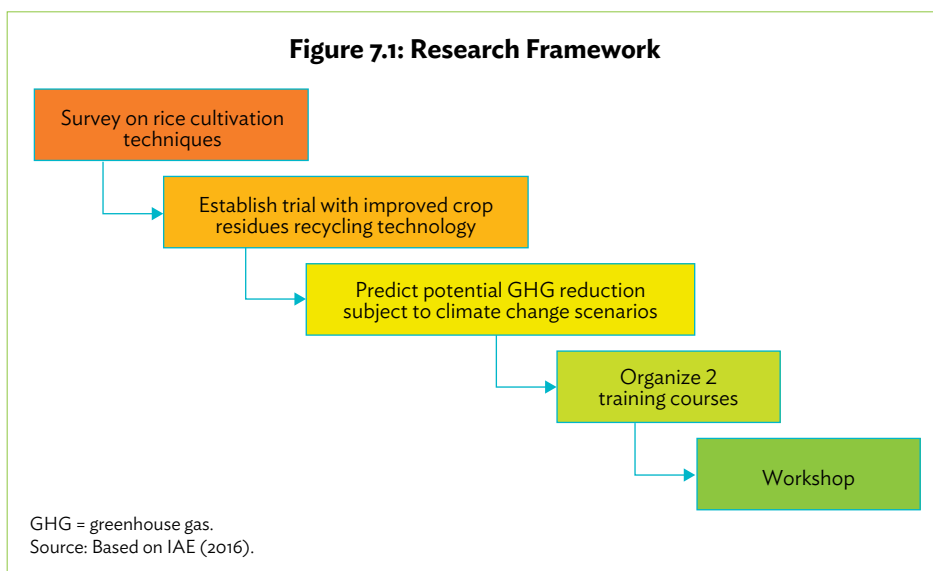
Nam Dinh Province was selected as the pilot area for the trials of different input practices. The province is in the Red River Delta of northern Viet Nam, and is the country’s second-largest rice-producing region. Rice is the main crop in Nam Dinh. Two crops are grown yearly: one in the dry season (January–June) and one in the rainy season (July–November). In 2013, the province produced close to 1 million tons of rice.

The province has increasingly been frequented by extreme weather occurrences such as powerful typhoons and prolonged drought. Saltwater intrusion has been a rising concern, as it has increased the salinity of rice land. This is exacerbated by farmers’ excessive use of low-quality agrochemicals, which has degraded the quality of the rice land. The farmers are applying 215 kilograms (kg) of nitrogen per hectare (ha), which is more than double the optimal amount of 90 kg/ha and nearly triple the amount used by Thai rice farmers, their closest competitors in the rice business (World Bank et al. 2016).

Farmers’ incomes have become more unstable and insecure as the soil has become less productive; costs of production continue to rise with the increasing prices of synthetic agrochemicals; and crop losses have increased due the frequent flooding and drought brought on by climate change. Farmers lack knowledge about CFA practices that would help them adapt, mitigate, and cope with the vagaries of climate change.

Methodology

After selecting the study site, the IAE technical staff employed a step-by-step approach that was science- and evidence-based, iterative (involving 2 cropping seasons), and participatory. The research framework is summarized in Figure 7.1.



The research framework involved five steps. First, secondary information was gathered to understand the technical aspects of rice production and socioeconomic demographics of the project site. Key information was collected on the quantity, type, and costs of fertilizer; the extent of use of organic fertilizer, biological fertilizer, and biochar; labor use, land use, and other production-related data including weather; and farmers' awareness of climate change concerns. Rice supply, consumption, and sale data were also gathered.

The research team conducted a participatory rural appraisal in Hai Hau District, Nam Dinh Province using a combination of questionnaires, focus group discussions with 38 households, and interviews with key informants. The purposes of the appraisal were to understand the farmers' perceptions of biochar and the extent to which they use it, and the depth of their knowledge about climate change.

The second step of the research was to set up trials with 3 pilot farm households, including hands-on training on biochar and building a composting facility (Figures 7.2 and 7.3) and control testing (CT) of 5 fertilizer mixtures:

- CT1: conventional method prior to the test, which applies 100% nitrogen, phosphorus, and potassium (NPK)¹;
- CT2: 75% NPK;
- CT3: compost² plus 75% NPK;
- CT4: biochar³ plus 75% NPK; and
- CT5: 50% of compost applied in CT3 (5 tons/ha), 75% of biochar applied in CT4 (1.125 tons/ha), and 50% of NPK applied in CT1.



Producing biochar using a kiln (photo from IAE 2016 [top], ICEM 2016 [bottom]).

1 100% NPK = 195N+69P₂O₅+63K₂O kg/ha for spring rice and 215N+83P₂O₅+42K₂O kg/ha for summer rice.

2 Compost made from rice straw applied at 10 tons/ha.

3 Biochar made from rice straw applied at 1.5 tons/ha.



Producing compost from rice straw (photo from IAE 2016).

The trials covered two cropping seasons. Trials were monitored regularly at the field level using objective parameters such as crop height, number of effective panicles, yield, soil sampling and analysis of soil elements, prices of inputs, need for pesticides, volume, and markets.

Third, data were analyzed employing scientific models.

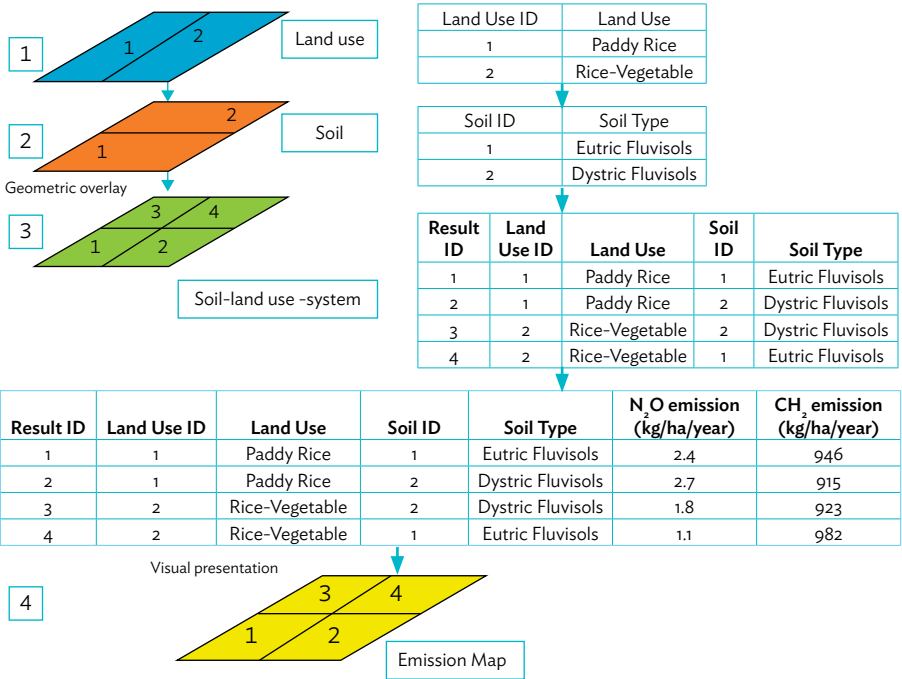
- (1) The chamber method (Figure 7.4) was used to collect air samples for measuring actual methane and nitrous oxide emissions from different practices.
- (2) Simulations of climate change scenarios used the DeNitrification-DeComposition for GHG emission model and the methodology developed by the Ministry of Natural Resources and Environment (Figure 7.5).
- (3) The program for predicting GHG emissions from rice fields was based on actual GHG emission measurements at the field levels.
- (4) Regression analysis was used to verify the accuracy and veracity of the predicted GHG emission compared to measured values.
- (5) DeNitrification-DeComposition for GHG emission results were interphased with a geographic information system to produce emission maps for Nam Dinh and other provinces in the Red River Delta for 2015–2050.
- (6) Simulations were run to predict the overall impacts of different fertilizer mixtures on GHG emissions, soil enhancement, and productivity.
- (7) The effects of different fertilizer mixtures on GHG gas emissions, soil nutrient changes, and yield were subject to statistical analysis.
- (8) The net income effects of the different fertilizer mixtures were determined through a simple benefit–cost analysis.

The last step was the IAE extension services—the IAE conducted training courses for extension workers, farmers, and local stakeholders, and discussed with them the results of the study. The IAE also organized workshops to present the model applications to local leaders, agriculture extension staff, and farmers with the aim of raising their awareness of the environmental and economic benefits of switching from excessive fertilizer use to a practice that is environment-friendly, climate resilient, and economically beneficial to rice farmers.



Chamber method for sampling and measuring methane and nitrous oxide emissions (photo from IAE 2016).

Figure 7.2: Calculation of GHG Emissions for Nam Dinh and the Red River Delta, Based on the DNDC Combined with GIS



DNDC = DeNitrification-DeComposition for GHG emission, GHG = greenhouse gas, GIS = geographic information system, ha = hectare, ID = Identity, kg = kilogram.
 Source: IAE (2016).

Findings

The key findings from the baseline survey for the research and extension work were as follows:

- Rice farmers in Nam Dinh used large (to excessive) amounts of fertilizers, mainly urea, and a compound fertilizer of NPK.
- A majority of the farmers were aware of biochar and composting, but hardly any farmers used them.
- Farmers were aware of climate change, noting the increased frequency of flooding, drought, and salt intrusion in farmland. However, they were not aware of CFA practices such as the appropriate mix of synthetic and biofertilizers.

The pilot trials showed the following:

- Application of biochar and compost with NPK (CT5) increased plant yield by an average of 2.4%–11.1% over CT1, the conventional intensive use of agrochemicals in rice (Table 7.1).
- Compost mixed with 75% NPK (CT3) yielded the highest productivity rise, followed by biochar mixed with compost and NPK (CT5). Reducing NPK by 25% (CT2) significantly reduced yield, by an average of 4.5% from the conventional approach (CT1).
- Soil nutrients improved when biochar and compost were applied (although the findings are not scientifically conclusive because of the short duration and low number of observations). Water absorption was also enhanced.

Table 7.1: Effect of Different Fertilizers on Rice Yield

| Treatment | Summer Season 2015 | | Spring Season 2016 | |
|-----------|--------------------|--|--------------------|--|
| | Yield (t/ha) | Change in Yield Compared with Conventional Treatment (%) | Yield (t/ha) | Change in Yield Compared with Conventional Treatment (%) |
| CT1 | 4.25 | | 5.25 | |
| CT2 | 4.11 | -3.33 | 4.96 | -5.58 |
| CT3 | 4.87 | +14.5 | 5.66 | +7.79 |
| CT4 | 4.38 | +2.75 | 5.36 | +2.04 |
| CT5 | 4.58 | +7.65 | 5.49 | +4.58 |

CT = control test, t/ha = tons per hectare.

Source: IAE (2016).

The effects on GHG emissions of the different fertilizer mixtures are shown in Table 7.2. Applying compost and reduced NPK (CT3) increased GHG emissions the most, even more than the conventional approach. However, the amount of GHG emission declined significantly when applying biochar mixed with 75% NPK (CT4), followed by composting, biochar, and reduced NPK (CT5). However, applying compost without biochar and mixed with a 25% reduction of NPK (CT3) clearly increased methane emissions in both seasons and nitrous oxide only in summer season when compared with all other treatments (for an average total GHG increase of 13.1% when compared with farmer's practices in CT1 and by 52.4% when compared with application of biochar either with or without compost in CT4 and CT5). The results suggested that applying biochar can effectively reduce GHG emissions.

Table 7.2: Effect of Different Fertilizer Mixtures on GHG Emissions

| Treatment | Summer | | | Spring | | | Total CO ₂ e (kg/ha/year) |
|-----------|--------------------------------|---------------------------------|--|--------------------------------|---------------------------------|--|--------------------------------------|
| | CH ₄ (kg/ha/season) | N ₂ O (kg/ha/season) | Total CO ₂ e (kg/ha/Season) | CH ₄ (kg/ha/season) | N ₂ O (kg/ha/Season) | Total CO ₂ e (kg/ha/Season) | |
| CT1 | 576 | 0.728 | 14.608 | 416 | 0.508 | 10.559 | 25.584 |
| CT2 | 550 | 0.654 | 13.953 | 406 | 0.472 | 10.302 | 24.662 |
| CT3 | 661 | 0.752 | 16.746 | 464 | 0.446 | 11.725 | 28.935 |
| CT4 | 473 | 0.590 | 11.992 | 265 | 0.374 | 6.727 | 18.984 |
| CT5 | 419 | 0.578 | 10.642 | 316 | 0.432 | 8.022 | 18.980 |

CH₄ = methane, CO₂e = carbon dioxide equivalent, CT = control treatment, GHG = greenhouse gas, ha = hectare, kg = kilogram, N₂O = nitrous oxide.

Source: IAE (2016).

In the longer term (30–40 years: 2015–2050), the model simulation suggests an increase in GHG emissions in Nam Dinh if farmers continue to apply only chemical fertilizer for rice cultivation, but the emissions would be significantly reduced if biochar were applied either with or without adding compost (Figure 7.7).

Figure 7.6a shows that

- CT4 and CT5 decreased GHG substantially;
- CT2, while lower than CT1, has the same trend as CT1; and
- CT3 shows highest methane emissions.

Figure 7.6b shows that nitrous oxide emissions were highest for CT1 and CT5. In CT3, the emissions tend to increase over time

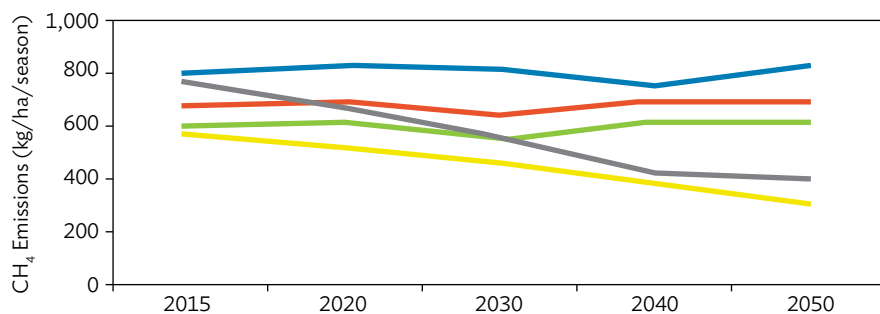
The benefit–cost analysis showed that the investment costs of using both biochar and compost were greater than the cost of applying only chemical fertilizer (Table 7.3). This is due to the high cost of labor for collecting residues and for the biochar or compost making process at the farm level. More research is needed in this regard.

However, application of compost alone with 25% reduction of NPK showed the highest net benefit but the benefit–cost ratio was moderate when compared with other treatments.

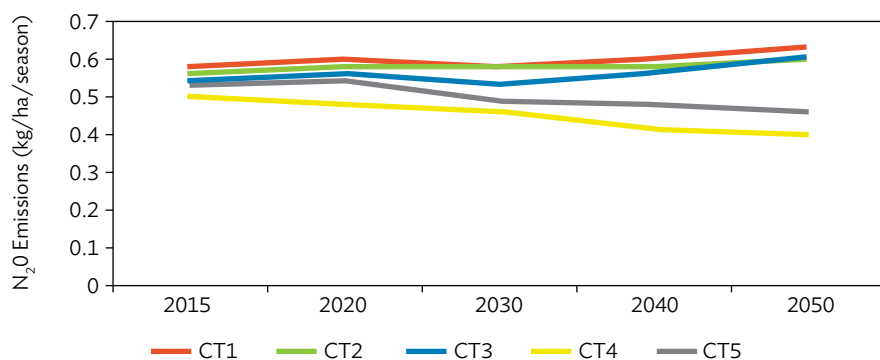
An interesting finding, though, was that a 25% reduction in fertilizer use resulted in the lowest production cost among the five options, and the highest net benefit–cost ratio despite garnering the lowest gross benefit among the five options.

Figure 7.3: Simulation Results for Long-Term Prediction of Greenhouse Gas Emissions in Nam Dinh

7.6.a: Methane Emissions



7.6.b: Nitrous Oxide Emissions



CH₄ = methane, CT = control test, GHG = greenhouse gas, ha = hectare, kg = kilogram, N₂O = nitrous oxide.
Source: IAE (2016).

Table 7.3: Benefit–Cost Analysis for Two Crop Seasons

| Treatment | Investment Cost (C) | Gross Benefit (B) | Net Benefit (B–C) | Ratio (B/C) |
|--------------------|---------------------|-------------------|-------------------|-------------|
| Summer 2015 | | | | |
| CT1 | 17.56 | 34.00 | 16.44 | 1.94 |
| CT2 | 16.15 | 32.87 | 16.71 | 2.03 |
| CT3 | 20.65 | 38.93 | 18.28 | 1.88 |
| CT4 | 19.75 | 34.93 | 15.18 | 1.77 |
| CT5 | 19.86 | 36.60 | 16.73 | 1.84 |
| Spring 2015 | | | | |
| CT1 | 19.62 | 42.03 | 22.41 | 2.14 |
| CT2 | 17.93 | 39.68 | 21.75 | 2.21 |
| CT3 | 22.43 | 45.29 | 22.87 | 2.02 |
| CT4 | 21.53 | 42.88 | 21.35 | 1.99 |
| CT5 | 21.34 | 43.95 | 22.60 | 2.06 |

CT = control test.
Source: IAE (2016).

After seeing the positive results on the pilot farms and noting the science-based approach for the selection and use of the input mixtures applying recycled agriculture wastes, the farmers and extension workers were favorably influenced about the proposed biofertilizers. They also appreciated that, by adopting the environment and climate friendly practices, they could contribute to averting the adverse effects of climate change. However, the higher labor costs entailed in compost and biochar production were a deterring factor for their potential widespread application in the future.

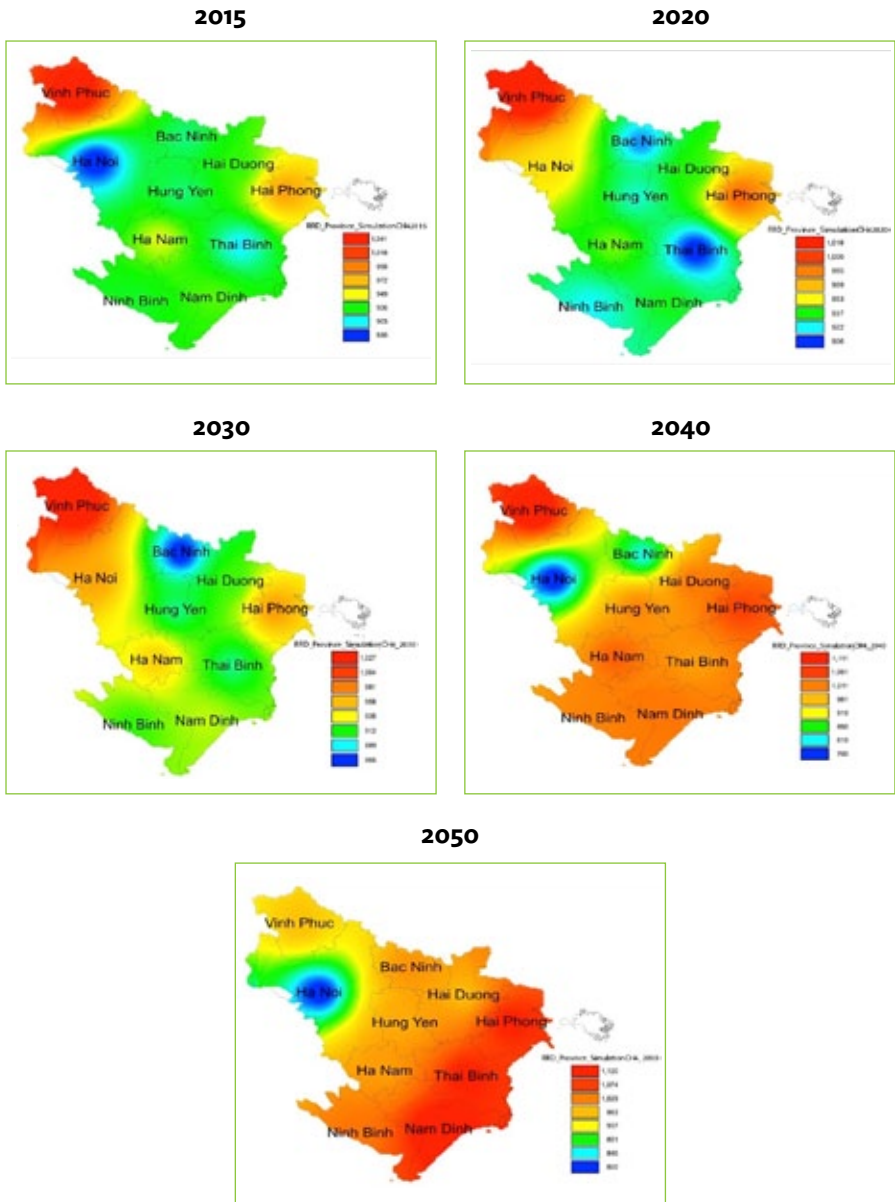
Simulation Results in the Red River Delta

A status quo scenario of excessive use of agrochemicals showed the results in terms of methane and nitrous oxide GHG emissions.

Methane Emissions. Methane emissions were generally predicted to increase from 2015 to 2050, except in Vinh Phuc, where methane emissions rose during 2015–2040, but declined by 2050 (Figure 7.7). The emission rate was on the rise especially in provinces with large rice areas, such as Hai Duong, Hung Yen, Nam Dinh, and Thai Binh. Methane emission rates climbed to critical levels in these provinces in 2040–2050.

Nitrous Oxide emissions. The simulation results (Figure 7.8) reveal that from 2015–2050, Ha Noi had the highest nitrous oxide emission, followed by Thai Binh, Nam Dinh, and Ninh Binh. The lower emission points were observed in Hung Yen, Hai Duong, and Hai Phong. Nitrous oxide emissions were rising but did not reached critical levels by 2050.

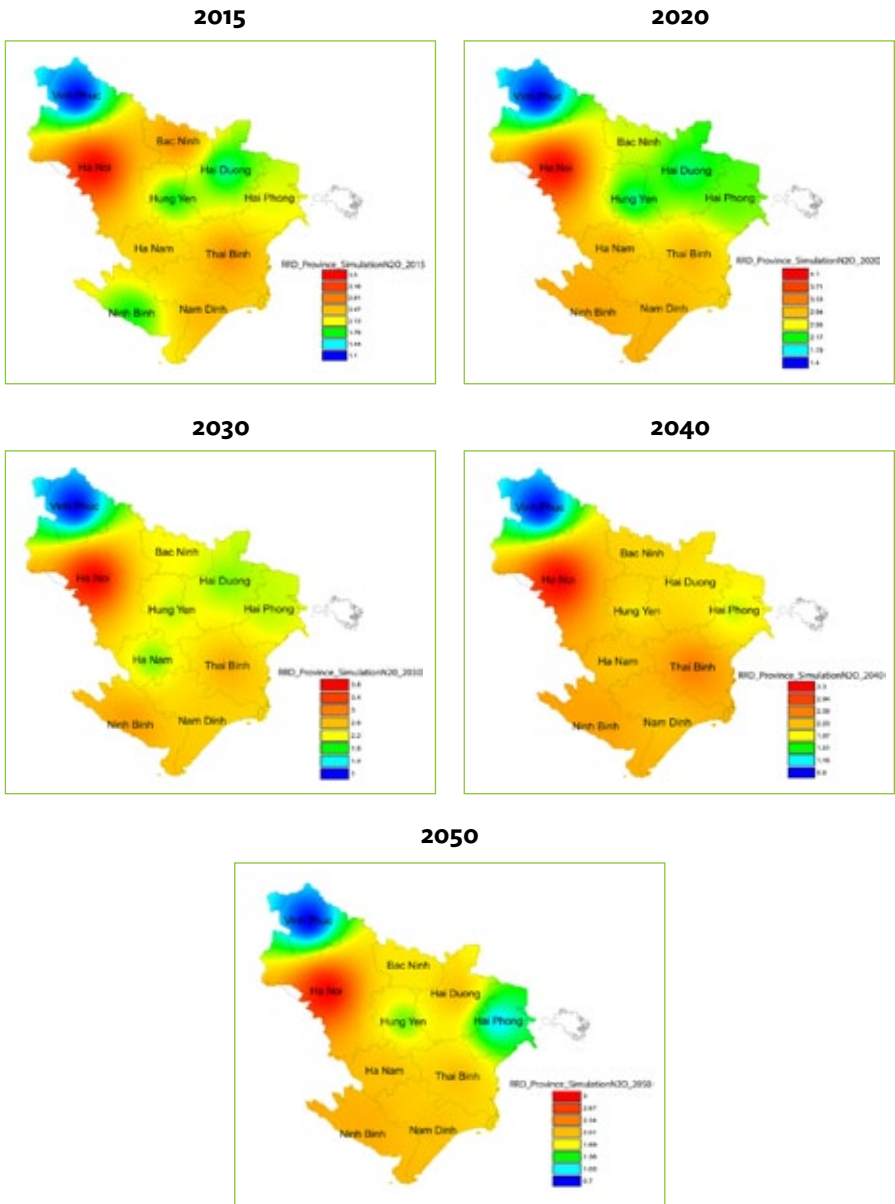
Figure 7.4: Methane Emissions, Red River Delta Provinces, 2015–2050 (kg/ha/year)



ha = hectare, kg = kilogram.

Source: IAE (2016).

Figure 7.5: Nitrous Oxide Emissions in the Red River Delta, 2015–2050 (kg/ha/year)



Source: IAE (2016).

7.3. Lessons Learned

The IAE report generated several lessons. First, the present agronomic practice of intensive rice farming applying large amounts of fertilizers (and pesticides), coupled with the near absence of proper agriculture residue management, proved hazardous to the environment (particularly to soil quality, water, and biodiversity); detrimental to rice farmers' incomes and livelihoods and vulnerability to the effects of climate change; and contributory to GHG emissions.

Second, IAE's study demonstrated a menu of options that could replace the conventional farming practice. Farmers were interested in the options such as reduced fertilizer use, or reduced fertilizer quantities and replacement with biochar and/or composts. With the exception of CT3, the options that apply biochar either with or without compost with NPK could reduce their environmental footprint and slightly enhance their gross revenue streams through improved productivity and reduced production costs. More research will be needed to reduce the costs of labor for producing biochar and compost at the farm level. Clearly, adoption of the innovations would be facilitated if farmers will not become worse off financially as a consequence of the change.

Third, applying compost without biochar in CT3 with 25% reduction of NPK produced the highest rice yields and showed the highest net benefits in both seasons. This has resulted in an increase of methane emission in both seasons and nitrous oxide emission only in the summer season. The countries in the GMS have been promoting the application of compost to improve soil health and crop yields. The results on yields and economic benefits have been positive but there has been no or only limited assessment of the impact as regard to climate change. This IAE study clearly suggested that application of compost alone could increase GHG emissions and that biochar could help minimize this effect. However, the IAE study was conducted only for 1 year and in paddy rice; therefore, further research covering wider agro-ecological conditions (e.g., in other cropping systems) is needed before concrete conclusions can be drawn to establish scientifically based recommendations for more appropriate policy directions.

Fourth, the IAE's linking of research with training and awareness-raising among the farmers and government extension workers hastened the process of adopting new practices. The farmers' hands-on involvement in capacity building reduced the pecuniary costs associated with the uncertainties from the change and the transaction costs of a first-time adoption. Performing the extension roles also enabled IAE to obtain immediate feedback on the strengths and gaps of the options.

It likewise demonstrated that extension and research institutions will need to work closely with each other for innovations to be effectively and efficiently delivered to the farmer-clients.

7.4. Research and Development Agenda

Research Concerns. The IAE's work is still unfinished—their study indicated other research concerns that need to be addressed.

Because Viet Nam has varied agroecological landscapes, input mixtures that would be suitable to other rice-producing areas should be tested.

Biochar and compost production is labor intensive, and labor cost in Viet Nam's rural areas has been rising. Labor for agriculture is becoming increasingly scarce as workers (especially male workers) prefer urban jobs. This leaves more women to do the farming activities. Research on technologies for producing organic fertilizers that reduce labor inputs and are women-friendly is vitally needed.

The pilots on biochar and compost production were done on rice farms, which are generally small (less than a hectare) and scattered. It may be more efficient and effective if the organic inputs are produced, processed, and marketed on larger scales through cluster groups (or by zones), as is being done by several private sector enterprises in Guangxi Zhuang Autonomous Region, the People's Republic of China, with support from the government. Producing biofertilizers at the farm level adds to the pecuniary costs of farmers—most important are the inconvenience, cost of learning, and loss of flexibility through competition for the limited production space in small farms. There may be need for time-bound and transparent start-up incentive schemes for the private sector in Viet Nam to incubate the development of organic inputs on a large-scale, value chain, and commercial basis.

Perceptions of the desirable effects of reduced fertilizer use on the environment, climate change, and livelihoods would be enhanced if complemented with efficient use of irrigation water, appropriate seed varieties, integrated pest management, and other land-based and land-use practices in rice farming. While irrigation water for rice is available year-round, enabling double and triple cropping, better access to and more efficient use of water for other crop production are essential. Potential areas for irrigation investments are (1) upgrades of irrigation systems that allow alternate

wetting and drying of fields, (2) drainage improvements for multipurpose use, (3) proper operation and maintenance, and (4) “green water management systems”.⁴

Viet Nam has started developing and using improved seed varieties for (1) resilience to extreme weather changes, (2) low-input/organic high quality rice, and (3) complementarity with crop diversification programs. India’s approach to basmati rice development (including R&D) involves a strong link between the public research institutions, its Ministry of Agriculture, and the private sector’s rice agribusinesses.

Research is needed on institutional land-use arrangements that encourage land consolidation, such as outgrowers’ schemes, land lease schemes, and joint venture arrangements of agribusinesses with farmer groups. Other areas to investigate for rice-producing zones include rental services for technical advice, provision and delivery of biofertilizers, rice quality control, and outsourcing of labor services for the tedious work of biochar and compost production and application on the farms.

Enhancing the knowledge of modeling that includes environmental, climate change, economic, and social aspects will provide important information for formulating policy and making decisions. One option may be wider use of the International Model for Policy Analysis of Agricultural Commodities and Trade developed by the International Food Policy Research Institute.

Additional support for R&D is needed, initially from government and subsequently through public–private collaboration. Experience shows that government should set aside at least 1% of the agricultural GDP for R&D of agriculture, of which at least half could be earmarked for safe and environment-friendly agriculture products such as high-quality low-input rice.

Research and Development with Extension. The IAE’s approach of combining R&D with extension services is a novel one, and may merit emulating. The Viet Nam National Extension System would need to work closely with the IAE to facilitate the dissemination and adoption of research on CFA, ensure more practical and site-specific outreach of the farmers nationwide, and provide a quick feedback loop on innovations.

⁴ Green water refers to soil moisture from precipitation that is used by plants via transpiration. Water from rainfall provides essential moisture, which is stored in the root zone of the soil. That moisture, in turn, is evaporated, transpired, or incorporated by plants. Green water management encompasses practices that improve stewardship of this critical resource in all farming systems, but most particularly in rain fed areas. The amount of green water available and the efficiency of its use depend on: (1) occurrence of rain events and the capacity of soil to capture and store that rain, and (2) appropriate farming practices that can optimize this precious rainfall water. An example of a green water management system is the development of ponds adjacent to farms. The pond catches and stores rainfall, for use by the farmer during the dry season. Another type of water is “blue water,” which is the fresh water: surface and groundwater. It is stored in lakes, streams, groundwater, glaciers, and snow.

Policies will be needed that incentivize and support farmers to use biochar, and enterprises that mass produce and sell biochar and other biofertilizers. Incentive schemes should include requirements for action that are time bound, transparent, and accountable.

The IAE's technical expertise on climate change modeling and economic analysis can be shared with their research institute counterparts and other extension departments in the agriculture ministries of the GMS' less-developed economies, particularly Cambodia, the Lao People's Democratic Republic, and Myanmar. Such knowledge sharing will enhance their research and extension capabilities, providing them with more rigorous methodologies for assessing and testing technological agronomic options and providing evidence-based approaches to policymaking.

Several knowledge-sharing modalities are available, e.g., the internet-based Agriculture Information Network Service system, networking of the GMS-based research institutes for developing sustainable rice and safe and environment-friendly agriculture products, and public-private collaboration through outgrowers' schemes where the private sector provides the market for sustainable rice products and partners with the research-cum-extension departments to help the farmers use sustainable rice practices.

7.5. Policy Directions

The significance of the IAE's research work is that it focused on major concerns for the country's rice sector in general. The country's rice strategy has been based on a high-volume, low-priced, and low-quality rice supply chain that relies on irrigation, high-yielding seeds, and extensive fertilizer use. While the government is shifting toward a more sustainable high-quality rice pathway,⁵ strategic restructuring and repositioning of the rice sector is urgently needed to simultaneously

- prevent further diminution of the country's comparative edge in its suitable natural resource endowments;
- seize the opportunities accorded by urbanization and growing global demand for safe and good quality rice; and
- tackle the external challenges of climate change, price volatility, and fierce competition from profitable crops.

⁵ Viet Nam's relevant policies include the (1) Viet Nam Agriculture Restructuring Plan in the period 2016–2020; (2) Action Plan on the Green Growth of the Agriculture Sector and Rural Development to the year 2020 (Decision No. 923/QĐ-BNN-KH dated 24 March 2017); (3) Plan on the Reduction of Green-house Emission (GHG) in the agriculture sector to the year 2020; (4) National Action Plan on Support to Adapt to Climate Change 2012–2020; (5) Viet Nam National Strategy on Green Growth; and (6) Master Plan for the Production Development of Agriculture to 2020 and Vision to 2030.

The key policy agenda for the rice subsector can be inferred from Table 7.4. The table compares the rice farm productivity parameters of Viet Nam with Thailand, its closest competitor in the global rice economy. Relative to Thailand, Viet Nam has higher yields in both ordinary and aromatic rice in wet and dry paddy areas, and greater cropping intensity. The two countries have similar availability of and access to irrigation, seeds, mechanization, and other inputs. What distinguishes the two countries is (1) Viet Nam's abnormally high use of fertilizers (more than double that of the average Thai rice farmer and the technically required optimum level); and (2) for Viet Nam, the much lower labor profitability (measured in yield, labor profitability in Thailand is nearly triple that in Viet Nam, and in dollars/person-day, it is more than six-fold), and lower farm gate price (the price received by Thai farmers is nearly double that in Viet Nam).

To address the overuse of fertilizer and the low labor profitability, the following policy directions are suggested.

Road Map and Programs. A policy road map with a strategic set of programs for soil nutrient development, crop residue management (e.g., promoting biochar and compost), and integrated pest management is needed. The objective would be to synergize resource efficiency, sustainability, climate change, and profitability. One program could be for developing centers of excellence on crop residue management innovations such as biochar and composting. Thailand has indicated its interest in developing such a center. Similarly, a consortium or networking of the research institutes, academe, national research and extension systems, and the private sector could be formed to share knowledge and expertise.

Standards. An internationally recognized metrics for sustainable rice is needed. The Sustainable Rice Platform (SRP) has just developed a global rice standard that combines the parameters for technology and good agronomic practices with synergies in productivity, sustainability, food safety and quality assurance, and value distribution (Box 7.1). The SRP is working closely with GLOBALG.A.P. with the end view of harmonizing its sustainable rice standard with international standards. Recently, the SRP rice standard is being tested in Cambodia, Thailand, and Viet Nam by private agribusinesses with support from government and international development partners. As Viet Nam and the GMS are generally net rice surplus economies,⁶ the application of the SRP sustainable rice standard merits consideration as a basis for harmonizing the food safety and quality assurance standards for sustainable rice within the GMS and leading to a "GMS brand" or trademark of GMS-produced safe, high-quality, and environment-friendly rice.

⁶ GMS countries have been net rice surplus economies for decades. See Demont and Rusaert (2017) and World Bank (2013).

Table 7.4: Comparative Indicators of Rice Farm Productivity: Thailand and Viet Nam

| | Measure | Indicator | Thailand | Viet Nam |
|--|--|---|----------|----------|
| Input | Access to affordable fertilizers | Urea price at farm gate (\$/ton) | 426 | 357 |
| | | Ratio of price of urea to price of dry paddy | 1.1 | 1.6 |
| | Depth of fertilizer market | Farmers using urea fertilizer for paddy production (%) | 100 | 100 |
| | | Farmers using NPK fertilizer for paddy production (%) | 100 | 100 |
| | Availability of seed | No. of new rice varieties released during 2009–2014 | 18 | 34 |
| | | Demand met by supply of good seeds (%) | 100 | 100 |
| Depth of seed market | Farmers using purchased seeds (%) | 60 | 53 | |
| Land | Land productivity | Yield, wet paddy (t/ha) | | |
| | | Ordinary rice | 6.1 | 7.4 |
| | | Aromatic rice | 2.6 | 6.5 |
| | | Yield, dry paddy (t/ha) | | |
| | Ordinary rice | 5.0 | 7.4 | |
| | Aromatic rice | 2.2 | 6.0 | |
| | Seed technology used | Transplanting, paddy area in monsoon season (%) | 7 | 0 |
| | Fertilizer use | Nitrogen, kg/ha | 79 | 230 |
| | | Actual versus optimum fertilizer used (%) | -12 | 156 |
| | Extent of mechanization | Farmers using ox power (%) | 0 | 0 |
| Farmers using machinery for land preparation (%) | | 100 | 100 | |
| Farmers using machinery for harvesting (%) | | 100 | 100 | |
| Land Profitability | Remuneration | Farm gate prices, wet paddy (\$/ton) | | |
| | | Ordinary rice | 376 | 220 |
| | Aromatic rice | 504 | 245 | |
| | Costs | Production costs (\$/ton) | 849 | 552 |
| Profit | Profitability, ordinary rice (\$/ton) | 1,253 | 820 | |
| Higher value added opportunity | Land under aromatic rice varieties (%) | 13 | 28 | |
| Labor Productivity | Labor intensity | Labor use (days/ha) | 6 | 23 |
| | Labor intensity | Cost of labor (\$/ha) | 9.5 | 7.2 |
| | Labor productivity | Share of hired labor in total labor (%) | 55 | 43 |
| | Labor profitability | Yield/labor use (kg/ha) | 836 | 294 |
| | Labor profitability | Profit, ordinary rice (\$/day) | 253.5 | 39.3 |
| Farm Productivity | % of dry paddy in total paddy production | Share of dry season paddy in total paddy production (%) | 43 | 54 |
| | Opportunity for producing second crop | Paddy area equipped with irrigation (%) | 100 | 100 |
| | | Wet paddy area irrigated during dry season (%) | 80 | 100 |
| | Cropping intensity | (Paddy area in dry season/paddy area in wet season)x100 | 124 | 154 |

ha = hectare; kg = kilogram; NPK = nitrogen, potassium, and phosphorus fertilizer.

Source: World Bank Group and IFC. (2016: Tables 37–41).

Box 7.1: A Sustainable Rice Platform

Rice plays a critical role in global food security. It is the staple food for more than 3.5 billion people, accounting for one-fifth of dietary energy worldwide, and providing jobs to more than 140 million smallholder farmers in developing economies. With the growing demand for food, rice production needs to increase by 25% in the next 25 years. Rice farmers are most vulnerable to climate change impacts—rising sea level, salinity, flooding, drought, and increasing temperature. Paddy rice production also contributes to about 10% of the annual global greenhouse gas emissions originating in agriculture, with more than 90% of such emissions coming from developing countries, and especially Asia.

To address these concerns, the Sustainable Rice Platform (SRP) was established in December 2011. It is a multistakeholder alliance comprising 34 international and national agriculture research institutions, agrifood businesses, and public sector and civil society organizations. The SRP was convened by the International Rice Research Institute (IRRI) and the United Nations Environment Programme (UNEP). Its mission is to promote resource efficiency and sustainability in rice trade, supply chains from local to global levels, policymaking, and production and consumption through voluntary coalitions of stakeholders.

In October 2015, the SRP issued the first global standard for sustainable rice cultivation. The SRP standard consists of 46 requirements that aim at reducing the environmental footprint of rice production while improving the lives of rice farmers. The standard's requirements cover major topics on productivity, food safety and quality assurance, worker health, labor rights, and biodiversity.

The SRP is also working with GLOBALG.A.P. toward good agriculture practices in rice production. A Working Group in SRP with GLOBALG.A.P. as a member is currently developing a reliable and efficient assurance framework for the SRP standard.

The SRP in action includes public–private and other sector initiatives for piloting the SRP standard. Some are being tested in Greater Mekong Subregion economies.

- In December 2016, an agreement to pilot the SRP Standard for Sustainable Rice Cultivation was signed between the Loc Troi Group, the International Finance Corporation, and the International Rice Research Institute. The Loc Troi Group is one of Viet Nam's largest agrifood businesses—about 37,000 Vietnamese farmers are producing rice for the company through a contract farming arrangement. The Loc Troi Group's rice mills have an annual milling capacity of 1 million tons. The Loc Troi Group aims to develop a sustainable, high-quality rice value chain, and eventually market SRP-certified rice domestically and abroad. The 2-year project will provide training on the SRP standard initially to some 4,000 farmers to assist them to grow high-quality, high-yielding, and sustainable rice; the capacity-building support will be eventually up-scaled. It is envisaged that the use of the standard will help build for the Loc Troi Group a specific high-quality rice brand that can compete in international markets.
- In June 2017, the International Finance Corporation partnered with AMRU Rice, a leading rice exporter in Cambodia, for an advisory project to implement the SRP standard and practices in the company's supply chain, involving at least 2,000 contract farmers in Kampong Cham Province. By adopting the SRP standard, AMRU Rice will be equipped to meet the requirements of international buyers and to respond to global market trends of sourcing rice products in a more sustainable manner.
- In Thailand, the Ministry of Agriculture and Cooperative and Ministry of Commerce joined forces with the Ministry of National Resources and Environment to implement a plan for shifting from conventional to low-emission rice farming so as to reduce greenhouse gas emissions by more than 26 % within 5 years. Implementation of the plan will be funded by the multidonor Nationally Appropriate Mitigation Actions facility. The shift will involve 100,000 Thai rice farmers from six provinces adopting the SRP's rice standard. The aim is to implement the plan nationwide and, if it is successful, to implement it at level of the Association of Southeast Asian Nations.

^aGLOBALG.A.P. is an internationally recognized set of farm standards dedicated to good agricultural practices. SRP = Sustainable Rice Platform.

Source: Sustainable Rice Platform. Website: <http://www.sustainablerice.org/About-Us/>

Restructuring and Linking Extension Services. The policy on extension services for rice needs restructuring to

- (1) ensure close collaboration between research and academic institutions on the one hand and government extension agencies on the other;
- (2) triangulating public research, extension, and private agribusinesses (traders, logistics providers, processors, marketers, food services, supermarkets, etc.);
- (3) incentivize the development of “on-the-ground” doctors and service centers (e.g., soil doctors, e-clinics such as those in the Philippines and those of CABI, and India’s mobile food laboratories); and
- (4) enhance knowledge and expertise sharing between fairly advanced rice economies (Guangxi and Yunnan of the People’s Republic of China, Thailand, and Viet Nam) and less developed ones (Cambodia, the Lao People’s Democratic Republic, and Myanmar).

Linking Farmers and Downstream Partners. Most important is a policy agenda for strengthening the links between farmers and their downstream partners in the rice value chains. This is partly captured by the disparity in the distribution of the value addition where the farmers and rice workers receive too small a share. There are emerging trends toward Vietnamese exporters, traders, and rice mills contracting farmers directly. Incentives for responsible contract farming arrangements may be needed.

Road Map for a Sustainable Rice Value Chain. To substantiate the GMS Strategy for 2018–2022, a road map for a GMS sustainable rice value chain could be developed. It would essentially be a strategy for harnessing the subregion’s bright prospects for being a global supplier of safe, high-quality, and sustainable rice. The road map could include (1) improved rice productivity and diversification; (2) value chain facilitation (especially for reducing wastes and losses); (3) predictable trade policy and trade facilitation services for cross-border rice trade; and (4) support for market intelligence, branding, marketing campaigns.

7.6. Conclusion and Way Forward

Viet Nam’s rice subsector needs to be strategically restructured. The subsector’s path is still operating on a business model of high-volume but low-quality rice production that applies intensive farming systems, including excessive reliance on agrochemicals, double to triple cropping, and use of year-round irrigation water for rice cultivation. The IAE study mirrored in large measure the major problems afflicting the country’s rice subsector in general. The study validated that the pathway of the present growth

trajectory is unsustainable and proposed pragmatic options for changing the growth course to one that is sustainable, climate resilient, inclusive, and growth inducing. Using scientific modeling, piloting, and benefit–cost analysis, the study proposed a menu of options that are better roads toward “producing more with less.” The IAE also showed that a mainly research focus is insufficient, and needs to be put into action through capacity building and awareness raising among the primary clients—the farmers and government extension workers. Farmers are responsive to innovations that bring them profits while tackling national environmental and global climate change challenges.

Using the lessons learned from the IAE study and their implications for Viet Nam’s rice economy, this chapter posits the directions of the R&D and the policy agenda for influencing the change in the growth course of Viet Nam’s rice subsector to one that is environment friendly, productive, inclusive, and climate resilient.

Moving forward, the restructuring of Viet Nam’s rice economy needs to be contextualized as an integral part of the GMS’ rice value chain. The GMS Strategy for 2018–2022 envisages the subregion as a web of interlinked supply chains for safe and environment friendly agro-based products. One of these will certainly be the GMS sustainable rice value chain. At this stage, it may be judicious for the GMS to develop a road map for this subregional rice value chain that is premised on the key principles laid out in the GMS Strategy and has a thematic focus on food safety and quality assurance as well as inclusive and sustainable rice chains. For Viet Nam, the urgent agenda will be moving toward low-input rice production and closer links between farmers and their downstream partners, locally and at the intra-GMS level. With better connected GMS rice value chains and a rice standard that is internationally recognized, the branding of a distinctly GMS rice will be the way for the future.

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Theme 3
**Toward Value Chains
for Safe and
Environment-Friendly
Agriculture Products**

Chapter 8

A Natural Rice Supplier: Case Studies of Reduced-Input Rice Value Chains in the Greater Mekong Subregion

Chapter 8 was prepared by Thomas R. D. Weaver, Vichelle Roaring-Arunsuwannakorn, and Van Anh Truong.

8.1. Introduction

Rice remains the key staple food for the majority of Greater Mekong Subregion (GMS) households and as such is essential for the subregion's food security and for reducing poverty and vulnerability (World Bank and IFC 2016). Although rice is a staple, rice varieties exhibiting exceptional characteristics have long been cultivated in the subregion. Historically, the bulk of the high-value rice was produced for home consumption by smallholders; only small surpluses, where available, might be sold into local markets. Thai suppliers provide a recent exception to this. However, rising household incomes and consumer awareness has led to strong growth in demand for rice with different types of characteristics, leading to greater commercial supply of higher-value varieties carrying assurances of safety and quality. Moreover, the international market for high-value rice varieties is large and there are opportunities for high-quality GMS varieties to increase their access to and share of export markets, following in the footsteps of Hom Mali of Thailand. Furthermore, the negative impacts on local environments and low sustainability of conventional cultivation of high-yield rice varieties using large volumes of synthetic fertilizer and plant protection are increasingly well recognized by producers, consumers, and policymakers.

Against this background considerable changes have occurred or are occurring in rice value chains, described by Reardon, et al. (2012) as “a quiet revolution.” The changes are altering the nature of smallholder rice value chain operations and how value chain stakeholders interact. This context offers various and considerable opportunities to promote the development of inclusive, safe, and environment-friendly rice value chains in the GMS.

The literature on rice in the GMS countries is extensive, notably the significant contributions of the Food and Agriculture Organization of the United Nations, the International Food Policy Research Institute, the International Rice Research Institute, and the World Bank Group (among many others). However, the sector is dynamic and less work has considered safe and environment-friendly rice supply and market access in the context of the GMS countries as a unit. The objective of this chapter is to briefly summarize the findings of recent case studies of reduced-input rice value chains in the GMS and to make recommendations for their sustainable and inclusive development. The studies were conducted under the Asian Development Bank-led Core Agriculture Support Program, Phase II (CASP2).

Reduced-input rice value chains in the GMS have the potential to meet growing domestic demand for quality and safety assured rice products with distinguishing characteristics. Moreover, there are opportunities to increase their presence among the food products exported from the GMS. However, policy adjustments and investments are needed for the potential to be realized.

Building on a review of literature, this chapter presents a synopsis of detailed case studies of three reduced-input rice value chains, one each in Cambodia, Thailand, and Viet Nam. The chapter outlines some of the high-priority issues that can best be addressed collectively by the GMS countries for developing reduced-input rice supply in the subregion, and then recommends an approach and proposes feasible and politically attractive initiatives to address the key issues.

The chapter has been developed within the scope of CASP2. CASP2's vision is for the GMS to become a leading producer of safe and environment-friendly agriculture products. This chapter is closely aligned with, and strongly endorses, the GMS Strategy and Action Plan for Promoting Safe and Environment-Friendly Agro-Based Value Chains 2018–2022, developed by the GMS Working Group on Agriculture for endorsement by the GMS ministers of agriculture.

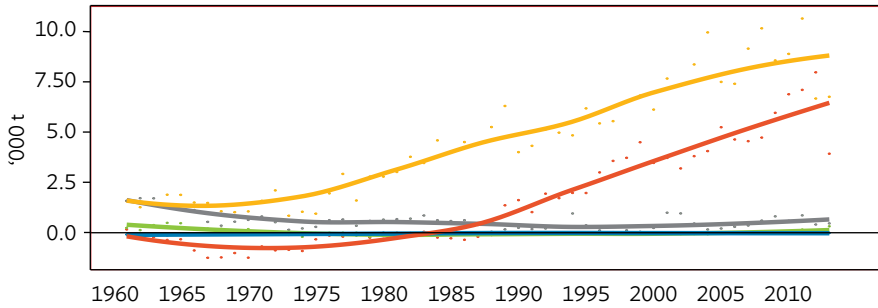
8.2. State of Play

Overview

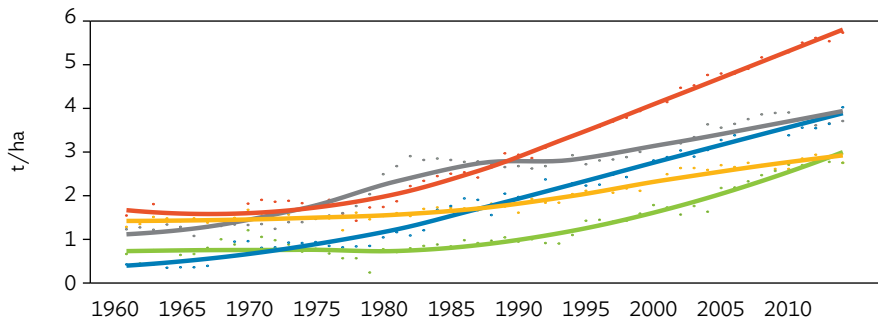
The GMS is a leader in the supply of both low-cost and premium rice and rice products to global markets (Figure 8.1.a). The GMS has enjoyed dramatic increases in rice productivity during recent decades. However, this has largely been associated with intensification of rice production through irrigation, the use of higher-yielding

Figure 8.1: Trade Balance, Rice Yields, and Fertilizer Use in Five GMS Countries

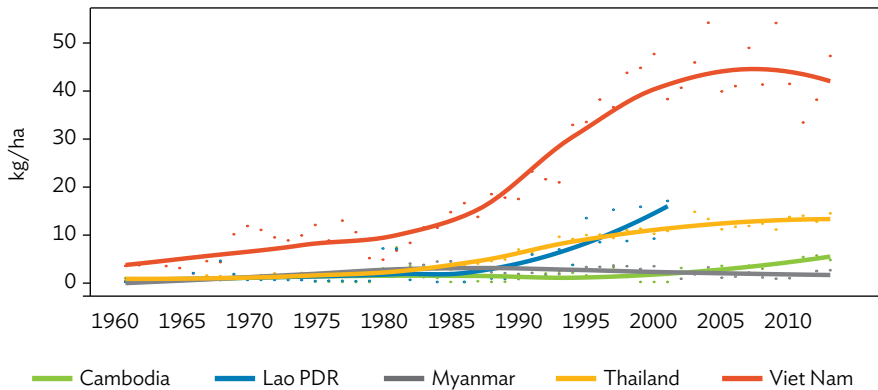
8.1.a: Trade Balance



8.1.b: Average Paddy Yield per Hectare



8.1.c: Fertilizer Use per Hectare of Rice Cultivated



GMS = Greater Mekong Subregion, ha = hectare, kg = kilogram, Lao PDR = Lao People's Democratic Republic, NPK = nitrogen, potassium, and phosphorous fertilizer, t = ton.

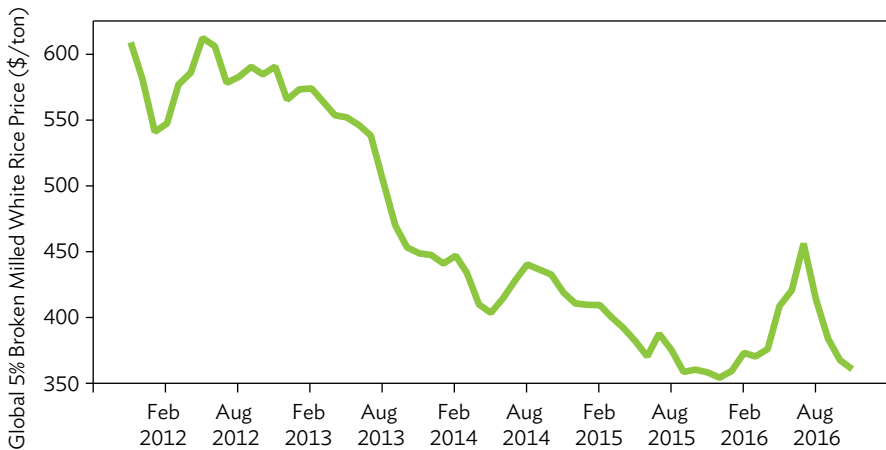
Note: No data were available for Guangxi Zhuang Autonomous Region and Yunnan Province, People's Republic of China

Source: Data from IIRRI (2016b), originally from FAO (2016).

varieties, and the increasing application of commercial fertilizers and plant protection products (Figure 8.1.b and 8.1.c). The negative impacts of increasingly intensive use of synthetic agrochemical products on land quality and local environments have become apparent in much of the GMS, particularly in the most productive agricultural areas. Rising household incomes and awareness of food quality and safety concerns in the GMS provide additional incentives for adopting safer, more sustainable production practices. In addition, rejection of rice consignments due to the presence of agrochemical residues threatens access to lucrative export markets for GMS rice. These threats to GMS rice production are exacerbated by the current and anticipated effects of climate change, the recent drop in global rice prices (Figure 8.2), and changing consumer demand. Considerable demand for high-value rice and rice products exists in markets in the GMS, the ASEAN+3,¹ and beyond. Identifying and addressing the current constraints and opportunities for developing inclusive, safe, and sustainable rice and rice product value chains in the GMS can support food security, livelihoods, and economic development throughout the subregion.

Global rice prices have diminished considerably in recent years, despite a brief revival in mid-2016 (Figure 8.2). This has been the case across core rice commodities in the global markets. Thai data show the universal decline of prices against 2013 levels for both high- and lower-value rice and rice products (Figure 8.3). Prices are predicted to remain low for the next 10 years (World Bank and IFC 2016).

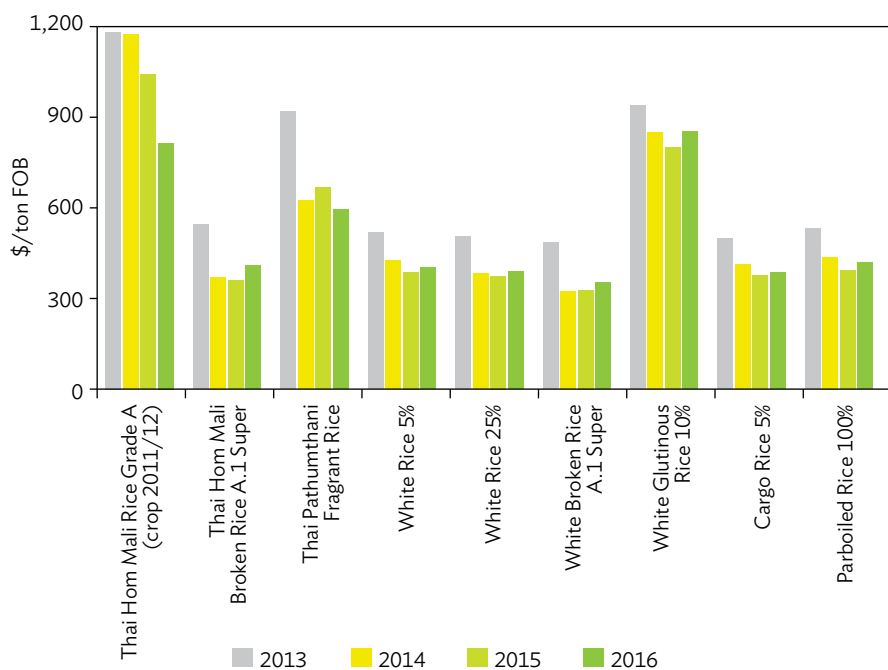
Figure 8.2: Global Prices for 5% Broken Milled White Rice, November 2011 to November 2016 (\$/ton)



Source: Data from IndexMundi (2016) accessed 20 December 2016.

¹ The members of the Association of Southeast Asian Nations (ASEAN) plus the People's Republic of China (PRC), Japan, and the Republic of Korea.

Figure 8.3: Thai Rice Product Export Prices, 2013–2016
(\$/ton, FOB)



FOB = free on board.

Source: Data from TREA (2016) accessed 26 December 2016.

Cambodia and Myanmar, and to a much lesser extent the Lao People's Democratic Republic (Lao PDR), are developing export markets for rice. These countries have potential competitive advantages over Thailand and Viet Nam in the costs of production and availability of unique fragrant rice varieties. Moreover, they all benefit from the "Everything But Arms" (EBA) trade agreement with the European Union (EU), presenting considerable potential to establish premium rice brands and leverage further investment in domestic rice value chains. However, the three countries are hampered by low technology uptake, limited access to extension services, high postharvest costs due to high losses, high milling margins and utility costs, and high costs of freight. Furthermore, rice produced in Cambodia, the Lao PDR, and Myanmar has yet to develop the brand awareness in global markets enjoyed by Thai premium rice varieties such as Hom Mali.

Guangxi Zhuang Autonomous Region and Yunnan Province, like the People's Republic of China (PRC) as a whole, are currently net importers of rice. The provinces are the most direct route for GMS formal and informal trade into the PRC market. At present, a large proportion of the rice and rice products entering the PRC through

the border provinces are thought to be of relatively low value, typically undergoing further processing on arrival. However, the increasing living standards and household incomes in the PRC are driving up demand for safer, higher-quality products. The recent spate of high-profile food safety scares in the PRC has accelerated demand for better products. The GMS countries are well-positioned to meet this growing demand but need to demonstrate effective risk management systems to obtain greater formal access to the PRC market.

Thailand and Viet Nam are the rice export powerhouses of the GMS. Thailand has long been among the top five global exporters and was joined by Viet Nam in the mid-1990s. Thailand has established a worldwide brand for premium jasmine and other fragrant rice varieties, while also exporting large volumes of lower-value high-yielding white rice, whereas Viet Nam remains largely an exporter of white rice. Both have suffered setbacks in recent years. The consequences of the populist Thai rice pledging scheme² had considerable impact on the domestic rice industry and affected rice prices in the GMS and globally. Viet Nam has recognized that current production methods are not sustainable in the long term. Moreover, Viet Nam has yet to establish a reputation for premium rice and rice products internationally, and this has been hampered by food safety scares domestically and rejection of consignments that failed to meet maximum residue levels in export markets. Each country can learn from the other and both have the research and technical capacity to support other countries within the GMS. Furthermore, by engaging at the GMS level, both Thailand and Viet Nam can manage risks more effectively and learn from their neighbors in developing sustainable production systems and policies that diversify and strengthen their rice industries.

The GMS countries share porous land borders and the volume of paddy (unhulled rice) and rice crossing borders both legally and informally is high and increasing, presenting potential food safety and quality risks to domestic consumers and exporters. Cross-border trade in paddy and rice supply between GMS countries is likely to grow further with trade liberalization within the GMS and ASEAN, epitomized by the advent of the ASEAN Economic Community. However, much of the current trade in paddy and rice is informal, with little recognition of safety and quality. Harmonized standards across borders are needed to protect consumers and producers and appropriately reward suppliers of safety and quality assured inputs, paddy, rice, and rice products. Moreover, mutual recognition of safety and quality assurances between GMS countries can increase transparency, facilitate legal trade, and increase access to export markets further afield.

² Prime Minister Yingluck Shinawatra's populist policy to buy rice from Thai farmers at above market prices and other events in global rice and commodity markets, notably India's return to rice exports, caused Thailand to lose its status as the world's leading rice exporter for a number of years and is associated with considerable, largely negative, socioeconomic and political impacts on Thailand, the GMS, and global rice markets.

Characteristics of Rice Industries in the Case Study Countries

Case studies of reduced-input rice value chains were conducted in Cambodia, Thailand, and Viet Nam. Each country has experienced considerable growth in domestic consumption and production relative to the total area cultivated, demonstrating improved rice performances and advances in the subregion's food security (Figure 8.4). However, the increased production has also been closely associated with increased application of agrochemicals (Figure 8.1.c). The current state of play of the rice sector in Cambodia, Thailand, and Viet Nam is summarized here.

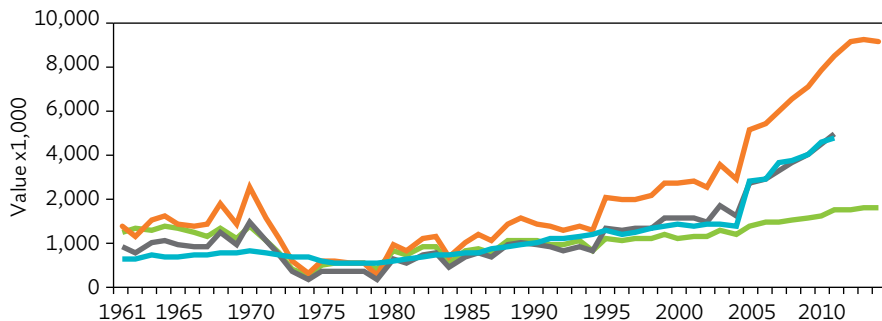
Cambodia. Cambodian rice production has kept pace with rapid growth in consumption since 1980, reflecting the country's increasing population and household incomes. Cambodian rice exports rose dramatically during 2008–2015, to over 350,000 tons/year. This is largely due to the signing of the EBA trade agreement with the EU, which provides a considerable advantage to Cambodian exporters. The large majority (90%) of Cambodian rice exports are to the EU and Russian Federation markets (Slayton 2015). Moreover, an increasing share of exports are premium fragrant rice varieties—up from 10% of exports in 2010 to 45% in 2013—for which Cambodian exporters have received a \$250/ton premium in the EU market relative to Thai fragrant varieties (USAID 2015). Giroud (2013) cited figures of \$1,100/ton for fragrant varieties compared to \$440/ton–\$580/ton for white rice. Cambodian rice has won global rice awards on three occasions in recent years, increasing the country's reputation as a producer of high-quality rice. Cambodia's main export competitors remain Thailand for fragrant rice in high-value markets such as the EU, Viet Nam in white rice markets such as the Philippines and Indonesia, and Pakistan and Myanmar in low-quality white rice markets primarily in Africa (Slayton 2015).

The effects of the EBA agreement may see Cambodian exports reach levels similar to the country's peak export period of the early to mid-1960s. However, achieving the national objective of exporting 1 million tons of rice per annum remains a challenge due to the industry's structure, bottlenecks within rice value chains, and costly essential services such as transport and utilities. These issues are discussed in greater detail in the next sections.

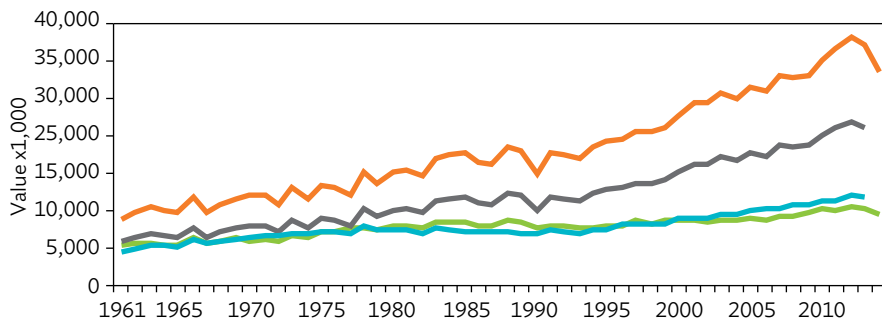
Thailand. Thailand is currently both a low-cost supplier of white rice and low-value rice products and an established supplier of premium rice products, particularly fragrant varieties such as Hom Mali, in both domestic and global markets. The production of lower-yield, higher-quality varieties is reflected in lower average paddy yields per hectare than in Viet Nam. Thailand has successfully developed strong global brand recognition for such products as Hom Mali rice varieties and products. Thailand

Figure 8.4: Total Rice and Paddy Production, Area, and Consumption, Cambodia, Thailand, and Viet Nam

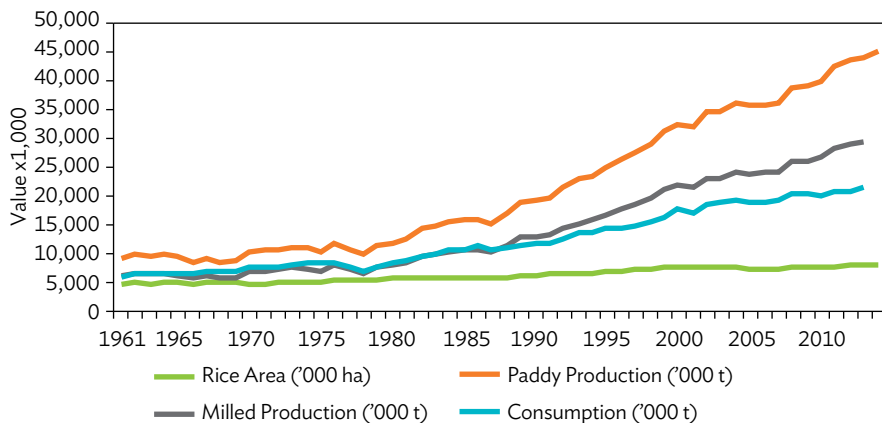
8.4.a: Cambodia



8.4.b: Thailand



8.4.c: Viet Nam



ha = hectare, t = ton.
 Source: Data from IRRI (2016b), originally from FAOS (2016).

has established protected Geographical Indications (GIs) for varieties such as Khao Hom Mali Thung Kula Rong-Hai, Sakon Dhavapi Haang Golden Aromatic Rice, and Sangyod Muang Phatthalung Rice. These are now recognized in international markets. However, considerable quantities of low-yielding, high-value local rice varieties are still cultivated. The Thai rice industry is mature and diversified, presenting a useful model for neighboring GMS countries.

There are opportunities to further strengthen Thai rice supply, particularly in the less well-connected areas of the country, such as the northeast. Priorities include building greater resilience of the rice value chain to biophysical threats such as flooding and droughts; ensuring sustainable production practices; increasing access to mechanized services for land preparation, harvesting, and postharvest processes; and increasing access to capital among value chain stakeholders. These challenges mirror those faced throughout the region. Moreover, Thailand's recent experiences under the rice pledging scheme provide a strong warning to policymakers domestically and in neighboring countries.

Thailand is well positioned to support other GMS countries in strengthening their rice value chains. Building on past experience and considerable technical and research and development capacity, Thailand can take a role at the forefront of developing the GMS as a global hub for sustainably produced premium and niche rice varieties and products.

Viet Nam. Viet Nam produces large volumes of low-yielding, high-value rice varieties to meet household needs and for the domestic market. High and increasing domestic demand for premium rice products with assurances of food safety standards has driven a surge in the domestic supply of niche rice and rice products. Organic rice production is growing quickly. Other reduced-input approaches to rice cultivation, such as the system of rice intensification, have been promoted for many years with slow uptake, primarily in northern Viet Nam. The Irrigated Rice Research Consortium and the national agricultural research and extension systems champion the “three reductions, three gains” and, more recently, the “One Must Do, Five Reductions”³ to promote more sustainable, safer, and higher-quality rice production (Demont and Rutsaert 2017).

As a major global exporter, Viet Nam resembles Thailand in the maturity of the rice industry. Moreover, Viet Nam's achievements in increasing food security and reducing poverty since the early 1990s are near unparalleled internationally. Viet Nam has become increasingly integrated with the global economy since the early 2000s;

³ “One Must...” use quality seed, and reduce seeding rates and the use of water, fertilizer, insecticides, and postharvest losses.

in 2008 Viet Nam joined the World Trade Organization and has signed a number of bilateral and multilateral free trade agreements. This opening of the economy has provided opportunities for rice exporters to access new markets. However, Vietnamese exports are not diversified in the way Thai rice is. Vietnamese rice exports are largely relatively low-grade rice from high-yielding varieties going to Indonesia, the Philippines, and West Africa. Viet Nam is yet to establish a brand for safety and quality assured premium Vietnamese rice, as achieved by Thai fragrant rice and South Asian basmati.

The opportunity to develop exports of higher-value products that reduce the costs on natural resources is recognized in Vietnamese national policy. Policy is shifting toward higher-value rice and more sustainable reduced-input production that lowers the impacts of rice on natural resources. Viet Nam has produced premium rice varieties for centuries, but they are largely consumed in the domestic market. Thailand's experiences provide lessons in developing a globally recognized brand in premium rice markets for Viet Nam and neighboring GMS countries.

8.3. Study Design and Scope

The study employed qualitative and quantitative methodology, involving secondary data collection, key informant interviews, focus group discussions, and surveys. Literature and secondary data were thoroughly reviewed. Interviews were conducted with 10–20 key informants in each country. Three focus group discussions were conducted per location, each involving 10–12 participants, representing key nodes in reduced-input or conventional rice value chains. In addition, 80–100 surveys were collected from persons representing input suppliers, producers, processors, traders, wholesalers, and retailers in each country. The data collected were used to map value chains in detail and calculate key indicators such as gross margins and profits along the length of value chains. The collection of detailed surveys and in-depth qualitative data from interviews and focus group discussions allowed triangulation and cross-checking of findings.

Case studies of reduced-input rice value chains were conducted in three locations:

- (1) Battambang Province, Cambodia, was selected as an area of high rice production in Cambodia where the nongovernment organization/company Center for Study and Agriculture Development in Agriculture (Centre d'Étude et de Développement Agricole Cambodgien, or CEDAC) had previously provided extension to rice producers on organic/low-input rice cultivation techniques. Moreover, considerable volumes of paddy and milled

rice from Battambang are exported to Thailand through both formal and informal channels.

- (2) Roi Et, Thailand, one of the five provinces in the Thung Kula Rong Hai area, was selected as an important rice producing area with third-party certified organic rice supply chains.
- (3) Thuong Phuc Village, Chuong My District, was selected in Viet Nam as most of the land in this area had been converted to organic rice production, which is collectively branded as PAMCI-Organic rice.⁴

8.4. Summary of Results

The farm sizes, production yields, profits, and gross margins calculated broadly reflected reported norms at key nodes in value chains in the countries and areas studied (Tables 8.1 and 8.2).

Table 8.1: Rice Areas Cultivated and Paddy Yields of Case Study Participants

| Variable | Cambodia | Thailand | Viet Nam |
|--|------------|-----------|-----------|
| Median Rice Area Cultivated (ha, mean) | 7.0 (10.4) | 3.0 (4.8) | 0.3 (0.3) |
| Median Paddy Yield (t/ha, mean) | 2.0 (2.1) | 2.1 (2.0) | 6.9 (6.8) |
| Average National Yield (t/ha) | 3.0 | 3.0 | 5.8 |

ha = hectare, t = ton.

Source: Case studies conducted by the Core Agriculture Support Program Phase II (ADB 2016).

Producer margins were relatively consistent across the study area (Table 8.2). The Vietnamese producers surveyed all PAMCI-Organic rice produced and were able to obtain considerable premiums for their products by aggregating and marketing directly to retail outlets in Ha Noi and Ho Chi Minh City, reflected in the high profit margins. The study findings were consistent with other reports documenting high Cambodian miller margins. Interestingly, the gross margins for millers calculated in Roi Et Province were similar to, in fact higher than, those calculated in Battambang. The high margins recorded in the Roi Et case study may relate to the remoteness of the area, the limited milling capacity available to producers and paddy traders, and/or milling of higher-value rice varieties, allowing millers to set higher margins. The relatively limited milling capacity in Roi Et could account for the relatively low margins received by producers in the area. That Vietnamese millers received relatively low margins and profits per

⁴ The PAMCI-SAFERICE Project stands for “Production and Marketing Capacity Improvement for Sustainable Agriculture and Farmer Empowerment, Rice Improvement, and Cleaner Environment.” This project was funded by the Japan International Cooperation Agency and was carried out jointly by Agro-Environmental Laboratory under the University of Tokyo and Hanoi University of Agriculture. <https://pamcisaferice.wordpress.com/about-pamci>

unit may reflect greater competition in a better-connected area and the milling of considerable volumes of lower-value rice in comparison with the other study areas.⁵

Table 8.2: Median Profits and Gross Margins at the Farm Gate and from the Mill

| Variable | | Cambodia | Thailand | Viet Nam |
|------------------------|---|-------------|-------------|--------------------------|
| Farm Gate (paddy) | Median estimated profit (\$/kg) | 0.2 (0.2) | 0.1 (0.2) | 0.5 (0.5) |
| | Median estimated gross margin, (% , mean) | 54.8 (54.0) | 63.9 (61.7) | 76.6 (76.6) |
| Ex-Mill (all products) | Median estimated profit (\$/kg) | 0.2 (0.3) | 0.4 (0.4) | 0.06 ^a (0.1) |
| | Median estimated gross margin (% , mean) | 41.0 (42.0) | 42.8 (43.5) | 13.8 ^a (22.7) |

kg = kilogram.

^a Based on the survey of millers trading conventional rice in the same area.

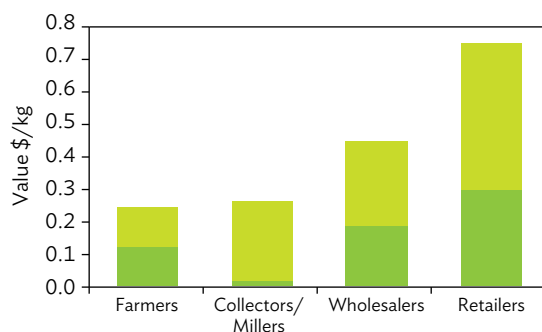
Source: Case studies conducted under the Core Agriculture Support Program Phase II (ADB 2016).

In terms of value addition along the three supply chains the most notable observations are that (1) the proportion of value added post-harvest was quite consistent across the studied chains; (2) suppliers in Battambang received very low prices and no price differentiation for higher value varieties or use of reduced-input production methods; (3) producers in the Thai case study did not receive greater value if rice was exported versus sold domestically; and (4) the vertical integration of the PAMCI value chain in Viet Nam allowed considerable value to aggregate with producers (Figure 8.5).

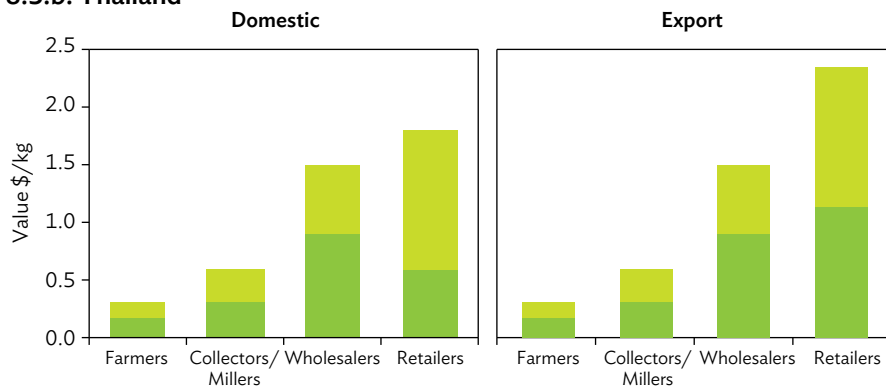
⁵ Only Vietnamese millers of conventionally grown paddy were included in this analysis as the PAMCI-Organic rice producers employed a mill on a fee-for-service basis.

Figure 8.5: Value Addition at Key Nodes Along the Case Study Value Chains

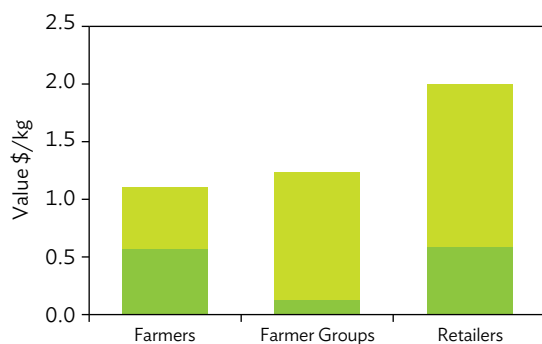
8.5.a: Cambodia



8.5.b: Thailand



8.5.c: Viet Nam



Notes: The lower dark area of the bar plots depicts costs; the upper, lighter shaded area indicates value added. Plots are annotated with the percent of value added at each node along the chain. The minor discrepancies between input costs and value added at each stage in the Thai and Vietnamese cases likely reflect different diversified input suppliers and various grades of rice milled/sold and/or flaws in data collection.

Source: Case studies conducted under the Core Agriculture Support Program Phase II (ADB 2016).

8.5. Issues and Gaps

The study assessed the value proposition of the GMS as a supplier of premium rice and rice products. This discussion draws on the findings of the specific case studies and the wider literature to identify avenues for further investment and activities to promote inclusive, fair, safe, and environment-friendly rice supply in the case study areas, as well as nationally and in the GMS context.

Three overarching themes were considered:

- value chain efficiency, value addition, and branding and marketing;
- risk management and safety and quality standards and assurances; and
- investments;

Value Chain Efficiency, Value Addition, and Branding and Marketing

The case studies demonstrate that smallholder reduced-input rice production can be profitable. However, producers in the case studies were hampered by variable input quality, environmental challenges associated with the overuse of agrochemical inputs, the effects of climate change, small cultivated areas, and lack of organization among producers and coordination with other value chain actors up- and down-stream. The high level of urban migration across the GMS threatens smallholder rice production in the subregion, increases loss of biodiversity, and increases urban poverty. Many consider this to be the greatest current challenge for poverty reduction and future food security in the subregion. Reducing the drain of labor from rural areas in the GMS begins with revitalizing rice. The World Bank and IFC (2016) noted the need to focus on farm incomes for paddy producers, recognizing that costs have to be reduced along value chains to improve farm profitability. The authors identify a series of potential policy and investments along value chains to achieve this, many of which were seen in the case study value chains. The series includes improving the input quality and access, reducing utility costs and the costs of transport through policy and infrastructure development, and promoting trade (World Bank and IFC 2016).

Costs of Supply. The insufficient supply of quality seed and subsequent low farm yields and high postharvest losses hampered smallholder productivity in Battambang (USAID 2015). This is also regularly reported in the Lao PDR and Myanmar for both farmer seed and the quality and availability of certified seed. Current seed supply is dominated by public sector suppliers in Cambodia, the Lao PDR, and Myanmar. Policies are needed that promote private sector engagement, particularly in seed

multiplication and research and development. In Cambodia, this would begin with developing a supportive policy framework around the Seed Law. Policies need to spread investor risk by providing cost-effective support for government certification of seed and access to credit at reasonable rates. Moreover, national bodies have a role to play in promoting private seed supply; for example, in Myanmar there is considerable mistrust surrounding commercial seed suppliers.

The issue of high price and variable quality of fertilizers and plant protection was raised repeatedly during the study and is a problem throughout the GMS. The porous borders in the subregion make this a regional issue. Thailand and Viet Nam, and to a lesser extent the PRC, produce the bulk of products circulating in the rest of the GMS. Limiting the movement of these inputs is unrealistic; therefore, the establishment and effective enforcement of common certifications, through incentives and effective regulation and testing protocols, are in the interest of all. Quality and price issues surrounding key inputs present an opportunity to further promote lower-input production methods. Continuing to promote demonstration sites and circulation of performance figures, and encouraging “premium” market channels that promote improved on-farm performance, such as those of CEDAC and Amrurice (one of the largest Cambodian integrated rice suppliers), are the most obvious means of promoting these approaches.

Although Cambodia’s costs of production are considerably lower than those of Thailand and Viet Nam, Cambodian milled rice struggles to compete ex-mill and in overseas markets due to Cambodia’s high milling and transport costs, inefficient export procedures, and port charges. Slayton (2015) estimated Cambodian milling and transport costs were nearly double those of Viet Nam in 2011, mirroring estimates that have been made for the Lao PDR and Myanmar. To increase Cambodia’s competitiveness, further investment is needed in basic infrastructure related to land and sea freight. Cambodian millers set high gross margins largely to cover their high utilities costs and to build up working capital. Increasing millers’ access to affordable credit to alleviate working capital issues may allow reductions in margins, improving competitiveness. Moreover, utility costs must be reduced. The increased use of rice hulls as fuel has improved the situation, reducing outlays for diesel and electric considerably. However, more needs to be done.

Inclusiveness. Women, smallholders, and small and medium-sized enterprises form the backbone of much of the rice supply in the GMS. Many of the producers in the case studies could be described as vulnerable in social and/or economic terms. Increasing rice value chain efficiency and inclusiveness can support rural development and drive safe and sustainable rice supply. Inclusiveness is a potential driver of the revitalization of rural areas in the GMS. Contracted supply arrangements may present opportunities

to better integrate smaller players but also present risks of less scrupulous players tying producers into unfavorable arrangements. Appropriate regulatory and legislative oversights need to be in place to ensure ethical contractual arrangements that are fair and inclusive.

Value Chain Efficiency. The case studies indicated that the fragmented nature of smallholder rice value chains in more remote areas, such as Battambang and Cambodia more generally, can present a difficult environment for extension and technology transfer. The value chains in the Cambodian case study were fragmented with numerous potential intermediaries between paddy producers and myriad end markets (termed “intermediationally long” in Reardon et al. [2012]). In contrast, the chains observed in Viet Nam and Thailand provided examples of considerable vertical integration in reduced-input rice value chains managed by smallholders and small and medium-sized enterprises—geographically long but intermediationally short chains. The small areas cultivated by household producers in the case study, particularly notable in Viet Nam, provided further evidence that greater organization is essential to increase the profitability and economic sustainability of smallholder rice production in a region where vertically integrated supply chains are becoming increasingly prevalent. Organization is needed to build the economies of scale that reduce input costs and provide efficiencies in postharvest processing and value addition, including the branding and marketing of products.

The Cambodian case study described productive but fragmented rice value chains in a relatively remote area. Many of the strengths of the suppliers are similar to those of rice value chain stakeholders in other areas of the GMS, such as the availability of local high-quality varieties; relatively low input usage and costs of production; and often good growing conditions, at least seasonally. The producers are hampered by limited value chain coordination, suffer the impacts of various biophysical shocks and stressors, endure high postharvest losses, and are hampered by high freight costs. The large majority of sales are conducted at the farm gate, in part due to limited access to dryers and storage capacity, and often cash is needed to repay input suppliers. Market information is largely collected from neighbors, friends, and family. Increased organization can strengthen horizontal and vertical linkages, facilitate information sharing such as on prices, and level playing fields in terms of decision-making at harvest. The limited use of reliable moisture meters in assessing paddy quality and value continues to inhibit fair negotiations at the farm gate in many areas.

In contrast, the PAMCI model in Viet Nam demonstrated the value that greater organization among smallholders can deliver to producers with a good product. PAMCI-Organic rice production is an example of a village-centered, smallholder-based vertically integrated rice supply chain. Stakeholders in the chain received

considerable advantages from aggregated input procurement and in the branding and marketing of products. The model demonstrated the advantages of organized, short, farmer-owned vertically integrated chains in the rewards to producers and allied value chain actors, and for communicating traceability and quality characteristics to buyers. Equally importantly in the context of Viet Nam and the GMS, the PAMCI rice supply chain demonstrates environmentally sustainable supply of a higher value product.

Although there were clearly opportunities to improve the functioning of the PAMCI chain, the approach has merit and potential for replication in other areas of Viet Nam and potentially elsewhere in the GMS. The PAMCI model suffers from the limitations of many such initiatives that rely on intensive technical support over extended periods, primarily in terms of scalability. However, key lessons can be learned from the initiative and the many like it around the region. Although assessments have been conducted in the past, a broad “state-of-play assessment” of such initiatives around the region could elicit key lessons and components of such schemes that might be more readily rolled out in other locations.

Further investment in producer organization, effective and accessible extension, mechanization in land preparation, and (perhaps most pressingly) reduction of postharvest losses and costs of freight are essential to improve the competitiveness of smallholder rice supply in many areas of the GMS. In addition to reducing efficiency and increasing postharvest losses, the lack of dryers and storage facilities is associated with periods of over and undersupply, affecting prices and the negotiating power of producers.

Generating Price Premiums at the Farm Gate. In many areas of the GMS, little or no product or price differentiation for organic or reduced-input rice production occurs, as was observed in the Battambang market. This relates to the limited available avenues for marketing rice products with specific quality characteristics in rural areas and limited, though increasing, consumer awareness and demand, particularly in rural areas. Although organic/low-input production reduces input costs and producers recognized the potential benefits in terms of soil, water, and broader natural resource management, several study participants had stopped using these techniques due to their increased labor requirements. The lack of differentiation of low-input/organic rice in the local market value chains does little to embed employment of reduced agrochemical usage practices. However, this may change quickly, as demand rises with increasing incomes and awareness among consumers. For example, in Cambodia the efforts of CEDAC and, more recently, Amrurice to establish vertically integrated organic rice supply that integrates smallholders are showing great promise. There is considerable potential to establish additional rice GIs in the subregion, such as Phkar Kukey in Cambodia.

Value Addition. The study observed opportunities to add further value to the rice, many of which are likely applicable in other areas of the GMS. Examples include parboiling and product development such as processing of “instant” precooked rice and other preparations such as an instant “Khmer fried rice.” Markets for these products are growing internationally. Slayton (2015) estimated global trade in parboiled rice to be about one-third that of regular milled rice and increasing. In Roi Et Province, opportunities to improve and extend product processing exist, such as improved packaging and further investment in branding and marketing. The PAMCI–Organic rice supply chain can also readily venture further into product development. Viet Nam has extensive small-scale rice and rice product processing capacity and a rapidly growing large-scale industry in this area. In Battambang, the supply of paddy with a consistent level of quality needs to be consolidated before such ventures can be considered.

Opportunities to market products made from quality assured rice byproducts are also evident. Examples include rice flour, rice starch, syrups, oils, and proteins. Other rice products include noodles, rice paper, cakes, and biscuits, much of which is currently imported in many areas of the GMS. Other avenues for investigation include puffed rice products, rice milk, rice “wine” (a beer), and pet food manufacturing. Again, packaging, branding and marketing, and logistical bottlenecks must be considered. Improving the management of by-products can reduce costs of supply while supplementing incomes, and many approaches are applicable throughout the GMS. The International Rice Research Institute has conducted extensive work on safe, sustainable rice straw management—such as disseminating straw baling technology from Viet Nam. This presents new business models for adding value to residues for use as animal feed and mushroom production. Other treatments being promoted include efficient biochar production, treatment with urea and *Trichiderma* fungi, and anaerobic digestion for more efficient use as a clean fuel (IRRI 2016a).

The surge in global popularity of dishes originating in the GMS presents great potential to develop product brands and ranges that promote geographically specific, niche, premium value-added products such as GI organic products from the region. This may be achieved through processing, preparations, packaging, branding, and marketing. Discussions with branding and marketing specialists in Europe also indicate the surge in demand for ready-to-eat rice preparations (Windward Group, pers. comm. with author, T. Weaver).

Such new products may require further investigation of packaging technologies and current national and subregional capacity, for example some global leaders in the packaging industry operate factories around the region, notably in Chonburi and Rayong, Thailand. Linking to current service providers within the region could minimize

capital investment requirements, circumvent current freight bottlenecks, and avoid high costs that hamper market access in areas of the GMS such as Cambodia.

Branding and Marketing. Hand-in-hand with product development comes investment in branding and marketing. The establishment of the Khao Hom Mali Thung Kula Rong-Hai GI exemplifies a relatively new approach to brand establishment on the basis of *terroir*,⁶ inputs, and quality assurances for agriculture products in the GMS. This supply chain offers lessons for suppliers of niche rice and rice products in other areas within the GMS. The specifications of the GI protection indicate that GI-registered producers better managed local natural resources and received price premiums and more stable prices for their products. The value chain's resilience to shocks, such as fluctuations in commodity prices and climatic events, appeared to be greater than that of conventional rice suppliers. Moreover, growing domestic and international demand for GI products indicates that stakeholders' positions will become stronger over time.

Market Access. The EBA agreement, to which the Lao PDR and Myanmar are also signatories, and favorable trade agreements with the Russian Federation have resulted in a dramatic rise in Cambodian rice exports since 2010. While it is in Cambodia's interest to continue to develop these markets, other markets in Asia and Africa also offer great promise. Establishing bulk carriage capacity, whether in Cambodia and Myanmar and/or via Thai and/or Vietnamese ports, could facilitate access to stable and potentially lucrative markets for lower-quality milled white rice in West African, Indonesian, and Philippine markets. Moreover, Cambodian exports already supply Malaysia and the PRC, and there are opportunities to grow the presence of premium Cambodian and GMS rice in these markets.

Alongside increasing exports of premium fragrant rice varieties, Cambodian suppliers have gained access to export markets for organic rice. Although the global organic rice market is relatively small,⁷ it is likely growing. If Cambodia can differentiate organic rice products by qualities such as variety and establish a brand, the country could leverage favorable trade agreements, such as the EBA, to carve out a niche in high-value markets such as the EU. This is also true of Lao PDR and Myanmar suppliers. Thailand exports approximately 4,000 tons of organic rice yearly (Slayton 2015), while in Viet Nam only the Hoa Sua company exports organic rice and in very small volumes of 70 tons–80 tons yearly. The Vietnamese case is particularly interesting as domestic demand for organic rice is now so high that Hoa Sua sells 80% of its organic product in the domestic market. Cambodia is already matching or surpassing Thailand in organic rice exports and the demand exists in Viet Nam.

6 A French word that conveys the geographical origin and the cultural and historical identity of products.

7 Slayton (2015) estimated global trade in organic rice at only 20,000 tons/year–30,000 tons/year.

As a major supplier of rice to export markets in Asia and around the world, Thai rice value chains and policy environments present many lessons for GMS producers. The advantages of larger, more contiguous rice fields are demonstrated in Thailand when compared to regional neighbors, such as Viet Nam and producers in the Red River Delta, where farm sizes are very small and often scattered. Furthermore, Thai stakeholders enjoy the advantages of relatively modern postharvest processing and lower freight costs associated with a larger economy and more advanced transport and logistics infrastructure and services. However, there are opportunities for Thailand to further aggregate and reduce transaction costs within supply chains.

Many of the reduced-input rice products in the GMS exhibit qualities that can appeal to consumers in higher-value export markets. The trade in these products requires greater market access. Such access can be facilitated by the establishment of track-and-trace systems, including bar codes, to demonstrate effective risk mitigation, product provenance, and quality assurance. Piloting track and trace systems with higher-value rice supply chains, such as GI-protected rice suppliers, in collaboration with specialists such as GS1 has considerable potential. GS1 has worked on track-and-trace systems for many agriculture products globally.

Risk Management and Safety and Quality Assurances

Multisectoral coordination between ministries is needed to improve the effectiveness of safety and quality management systems. It is essential that the public sector, private sector, civil society, and researchers are engaged in coordination and decision-making processes. Government bodies other than the ministry of agriculture—such as ministries of commerce, trade, science and technology, health, and environment—play key roles in the business environment, the natural environment, and technical considerations such as regulatory systems and enforcement.

Viet Nam must address concerns surrounding food safety. For rice this relates primarily to agrochemical residue levels. Although residue levels in rice are a concern across the GMS, Viet Nam is particularly vulnerable at present due to its considerably higher use of commercial fertilizers and plant protection products in fields. More generally, however, the capacities to analyze risks to food safety and to meet export market requirements are suboptimal across the region, except in Thailand. Viet Nam's infrastructural and technical capacity for risk analysis is considerably stronger than that in the neighboring Cambodia, Lao PDR, and Myanmar. However, much of the GMS, including Viet Nam, struggles to effectively implement adequate surveillance systems to protect consumers, demonstrate equivalence, and avoid rejection from foreign markets.

Fundamental to this is the establishment of accessible, reliable, and trusted certification systems, whether that is through promotion of the Sustainable Rice Platform global standard for sustainable rice, promotion of good agricultural practices (GAPs) in the forms of the GLOBALG.A.P. and the ASEAN GAP in domestic markets, improved implementation of national GAP standards, third-party organic certifications, holistic approaches such as GI or participatory guarantee systems, or myriad other potential assurance schemes.

Investments

Limitations in infrastructural capacity, which hamper the development of reduced-input rice and rice value chains more generally, have been identified throughout this chapter. The priority investment needs vary across the GMS. In more remote areas, particularly in the less economically advanced GMS countries, bottlenecks in drying and storage capacity, and high costs of utilities and transport hamper competitiveness and reduce margins along value chains. Addressing these shortcomings requires investment in infrastructure and appropriate policy changes and institutional capacity building that encourage private sector engagement. Priority issues include electricity grids, water supply, roads, ports, and related transport and logistics infrastructure.

In addition, investment in input, production, and product laboratory testing facilities and operating capacity are needed. Access to affordable and timely laboratory services can improve standards and mitigate and manage risks to food safety and quality for domestic markets and for increased access to export markets. While some investments, such as road, electricity, and water infrastructure, are primarily a public good and therefore a government responsibility, many of the current shortcomings can be addressed by private or public-private investment arrangements.

8.6. Recommendations

Initiatives and policies are needed that support, direct, and catalyze public and private investment in GMS rice value chain development. Greater organization and integration of smallholders into efficient value chains, more reliable quality and safety assurance systems, reduced losses and greater value addition and branding and marketing, domestically and in export markets, can increase the share of sustainable and higher-value rice and rice products from the GMS.

Value Chain Efficiency, Value Addition, and Branding and Marketing

Review and harmonize policy for and regulation of seed quality and agrochemical inputs across the GMS. For example, in Cambodia appropriate policies are need to support the recently established Seed Law.

Promote the virtues of local GMS rice varieties by strengthening current rice GIs and establishing additional GI protections. The GMS is exceptional in the diversity of rice varieties currently cultivated, which has led to the registration of several rice GIs domestically and in export countries.

Continue to fund and direct research and development into reduced-input rice production methods and disseminate findings through subregional platforms. Novel approaches to extension, such as the use of social media, can increase outreach. Given the high levels of connectivity in the GMS, information and communication technology (ICT)-based approaches to extension hold enormous promise for increasing outreach; however, best approaches have not yet been well-established. The Agriculture Information Network System (AINS) 2.0 and the GRET-coordinated⁸ Agro-Ecology Learning Alliance in South East Asia (ALiSEA) are examples of ICT-based knowledge sharing platforms in the GMS that can be harnessed to promote better practices, producer organization, and market linking.

Identify best practices in producer organization and innovative approaches to creating strong market linkages along smallholder-based rice value chains. The case studies reemphasize the well-known fact that organized smallholders can generate efficiencies of scale, enabling lower costs of production and processing and facilitating delivery of extension while promoting peer-to-peer learning. The high prevalence of smart phones and internet accessibility in the GMS present opportunities to build useful farmer-to-farmer relationships through services such as the AINS 2.0, for example. Novel initiatives that draw on other sectors, such as the “MATCH: Mekong AgTech Challenge” are also ripe for developing new ways of building social capital and creating and disseminating technical and market-related information.

Investigate opportunities for further value addition and establish joint branding and marketing initiatives among suppliers of safe and environment-friendly rice and rice products subregionally. The market for safety and quality assured rice in the GMS is growing rapidly and there is considerable global demand for niche

⁸ GRET: originally known as Groupe de Recherche et d'Échanges Technologiques.

rice and value-added rice products with premium quality characteristics, such as GI. Further investigation of consumer preferences and behavior in the subregion is needed to determine where opportunities currently exist and where they are likely to develop in the short, medium, and long term. Smallholders can provide the products if supply chain efficiency can be improved and branding and marketing initiatives are coordinated. Many novel rice-based products are produced in the GMS. The increasing popularity of prepared rice in the EU, for example, could be harnessed through the production and marketing of GMS specialty high-value rice-based dishes. Examples include ready-to-eat premium Cambodian amok fish and rice, Vietnamese pho bo, and Myanmar fermented tea leaves and rice. Branding and marketing initiatives can build on the successful experiences of branding and marketing high-value products from within the region, such as Hom Mali from Thailand.

Establish more transparent and efficient systems and greater traceability for paddy and rice trade across GMS borders. The World Bank and IFC (2016) estimate that cross-border trade in rice accounts for more than 60% of total exports from Cambodia, the Lao PDR, and Myanmar and 26% of total export in Viet Nam. A large, but difficult to estimate, proportion of rice trade in the GMS occurs through informal pathways. Facilitating services for cross-border trade will help to reduce the transaction costs along the chain, increase transparency, and protect industries and consumers from substandard products. Moreover, improving traceability and market access within the GMS can allow suppliers of premium rice products to meet growing demand in urban centers around the region.

Risk Management and Safety and Quality Assurances

Coordinate risk management systems for diseases, pests, and chemical residues. This is a crucial step toward harmonizing systems between GMS countries. Harmonized systems offer efficacy and efficiency benefits. Harmonizing can result in mutual recognition of equivalence and thereby facilitate formal intra-GMS trade and exports beyond the subregion. Demonstration and recognition of equivalence in risk analysis capacity with international standards and pest- and genetically-modified-organism-free status will increase export market access for rice. Ideally this would culminate in national certification with established surveillance systems that adequately reassure current and potential trading partners.

Harmonize quality and safety assurance standards and regulatory environments from inputs through to end products between GMS countries. Improve hygiene the length of value chains to enhance the safety of GMS rice and reduce the risk of costly rejections by export markets. Increase recognition and trust in standards among

consumers and trading partners by establishing robust systems and transparently communicating the processes and results of surveillance activities, good or bad. Establishing recognized and trusted assurances among consumers and retailers across GMS borders by recognizing equivalence can promote safe cross-border and environment-friendly rice and rice product supply chains.

Investments

Catalyze and direct public and private investment in infrastructure for safe and environment-friendly rice-related value chains. Legislative and regulatory systems need to be in place to ensure transparent and ethical terms and conditions for investment. Key needs include postharvest processing infrastructure such as for good quality drying and milling, particularly in less-developed areas of the subregion; utilities; transport and logistics infrastructure; border and wider export trade infrastructure; and risk analysis infrastructure. Greater transparency in regulations, terms, and conditions for doing business can reduce real and perceived risks to investors.

Short-Term Initiatives

Six initiatives were proposed in 2017.

- (1) Establish access to extension materials on reduced-input rice and marketing through AINS 2.0. Identify areas for potential collaboration with the “MATCH: Mekong AgTech Challenge” on specific communication and data-related solutions to social, technical, and market-related bottlenecks. (Action on this initiative commenced in late 2017.)
- (2) Review national regulations for addressing rice safety and quality issues, especially hygiene. Assure that farmers have accurate and transparent information about input constituents and their optimal use for domestic and export markets.
- (3) Establish standard operating procedures for the flow of rice samples for residue testing between GMS countries. Establish domestic food safety and quality metrics and skills. This may be done in partnership with the United Nations Economic Commission for Europe.
- (4) Pilot GS1 barcode-based systems for tracking and tracing exported premium rice varieties from the GMS, such as GI-protected rice and organic rice. (Action on this initiative commenced in late 2017.)
- (5) Review current national regulations and legislation on contract paddy supply arrangements to ensure inclusiveness, transparency, and fairness.

- (6) Establish standard operating procedures for ethical investment (domestic and foreign) in rice processing facilities and wider value chain investments among the GMS countries.

8.7. Conclusions

The disparities between and within GMS countries in economic development and the effectiveness of current legislative and regulatory systems present risks to neighboring areas due to the integrated nature of GMS rice supply. To protect suppliers and consumers in domestic and export markets, GMS countries need to act collectively to build essential controls for agricultural input quality, postharvest processing, and food safety and quality testing and assurances. Sharing of technical information, capacity, and rice value chain facilities and services between GMS countries can support sustainable rice production, food security, and increased market access.

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Chapter 9

Tracing Cross-Border Cattle and Buffalo Movement from the Lao People's Democratic Republic and Myanmar to the People's Republic of China and Assessing Associated Foot and Mouth Disease Risk

Chapter 9 is by Shen Yueming of the National Secretariat Specialist for the People's Republic of China; Thomas R. D. Weaver; and Liao Defang and Li Huachun of the Yunnan Animal Science and Veterinary Institute.

9.1. Introduction

Foot and mouth disease (FMD) is an important transboundary animal disease (TAD) that causes significant economic losses to livestock producers and has considerable effects on economic development and trade in the Greater Mekong Subregion (GMS). FMD is a highly infectious viral disease of ungulates, and animal movement presents a key risk pathway in the spread of the disease (Rosenberg, Astudillo, and Goic 1980; Windsor 2011). The disease causes considerable loss of productivity and animal value and is a major barrier to the export of GMS livestock products to FMD-free markets internationally under the terms of the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement). Employing impact survey questionnaires after an FMD outbreak in 2010 Young, et al. (2013) estimated that animals lost 54%–92% of their value, on average, post disease due to weight loss, treatment costs, lost draft capacity, and/or death. A related study demonstrated the considerable impact that effective control of FMD through vaccination of cattle and buffalo populations in Cambodia would have on reducing poverty and vulnerability and increasing food security (Young et al. 2016). Few would refute the assessment (Perry et al. 1999) that the control of highly infectious diseases is crucial to improving trade within and outside the region and that FMD is the top priority among diseases that affect cattle and buffalo.

The Yunnan Animal Science and Veterinary Institute (YASVI) estimated that approximately 1 million cattle and buffalo were illegally traded across Yunnan's international borders in 2015, which may be a conservative estimate. The majority of the animals are thought to originate in the GMS, although some may have transited through the subregion from as far away as Bangladesh and India. The high volumes of illegal cross-border movement of live cattle and buffalo into the People's Republic of China (PRC) in recent years has been driven by soaring demand and high market prices for beef in the PRC. As FMD is endemic in much of the region (Gleeson 2002), the risk of animals transmitting the virus en route to Yunnan, within the province, or on into PRC, are likely extremely high. In addition, cattle movement can spread other pathogens of importance to livestock, such as *Pasteurella* (hemorrhagic septicemia) and foodborne pathogens such as pathogenic strains of *Escherichia coli*.

The volume of uncontrolled or poorly controlled cattle and buffalo movement in the GMS—primarily into the PRC via Yunnan—is undoubtedly associated with the frequency and scale of FMD outbreaks in the subregion. This hampers the development of sustainable animal production and trade and has negative effects on GMS producers, allied businesses, and consumers. Moreover, large-scale, poorly regulated trade presents considerable risks of spreading other diseases, zoonoses, and foodborne hazards. This hampers the development of sustainable animal production and trade and has negative effects on GMS producers, allied businesses, and consumers. Further, the uncontrolled or loosely controlled trade in live animals and associated hazards present a major barrier to the GMS becoming recognized as a leading global supplier of safe and environment-friendly agriculture products. Under the SPS Agreement, the lack of control over animal movement makes demonstration of freedom from disease and/or effective risk management systems to potential trading partners nearly impossible. Due to the cross-border nature of animal trade in the GMS, it is in the interest of the GMS countries to act collectively to improve the monitoring and management of risks associated with animal movement and trade in the GMS.

9.2. Background and Approach

In 2014, the Asian Development Bank (ADB) and the GMS countries agreed that ADB regional technical assistance would support country-initiated activities consistent with overall objectives of the Core Agriculture Support Program, Phase II. The following year, ADB signed letters of agreement with individual GMS countries and allocated a grant of \$300,000 to the PRC for multiple projects. The PRC's Ministry of Agriculture

designed five projects to be implemented under the letters of agreement, including a project for tracing cross-border livestock movement and the risk of spreading FMD across Yunnan Province's borders with the Lao People's Democratic Republic (Lao PDR) and from Myanmar into Yunnan Province.

The cattle and buffalo movement and FMD risk project received a total grant of \$60,000 and was implemented by YASVI during July 2015 to June 2016. The purpose of the project was to identify the major cattle and buffalo movement pathways between the PRC and the two neighboring countries, with particular focus on tracing animals entering Yunnan from the two countries and transiting to other destinations within the PRC. The study was also intended to inform the identification of key counties along major animal movement corridors in Yunnan Province, for targeting future control measures to reduce the risk of FMD spread.

The project's three key components were

- (1) tracing cross-border cattle and buffalo movement across the Lao PDR–Yunnan and Myanmar–Yunnan borders, and identifying movement patterns;
- (2) predicting the risk of FMD spread; and
- (3) developing policy, institutional, and investment recommendations and interventions to reduce illegal cross-border cattle and buffalo movement and decrease the risk of hazard entry into and subsequent spread of disease in the PRC.

Specific tasks included tracing and describing actual cross-border cattle and buffalo movement in Yunnan; identifying the source and destination of individual animals; understanding the risk profiles and identifying risk hot spots for disease spread along movement pathways; and holding workshops and field trips to build the capacities of animal health workers, farmers, and traders to rapidly identify FMD and animal characteristics—such as diagnosing FMD and introducing the pilot animal identification system.

The project piloted the tracking of cross-border cattle and buffalo trade from the Lao PDR and Myanmar into Yunnan. The project provided data on movement patterns and indications of potential policy, regulatory, and investment solutions to formalize trade and support FMD prevention and control. A tag-based animal identification system was designed and piloted. This facilitated traceability of animals and the collection of animal data (including identification of animals with prior exposure to FMD) that could be fed into risk assessment and risk management decision-making processes. The results provided evidence for scaling-up livestock traceability systems

based on information and communication technology systems in the GMS, and supported the establishment of disease control zones (DCZs) along Yunnan's borders and, potentially, more widely in the GMS.

9.3. Methods

Six cities and prefectures in Yunnan (together totaling 17 PRC counties) share borders with the Lao PDR and Myanmar. Extensive interviewing and surveying of cattle and buffalo traders and blood sampling of live animals were conducted in these prefectures.

To collect preliminary data, a project coordination meeting was held in September 2015 in Kunming. Four experts from YASVI and eight animal health workers/veterinary officers, two from each of the prefectures of Dehong, Lincang, Puer, and Xishuangbanna, attended the meeting. Information was collected on transboundary animal movement, FMD status, and approaches to control and prevention. The key informants provided information on the suspected origin of animals entering the PRC through borders in their prefectures, and the locations of live animal markets and probable movement pathways were mapped. The participants also estimated the number of animals arriving in Yunnan from the Lao PDR and Myanmar and identified their suspected final destinations. In March 2016, the study team hosted a workshop on Tracing Cross-Border Livestock Movement and the Risk of Spread of FMD along the PRC–Lao PDR and PRC–Myanmar Borders in Yunnan Province. In total 62 veterinary officers, animal health workers, traders, and farmers from 14 border counties and cities within the four target prefectures attended. In addition, officers from provincial departments of agriculture and scientists from provincial veterinary diagnostic laboratories attended the workshop. All participants were surveyed and the majority were interviewed.

Serum samples were collected from cattle and buffalo entering Yunnan from the Lao PDR and Myanmar and tested in YASVI's Tropical and Subtropical Animal Disease Laboratory. In January 2016, 2,398 samples were tested using C-ELISA and 3ABC-ELISA for FMD virus antibodies against FMD serotypes O, A, Asia-1, and nonstructural proteins. In addition, 216 samples were tested by qPCR for the presence of FMD virus ribose nucleic acid (RNA).

9.4. Results

Cattle and Buffalo Trade

Four main pathways through which cattle and buffalo enter Yunnan directly from the Lao PDR and Myanmar were identified, although significant numbers of live animals also enter at other locations not detailed here (Table 9.1).

Table 9.1: Live Cattle and Buffalo Trade Pathways into Yunnan from the GMS

| Pathway | Estimated Volume head/day (head/year) | Main Mode of Transport |
|--|---------------------------------------|------------------------|
| From Luang Namtha Province to Boten, Lao PDR → Mohan, PRC → Mengla County, Xishuangbanna Prefecture, PRC. | 300 (100,000) | Truck |
| From Chiang Rai Province, Thailand → Soley, Myanmar → Jinghong City, PRC | 1,200 (300,000) | Boat and truck |
| From Mandalay, Lashio, and Panghsang in Shan State, Myanmar → Mengla Village of Mengla Township, Menglian County of Puer Municipality, PRC. | 500 (180,000) | Truck or on foot |
| From Mandalay, Lashio, Namhkam, and Muse in Shan State, Myanmar → Longdao Township of Ruili City, Dehong Prefecture, PRC | 800–1,000 (300,000) | Truck or on foot |
| Other Cross-Border Pathways | 1,000 (100,000) | Various |

GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China. Source: Yunnan Animal Science and Veterinary Institute, in a study funded under the Core Agriculture Support Program, Phase II (ADB 2016).

Four cities/prefectures, consisting of 12 counties, were identified as key target areas for monitoring and risk management initiatives—Dehong, Lincang, Puer, and Xishuangbanna—on the basis of high absolute numbers of transiting animals and estimates of illegal movement. These counties were identified as key for targeting risk management efforts.

The study found that most cattle and buffalo that enter Yunnan were traded in Myanmar and Thailand. In particular, Mae Sot, Thailand, is a major live animal market hub, where it is believed as many as 100,000 head of cattle and buffalo are traded each month. Key cattle and buffalo markets in Myanmar are Lashio in Shan State and Kyaukpadaung, Maymyo, and Sagaing in Mandalay.

Foot and Mouth Disease Exposure

The serological results indicated that 15.0%–34.3% of the animals tested were positive for FMD virus O antibodies, 4.8%–15.8% for FMD virus A antibodies, and 20.1%–35.5% for Asia-1 virus antibodies. However, sampled animals positive for 3ABC antibodies were considerably higher, at 20.0% to 47.8% of the population. These findings clearly demonstrate the high rates of FMD virus exposure among cattle and buffalo entering Yunnan from the GMS and indicate a high risk of FMD transmission during transit. Moreover, the origins and typically lengthy pathways the animals travelled within the GMS indicate high risks of transmitting FMD en route. This is likely reflected in the high frequency of FMD outbreaks experienced in the GMS.

Importantly, the project resulted in the development of extensive social networks that will form a basis for future data collection and information sharing.

Greater information sharing is essential to promote inclusive, safe, and environment-friendly food production in the GMS and to unlock potential markets for GMS animal products. The project established a network of animal health workers, traders, farmers, and key informants from four PRC prefectures/cities to collect and share information of TAD control. The network can contribute to improved monitoring of cattle and buffalo movement from the Lao PDR and Myanmar into the PRC, facilitate implementation of traceability systems and the establishment of DCZs, and thereby support GMS FMD surveillance and control. The project also provides a further step toward increased information sharing between GMS countries in relation to FMD, other TADs, important trade and sanitary and phytosanitary hazards, and human health hazards more generally.

9.5. Policy Directions, Including Needed Investments and Institutional Reforms

The project resulted in five main recommendations for policy and investment.

First, establish bilateral and/or multilateral mechanisms for (1) coordinating policies, investments, and institutional capacity building for the control of live cattle and buffalo trade between the PRC and the Lao PDR and the PRC and Myanmar; and (2) managing associated disease and broader hazard-associated risks. Draw the attention of high-level decision-makers to the significance of TADs and continue promoting cooperation among GMS countries in this regard.

Second, establish collaboration mechanisms among the GMS countries with the objective of establishing electronic track and trace systems for livestock movement to safely increase access to the PRC market for GMS suppliers. This will benefit the PRC, as a large and growing importer, and the GMS countries, as current and potential exporters of live cattle and buffalo. Coordination with organizations such as GS1 on options for barcode-based traceability systems for animal products leaving the DCZs can also be considered.

Third, given the PRC government's efforts in developing the transboundary DCZ in Yunnan, the GMS Working Group in Agriculture could conduct feasibility assessments and identify investment opportunities that support the establishment and management of the proposed DCZs, so as to effectively control TADs, reduce sanitary and phytosanitary barriers to trade, and facilitate cross-border livestock trade in the region.

Fourth, based on the project's findings, the PRC has proposed two key investment needs within the Strategy for Promoting Safe and Environment-Friendly Agro-based Value Chains in the Greater Mekong Subregion and Siem Reap Action Plan, 2018–2022: (1) a technical assistance project of \$1 million to build an e-traceability system for tracking livestock movement along GMS borders to better control TADs, and (2) a \$50-million investment in establishing livestock DCZs along GMS borders. Other GMS countries have proposed similar technical and infrastructural investments to establish traceability systems and DCZs. Resources need to be mobilized to support implementation of these initiatives.

Fifth, establish livestock DCZs at key border areas in the PRC, the Lao PDR, and Myanmar to (1) mitigate and manage the risk of FMD spread through cattle and buffalo, (2) control other key production and zoonotic diseases, and (3) serve as a buffer zone to regulate livestock trade between the PRC and other GMS countries. A DCZ can encompass systems for risk analysis and facilities such as animal identification (tagging); livestock movement management (e-traceability); quarantine, serological, and pathological surveillance infrastructure and expertise; and vaccination facilities and services. Food safety testing for pathogens and residues could be built into the system when it is operational. It is also important to encourage the private sector to be involved in the DCZs and set up modern slaughterhouse, meat processing, and bio-digester facilities, and local feedlots, through public–private partnership schemes.

9.6. Conclusions

That demand for beef and beef products is high and increasing in the PRC is well-established. The large cattle and buffalo populations in Cambodia, the Lao PDR, Myanmar, Thailand, Viet Nam, and the South Asian countries offer great opportunities to supply this large and growing market. However, unchecked animal movement presents considerable animal disease, zoonose, and food safety risks. The large numbers of cattle and buffalo traded illegally into the PRC pose considerable risks for the spread of pathogens important for reasons of human health and economy. Examples are the FMD virus and pathogenic *Escherichia coli*, which threaten livestock producers, allied businesses, and consumers throughout the GMS.

Understanding animal movement patterns, monitoring risk, and establishing effective traceability systems are essential for the timely identification of key hazards such as FMD, and for the implementation of effective and efficient outbreak responses. This can better protect the livestock industries of the PRC and the GMS countries. Assessing FMD risk in the live cattle and buffalo trade into the PRC via Yunnan can inform wider GMS risk management strategies for FMD and the many other hazards of importance to animal and human health and trade. Addressing the issues can benefit livestock industries throughout the GMS, including the smallholders and small enterprises that dominate the industry numerically.

Encouraging legal animal movement by developing DCZs along the Lao PDR–Yunnan and Myanmar–Yunnan borders is a novel strategy that can minimize the risk of FMD spread from the GMS countries to the PRC, promote livestock trade to the benefit of communities living in the border areas, and support smallholder farmers in the Lao PDR and Myanmar whose livelihoods depend on livestock raising and trade. In addition, the establishment of DCZs can enable improved surveillance and management of foodborne hazards within Yunnan and the GMS more widely.

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Chapter 10

Geographical Indications and Inclusive, Safe, and Sustainable Food Supply in the Greater Mekong Subregion

Chapter 10 is by Thomas R. D. Weaver with contributions from Vichelle Roaring-Arunsuwannakorn and Van Anh Truong

10.1. Introduction

Geographical indications (GIs) for food products have proliferated outside Europe during the last 20 years. In the Association of Southeast Asian Nations (ASEAN), hundreds of food products are produced under GI protection. Examples of some of the most successful and best recognized GIs in Asia include Darjeeling tea from India and Kobe beef from Japan.

The objective of this chapter is to outline issues relating to GIs in the Greater Mekong Subregion (GMS) and to make recommendations for their sustainable and inclusive development. GMS GI products have the potential to join the likes of Kobe beef in terms of recognition and value attribution in domestic and international markets. However, to achieve this, policy adjustments and investments are needed. Building on a review of literature, this chapter presents a synopsis of the key points and discussions from the GMS Public–Private Dialogue on GI hosted during the 15th GMS Working Group in Agriculture (WGA) Annual Meeting in Siem Reap, Cambodia. These events brought together diverse food and agriculture stakeholders from the private sector, public authorities, development partners, civil society, and research institutions from across the GMS. This chapter outlines some of the priority issues in relation to GI in the subregion that can best be addressed collectively by the GMS countries. The chapter then recommends an approach and proposes feasible and politically attractive initiatives to address key issues.

This chapter is closely aligned with, and strongly endorses, the GMS Strategy and Action Plan for Promoting Safe and Environment-friendly Agro-based Value Chains 2018–2022 developed by the GMS WGA and endorsed by the GMS ministers of agriculture.

10.2. State of Play

The concept and adoption of GIs has risen to global prominence as a tool to protect local traditions, maintain biodiversity, and promote rural development. Stefano Inama of the United Nations Conference on Trade and Development (UNCTAD) noted that “Consumers now are more sensitive to products carrying extraordinary and unusual tastes. Branding products through GI can help to generate capacity and reduce poverty” (UNCTAD 2014). By definition, agricultural GIs are place-based names, such as Champagne or Parmigiano Reggiano, that convey the geographical origin and the cultural and historical identity of products—a concept perhaps best encompassed by the French word *terroir* (Bowen and Zapata 2009).¹ The World Trade Organization Agreement on Trade Related-Aspects of Intellectual Property Rights (best known as “TRIPS”) protects GI as an intellectual property right. As such, GI registration is typically managed by the country’s ministry of commerce or national body responsible for intellectual property rights. However, in some countries the ministry of agriculture may lead GI, for example, in the People’s Republic of China (PRC) and Japan. Unlike other quality assurances, such as organic and fair trade, GI producers determine the relevant specifications for the specific GI. Therefore, GI registration is owned by a collective—a community, village, or cooperative—and is defined by the local environment and indigenous knowledge.

Bramley, Biénabe, and Kirsten (2009) identify three fundamental objectives that may be pursued through GI protection: consumer protection, producer protection, and rural development. GI functions as a consumer protection measure by addressing information asymmetries and product quality, and as a producer protection measure through its role in protecting product reputation as an asset (Lucatelli 2000). GI offers a means of differentiating products for buyers and consumers in domestic and international markets. For example, Teuber (2010) demonstrates the value of single origin coffee shown through the modeling of internet auction data. In this way, GI can facilitate the move from reliance on raw material markets to value-added and/or distinguished end-use products that command premiums on the basis of recognized qualities. GI can provide a means of signaling product quality, increasing market access, and supporting rural development, and a potential means for suppliers to

1 A French word for the environmental conditions (soil, water, geographic location, etc.) in which a crop is grown.

access new distribution channels and markets (Bramley 2011, Jena et al. 2015). A key advantage of GI over, say, trademarks, is the specific linking of a distinct, premium product to a delimited area and to the traditional producers of that product. With the requisite assurance of quality, GI also offers a potential means of capitalizing undercapitalized suppliers of traditional products with unique qualities. This can then be used to strengthen value chains and benefit local communities and areas both economically and socially. Beyond the potential economic advantages, the local specificity can also contribute to the quality of life and enhanced image and prestige among local communities (Blakeney 2012). GI presents a feasible alternative to the continued spread of larger-scale/monoculture agricultural production systems and can help to sustain activities and create jobs in less-favored areas. In this way it can be legitimately argued that GI presents a means of supporting smallholders and local rural development in an increasingly globalized agriculture sector.

Although GI registration has a relatively short history in the GMS countries, strong interest has developed quickly among both public and private sector stakeholders. This is demonstrated by the recent proliferation of GI products in the subregion. Thailand now has 89 registered GIs, and Viet Nam has 55. This is hardly surprising given the diversity and quality of local agricultural production in the subregion. Moreover, price premiums for GI products are emerging; an example is the 300% price premiums reportedly received by Kampot Pepper suppliers at the farm gate. Each GMS country has established the legal framework for GI registration, with the exception of Myanmar where the legislation is being drafted.

10.3. Issues

Five priority issues for GI in the GMS have been identified:

- (1) legislative systems, roles, and responsibilities, as well as mutual recognition;
- (2) complexity and costs;
- (3) gender, inclusiveness, and environmental protection;
- (4) reputation—safety and quality assurances; and
- (5) supply chains and price premiums.

Legislative Systems, Roles, and Responsibilities, and Mutual Recognition

The legislative frameworks for GI have been established in five of the six GMS member countries; it is anticipated that Myanmar will establish the required legal framework in the very near future. However, among GMS countries a degree of variation between GI legislation exists and recognition of equivalence of the pertinent legal frameworks

has not yet been achieved. Given that a number of GMS GIs are now fully registered in third countries/regions, including the European Union (EU), mutual recognition would help to unlock markets in the subregion and further afield for other GMS GI products. Meanwhile, mutual recognition could generate scale that could be harnessed to address awareness raising and marketing campaigns that boost recognition of the principles, qualities, and value of GI products among consumers in the subregion and further afield.

Additionally, traditions and production methods often cross borders within the GMS, which may raise the possibility of and/or need for cross-border GIs. Establishing appropriate delimitation and ensuring appropriate protection of GI principles across borders would require mutual recognition of GI status. Moreover, mutual recognition of external certifying bodies across national borders would make this feasible.

The responsibility for policymaking and implementation in relation to GI registration is multisectoral and the lead agency varies between GMS member countries. While GI is usually the responsibility of the national body for intellectual property rights, in the PRC GI is led by the Ministry of Agriculture. GI is inherently multisectoral given the roles and interests of ministries such as those in charge of commerce, trade, science and technology, customs, quarantine, and inspection. This complexity can complicate coordination and harmonization of policies and initiatives within and between jurisdictions.

Complexity and Costs

Hughes emphasized that GI laws alone do not lead to socioeconomic benefits (Bramley 2011; Hughes 2010). Key considerations include the strength of the GI collective; the definition of specifications; the effectiveness of internal control systems; the availability and feasibility of external validation; the establishment and management of consistent supply through efficient and well-controlled value chains; and the development of product and/or brand recognition among target customers—be they domestic or in export markets. This complexity can make registration challenging without considerable support from public agencies.

GI protection must address whole value chains to develop the robust assurances of provenance and quality required to build and protect product and brand reputations. GI supplier specifications must typically address inputs, production, processing, packaging, and marketing of produce. This complexity requires establishing effective collective management and internal control systems, which can prove challenging for established GIs, let alone suppliers seeking to establish GI status or newly minted GIs.

The costs associated with registering and maintaining GI protection are high, which constrains recruitment of producers and growth in supply from individual GIs, limiting scale and reach. This stems in part from the complexity of the registration process and the high costs typically associated with external validation. To be successful and sustainable it is essential that suppliers along the length of supply chains receive premiums that adequately reward them for additional costs associated with GI protection.

Gender, Inclusiveness, and Environmental Protection

Ensuring the participation of women, vulnerable groups, smallholders, and small and medium-sized enterprises is fundamental if GI is to be promoted as a development tool. The roles of all stakeholders must be enshrined in the requirements for establishing and maintaining GI protection. In addition to environmental protection being essential for sustainable agricultural supply, the association of GI products with their environment is explicit in the principles of GI and is typically a core component of product marketing. Therefore, GI regulation and implementation must ensure the local environment is adequately protected.

Requirements in the subregion for postharvest handling of GMS GI products currently lack uniformity and clarity. GI products are sometimes repackaged outside the geographic limits of the GI. This reduces control by GI members (assuming they are not engaged in this segment of the value chain), presenting additional risks in terms of food safety, quality, and the credibility of the GI brand. This may also draw labor away from the GI area. GIs in the GMS are frequently located in remote rural areas—areas typically correlated with higher rates of poverty and vulnerability. Encouraging postharvest processing within GI areas can generate local employment opportunities and contribute to rural development.

Reputation—Safety and Quality Assurance

The reputation of a product, a brand, or a GI is developed over time through consistent delivery of safe, high-quality products and consumers enjoying positive product experiences. Building a GI's reputation is essential to generate the income and return the price premiums needed to encourage investment and wider adoption among producers. Effective internal control systems and external validation by accredited certification bodies are required to ensure product safety and quality.

Internal control systems depend on the GI organization and their own specifications; however, international best practices and standards and lessons from countries with well-established GI systems can improve the reliability and efficiency of systems in the GMS. More effective internal controls facilitate external validation, which typically reduces the time and cost of external certification. The variation between GI legal frameworks and systems within the GMS means that certifying bodies in one country may not be registered to certify GIs in neighboring countries, which limits scale and reduces competition, thereby pushing up costs.

Supply Chain Management and Price Premiums

Once safety and quality assurances are in place, developing successful GIs that reward stakeholders appropriately requires establishing efficient and well-managed supply chains and distribution channels, building scale, increasing market access, and developing effective marketing initiatives. A variety of internal and external factors can determine the level of success achieved by a GI and the premiums received by suppliers.

Most GIs in the GMS are relatively small in terms of production volumes and revenues. To increase levels of production and supply, added value must be demonstrated to attract other producers in the GI location and thereby create the critical mass of the GI product needed to interest traders and to enable further improvements in supply chain efficiency and management. Effective supply chain management is necessary to ensure that product and brand reputations are protected and that customer requirements are met with minimal waste and losses. World-renowned GIs, such as Champagne, operate tightly controlled supply chains at scale thereby ensuring consistent quality and supply volumes that enable a considerable market presence and generate substantial premiums for suppliers. Identifying and addressing constraints and bottlenecks in GI value chains and establishing premiums that create the incentives needed to draw in producers and suppliers is a key challenge facing GMS GIs.

Although local specialties and traditions are often highly valued by GMS consumers, recognition of the principles of GI remains limited among the large majority of the subregion's consumers. At present, GMS GI products are largely marketed outside the GMS and/or to tourists within the subregion; however, there are opportunities to increase the presence of local GIs in domestic markets. Increasing household incomes within the GMS and growing concern surrounding food provenance, safety, and quality present opportunities to establish GI as a trusted food certification among consumers

in the subregion. The safety and quality of GI products must be appropriately protected to allow their differentiation and generate consumer willingness to pay for the qualities associated with products, collectively and for individual GIs. Barjolle and Sylvander (2000:45) note that the main factor in the success of a GI supply chain is the ability of stakeholders to effectively coordinate on the “identification of joint objectives, definition and control of quality, variety management, image promotion, and research and development.” Market factors are typically of secondary importance, given that failure to effectively coordinate supply will tarnish reputations and ultimately limit the success of a GI.

The features of GI products are in essence fixed by product specifications. Therefore, attempts to add value by altering products must ensure the essential qualities of products remain tangible. However, beyond physical alterations to products, value can be added through, for example, improved messaging and packaging.

10.4. Recommendations

Medium- to long-term recommendations have been made on the basis of discussions during the public-private dialogue sessions held in July 2017 in Siem Reap, Cambodia; discussion with key informants; and literature review. Proposed policy and institutional initiatives are followed by a brief description of investment needs and initiatives proposed for immediate action during 2017–2018.

Policy and Institutional Recommendations

Five policy and institutional recommendations are posited in response to the issues and gaps identified:

- (1) embed legislative systems, employ multisectoral approaches, and establish mutual recognition;
- (2) reduce the complexity of GI procedures and the costs of designating a GI;
- (3) ensure gender empowerment, inclusiveness, and environmental protection;
- (4) build and maintain a reputation—ensure consistent product safety and quality, with a focus on effective internal control systems; and
- (5) ensure supply chain efficiency, increase market recognition, and set a platform for generating price premiums.

Embedding Legislative Systems, Employing Multisectoral Approaches, and Establishing Mutual Recognition

Support establishment of a GI legal framework in Myanmar. Myanmar is currently the only GMS jurisdiction yet to establish a legal framework for GI; however, the legislation is being developed and is expected to become law in the near future. Delegates from Myanmar expressed their interest in learning from successful experiences of the GMS countries that are more advanced in establishing a legal framework for GI and successfully implementing legislation once established.

Increase cross-coordination among relevant GMS government bodies. Coordination between ministries and agencies within GMS countries could be increased by establishing national multisector sub-working-groups on GI. There is a need to promote cross-sectoral coordination to achieve convergence on GI within and among GMS countries. Coordination among GMS ministries about how to harmonize existing GI systems in terms of legal obligations and roles and responsibilities can help to clarify and streamline GI registration. Communicating the roles and types of services of different agencies to stakeholders within GMS countries will also facilitate mutual recognition of GIs within the subregion and in third countries outside the GMS.

Increase coordination between GMS countries. This could be achieved through a GMS sub-working-group and/or taskforce on GI under the leadership of the GMS WGA. The GI sub-working-group's primary task should be to coordinate the legal requirements for GI protection between GMS countries toward harmonization of standards and mutual recognition of equivalence. Increasing recognition of GIs across GMS markets and further afield requires greater harmonization of legislation. Also, bilateral, multilateral, and regional agreements on recognition between neighboring countries should be pursued.

Due to the specific qualities of individual GIs there is scope for joint initiatives among GIs within and between countries. Even among GIs with similar products, joint initiatives that increase exposure of GIs could benefit all parties. Joint initiatives both within and between GMS countries can address marketing and access to potential distribution channels and markets outside the subregion as well as form a platform for information sharing between GIs. Moreover, stronger GI systems within the GMS can help to build the reputation of GI as a sign of quality and value in GMS markets, which is in the collective interests of the GMS countries. Examples of potential cross-border GI initiatives in the GMS include jasmine rice from northeast Thailand and Savannakhet in the Lao People's Democratic Republic (Lao PDR) as well as Arabica coffee from the Bolovens Plateaux in southern Lao PDR and the Central Highlands of Viet Nam.

Share experiences, lessons, and best practices between GMS countries for implementing and enforcing GI laws and principles. For example, the PRC has registered over 100 GIs in the EU; the other GMS countries can learn much from these experiences. Equally, Kampot Pepper, one of the two registered GIs in Cambodia, has been registered in multiple third countries and regions including the EU. The Thai experiences in responding to World Trade Organization requirements and guarding against challenges of piracy are also of great value. Beyond the subregion, there are important lessons and cautionary tales of GI experiences in Europe and, perhaps more pertinently, in other tropical and subtropical regions. For example, the challenges faced by the Mexican GI for tequila production outlined in Bowen and Zapata (2009) provide a cautionary tale with lessons for ensuring that GI quality is maintained and supply is not coopted by interests that lessen contributions to rural development.

Addressing Complexity and Reducing the Costs Associated with GI

Coordinate and, where possible, streamline the legal and regulatory requirements for establishing and maintaining GI protection. Although the reputation of GI must be adequately protected through regulation, there may be opportunities to bundle requirements in a manner that reduces the burden of registration and continuing certification. However, this is a long-term objective given that GI legislation is in place in five of the six GMS countries. To advance the bundling of requirements, comparative studies of the legal framework of each GMS member are required to identify the changes needed to existing laws and regulations.

Coordinate national systems within the GMS to develop and communicate pipelines for GI registration and maintenance. Coordination can be led by national and regional sub-working-groups on GI. National GI registration processes in each GMS member country would need to be reviewed and compared to support the recognition of GI equivalence between countries. The terms and conditions for doing business that affect GI in each country may also require review and adjustment to improve efficiency by reducing unnecessary costs and regulations.

Establish best practices for internal control systems. Best practices can be identified from the more successful GIs within the subregion and serve to reduce costs of external validation and certification. As the certification body, ECOCERT, has noted, effective internal control systems can reduce risk and better protect product reputation while reducing the time and costs of external validation and certification. Best practices in establishing and controlling GI supply chains have been developed internationally. Good examples of effective internal production and process controls within the GMS should be documented for use by relevant stakeholders and

committees such as the national and GMS sub-working-groups on GI. The public and private sectors, civil society, and community-based organizations all have roles to play in demonstrating best practices to established and proposed GI initiatives. For example, the IFOAM² internal control systems and participatory guarantee systems that were developed as means of establishing supply of organically produced agriculture products may offer useful insights and a model that could be adapted for GI safety and quality control.

Establish mutual recognition of GI certifying bodies. Recognition of certifying bodies in multiple jurisdictions can create economies of scale and greater competition between firms, thereby reducing the costs of external validation and certification for individual GIs. Further, the lack of mutual recognition of certifying bodies between GMS countries, for GI among other third-party certifications, is a major constraint to current market access, the harmonization of standards and measures for food safety, and the elimination of nontariff barriers to trade.

Ensuring Gender Empowerment, Inclusiveness, and Environmental Protection

Explicitly address gender, inclusiveness, and environmental sustainability in GI laws and requirements and individual GI specifications. As Bramley and Biénabe (2013) note, inclusiveness and environmental protection typically play a considerable role in the development of successful GIs. The close ties between GI, culture, and *terroir* mean that consideration of gender, inclusiveness, and environment are essential components in the marketing of produce and must, therefore, remain protected within the GI if it is to flourish. Integrating the principles of participatory guarantee systems, for example, presents a potential means of ensuring gender empowerment, inclusiveness, and environmental protection while establishing cost-efficient internal control systems. The collective ownership of GIs lends itself to the development of social capital and greater organization of producers, with subsequent economic and social benefits to suppliers and their communities.

Ensure rigorous assessment in the demarcation of GI areas. Appropriate GI demarcation—in line with global GI rules, regulations, and norms—is needed to establish and maintain product specificity, or “uniqueness,” and quality. A fine balance is needed. If the area is too large, the consistency, message, and qualities of the product may become lost, as Bowen and Zapata (2009) describe in the case of the tequila GI in Mexico. If the area is too small, the supply may never achieve the critical mass

² Originally known as the International Federation of Organic Agriculture Movements (IFOAM).

required by traders or to establish an adequate market presence, and could exclude producers of comparable products, which could create animosity.

Recognize that GI has limitations and is not universally applicable. Not all products and locations are suitable for GI. Although GIs can be an effective rural development tool, the capacity of a product to be successful as a GI depends on a variety of factors. Establishing GI protection inappropriately can place unnecessary or counterproductive burdens on producers without delivering adequate rewards. Moreover, inappropriate GI protection may undermine the reputation of GIs generally, nationally, and subregionally if the GI fails to meet the standards and expectations of consumers. As Bramley and Biénabe (2013) remark, although institutional and legal protection is important for commercializing GI products it is not sufficient in and of itself. The product specificity, reputation, market attractiveness, awareness, and attributed value among both producers and consumers, should be considered. The appropriate coordinating institutions, such as a representative organization, must be in place. Moreover, insuring that GIs support rural development requires

- established dialogue between producers;
- specifications drafted by the collective that ensure that women, the poor, and the vulnerable are not excluded, and that local environmental implications are considered; and
- internal and external auditing systems (CIRAD 2013).

The industry profile and potential environmental impacts should be considered to ensure positive outcomes in terms of inclusiveness and sustainable rural development. The characteristics of the supply chain, in terms of governance, inclusiveness, environmental sustainability, and capacity to deliver consistent products to the market, can also provide an indication of the likelihood of success. Guidelines for assessing the potential of products to become successful GIs in less developed countries have been developed by Bramley and Biénabe (2013) and warrant consideration.

Building and Maintaining a Reputation—Ensuring Consistent Product Safety and Quality

Make food safety explicit in GI legislation. Assessment, management, and mitigation of food safety risk must be built into national GI legal frameworks, into accompanying regulatory systems, and in the specification of individual GI internal and external control mechanisms. Vigilance is essential as food safety failures can rapidly destroy the reputation of a product and risk tainting consumers' perceptions of GIs more generally, devaluing the approach.

Establish standards for product specificity to ensure GI products are differentiated from similar products produced under different conditions, with different inputs, or using different methods. The specifics of production, processing, and the associated qualities of the product must be enshrined in the GIs' specifications to ensure fair competition and promote the association of GI with uniqueness and quality. Equally, product consistency is essential to build trust and the reputation of GMS GI products and to establish value that is rewarded in price premiums. Consistency in quality and volume of supply is essential to build the scale and reputation of GI products necessary to develop current markets and access new markets. Ensuring product consistency and adequate production volumes must be core competencies of GI value chains, from production to end market, for the GI to be successful (Barjolle and Sylvander 2000). Massimo Vittori, Managing Director of oriGIn, noted “[GI] is a great instrument that can facilitate trade provided that you have quality” (UNCTAD 2014).

The regulatory framework for GI should restrict GI postharvest processing, including packaging, to within the GI. Collective GI laws and individual GI specifications must explicitly address postharvest components of GI supply to establish rules that are adhered to throughout the GMS.

Share approaches and methods. As has been described previously, establishing and sharing the best approaches and methods for internal control systems between GMS countries and countries with more established GI systems can help to protect and strengthen the reputation of GMS GIs.

Supply Chain Efficiency, Increasing Market Recognition, and Setting a Platform for Generating Price Premiums

Strengthen supply chains through improved governance and increased access to required services. Efficient supply chain management is a core component of successful GIs. Improving supply chain efficiency requires investment from within GIs and good chain governance through transparent and fair internal GI specifications and in the terms and conditions for doing business locally, nationally, and in the GMS context.

Develop a unified plan for raising the profile of GI in GMS markets. Build a unified GMS GI message that promotes the links between GI products and rural development, food safety and quality, and the environment. A successful shared experience in harmonization and win-win results among multicountry participants could culminate

in a GMS GI logo and joint branding and marketing initiatives targeting consumers and potential buyers in the GMS, in the ASEAN+3,³ and further afield. Many GMS urban consumers are willing to pay premiums for food with specific qualities; for example, local chicken varieties can sell for 3–4 times the price of commercially raised high-growth-rate chickens in rural markets. This characteristic of GMS consumers can be harnessed by GIs in the subregion. GMS GI can become recognized as a trustworthy sign of quality in domestic and export markets. It is essential that other brand identities and public and private certifications, such as GI labeling, individual firm's or retailer's labels, and EU labeling, are consistent.

There may be opportunities to promote GMS GIs to environmentally conscious domestic consumers. Such opportunities may particularly interest urban middle-class consumers who value food produced locally with short supply chains and lower “food miles,”⁴ which has become increasingly popular in developed countries. The proliferation of organic products and farmers' markets is testament to the traction this can have with wealthier consumers, in particular. While this market segment may be essentially urban and relatively small in the GMS at present, it is likely growing, and many consumers in the GMS already prefer local varieties and products on the basis of quality characteristics. Traceability systems can be readily integrated eventually, with locally supplied “food with a story” initiatives by using barcode/quick response-based systems, improving food safety quality control while providing marketing advantages. Piloting these systems with select GIs should be considered.

Exhibit GMS GI products at trade fairs and events within the subregion and internationally. Such opportunities are numerous. For example, during the policy dialogue, the PRC delegates proposed that GI products from other GMS countries be included in their annual GI promotional events. Participation in other ASEAN+3 GI events should also be encouraged and may be supported through public–private arrangements involving cost coverage and/or in-kind support.

Develop marketing and distribution strategies for specific domestic and export markets. Evidence suggests that GI producers, and other suppliers of niche products, need to adopt different distribution strategies and channels in different countries and market segments (Rangnekar 2004). For example, selling through retailers and supermarkets in countries with highly concentrated supply chains, such as Malaysia and Singapore, and using local markets, direct selling, home delivery, and specialized outlets in places where niche products hold a greater influence in markets, such as Italy. In the GMS there are considerable differences (1) within countries, most notably

³ ASEAN+3 comprises the ASEAN members plus the PRC, Japan, and the Republic of Korea.

⁴ A “food mile” is a measure of the fuel needed to transport food, per mile, from producer to consumer (www.foodmiles.com).

between the urban and rural markets and centers of tourism; and (2) between countries, largely associated with level of economic development. There are strong indications that demand for safety- and quality-assured products is increasing across the GMS, albeit from a low base. The demand is rising with increasing household incomes and in response to frequent high-profile food scandals. Trends in consumer preferences and behavior are highly dynamic. GIs would benefit from monitoring these trends to better target product distribution and marketing—both the public and private sectors can contribute to this.

Investment Needs

Continue to catalyze development of GIs in the GMS through more precise investment in agriculture and allied sectors. Further investment to remedy value chain infrastructure gaps and human resource deficits can support the continued development of GIs. Necessary investments include infrastructure and technical, operational, and management capacity related to quality assurance, such as: traceability systems for input supply through to end products; requisite processing and packaging facilities; and transport and logistics infrastructure, such as road and rail access, warehousing, cold chains, port facilities, and trade facilitation. To protect the quality of GI products, much of the required infrastructure needs to be developed within the confines of the GI location. Public-private partnerships can help to direct and deliver investments effectively. The public sector has a role to play in working with producers to identify infrastructure gaps, prepare development plans, formulate and implement supportive fiscal policy measures, link GIs with potential investors, and ensure that terms meet the principles and standards required by GIs.

Further investment in risk analysis infrastructure. To facilitate the establishment of effective internal and external control systems, additional investment in risk analysis and quality assurance infrastructure, such as food testing, is needed. Current laboratory capacity, such as the availability and quality of food testing facilities, varies within the region, limiting access for some suppliers and driving up costs. The priority needs include human capacity and physical laboratory infrastructure and investment in operating costs, such as consumables. Additional investment in surveillance systems can also support GI development by reducing risks associated with production, foodborne, and trade-relevant hazards. There are opportunities to establish public-private partnerships to develop this capacity across the subregion and facilitate movement of samples and cost saving for submitters.

Facilitate other public and private roles. Specific investments in individual and potential GIs such as postharvest handling and packaging facilities, cold chains, and the like, should be derived from the private sector to ensure competitiveness, fairness, and sustainability. However, the public sector has an important role to play in attracting and directing investors such as agribusiness, venture capital, banks, social enterprises, and other novel and/or less conventional investors.

10.5. Short-Term Initiatives

Four initiatives were identified in 2017 for immediate action.

- (1) Showcase GI products from around the subregion at the GMS Market Place at the Second GMS Agriculture Ministers Meeting. This occurred as proposed at the Ministers Meeting in Siem Reap, Cambodia, September 2017.
- (2) Showcase a selection of GIs from the GMS countries at GI events in the PRC. Support GMS GI participation in other ASEAN+3 GI events, which may be supported through public-private arrangements for cost coverage and/or in-kind support.
- (3) In coordination with the Food and Agriculture Organization of the United Nations, establish multisector national sub-working-groups on GI under the leadership in the GMS WGA. The groups should include representatives from the lead ministry from each country and appropriate representation of ministries of agriculture, commerce, trade, science and technology; and relevant customs, quarantine, and inspection agencies.
- (4) In coordination with the Food and Agriculture Organization and through the national sub-working-group on GI, establish a GMS taskforce on GI to develop a road map to demonstrate the equivalence of national GI legal frameworks and achieve mutual recognition between the GMS countries.

10.6. Conclusion

Considerable interest in GI exists among key actors within the GMS countries, both policymakers and the private sector. GI can protect local producers, their traditions, and their incomes, while promoting biodiversity, food safety, and environmental sustainability. Coordination of GI legal frameworks in the GMS countries and mutual recognition can benefit each country and individual GIs by increasing access to wider markets, generating scale, and building consumer recognition of GI designation as a sign of quality and value. Sharing experiences, lessons, and best practices among GMS countries can help to establish more effective and efficient registration and enforcement systems that adequately protect the reputation of GI and establish GMS GI products among those that consumers in the GMS and further afield value most.

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Policies for High Quality, Safe, and Sustainable Food Supply in The Greater Mekong Subregion

The book presents research into the production of safe, high quality, and environmentally friendly agriculture products in the Greater Mekong Subregion. It also explores the actions and policy options that could be pursued. Three themes are examined: Improving Food Safety and Quality; Inclusive and Sustainable, Safe and Environment-Friendly Agriculture Products; and Value Chains for Safe and Environment-Friendly Agriculture Products. This aligns with the ASEAN Economic Community blueprint, which calls for the creation of a single market and production base for food, agriculture, forestry; and integration of the region into the global economy.

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