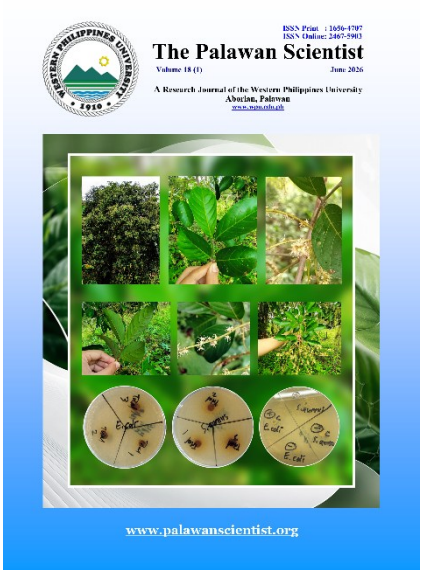

Segmental disruptions in rice value chains during the COVID-19 pandemic: A systematic review and policy implications in Asia

Clinsy Ann Angel J. Abapo, Loraine M. Ortega, Erika Mae S. Cabucos, Sheen Lee L. Balaba, Rosell R. Navaja and **Jake Joshua C. Garces***

Department of Biology, College of Computing, Artificial Intelligence, and Sciences (CCAIS), Cebu Normal University, Cebu City, Philippines 6000

**Corresponding Author: garcesjj@cnu.edu.ph*

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ABSTRACT

The COVID-19 pandemic affected several elements of the rice industry. Many rice value chains (RVCs) were harmed by preventative measures, threatening food security worldwide. This systematic review examines how the COVID-19 pandemic affected Asian RVCs. Harzing's Publish or Perish program was used to include peer-reviewed journals from 2020–2022 indexed in Scopus, Google Scholar, PubMed, and Clarivate Analytics. The upstream segment was the least affected, mainly because farmers stored agricultural inputs in preparation for lockdowns. However, domestic and household workers replaced migratory labor, reducing the availability of agricultural and production labor. In Myanmar, this labor shift contributed to a 28% reduction in overall rice production during the pandemic. The midstream segment, being the most affected, had to operate with fewer resources and longer shifts for post-harvest activities, resulting in disrupted transportation and distribution. For example, in Indonesia, logistical delays in Jakarta were 35% higher compared to Semarang, significantly impacting rice delivery times. This disruption affected the final component of the RVC, where rice scarcity in a state increases retail prices, while abundance lowers them. Retail rice prices in scarcity-affected regions rose by an average of 22%, while surplus areas experienced price drops of up to 18%, forcing farmers to consume unsold crops or sell them at low prices. Governments and farmers should collaborate on strategic planning and response, farmer support, and harvest-to-market operations to maintain market flow.

Keywords: COVID-19, food security, midstream segment, systematic review, upstream segment, value chain disruptions

INTRODUCTION

The COVID-19 pandemic triggered a global food price crisis, emphasizing the critical role of resilient domestic food systems in ensuring food security and combating malnutrition in developing countries (WHO 2021). Approximately 663 million people worldwide suffer from undernourishment,

reflecting persistent challenges in meeting basic caloric needs (Roser and Ritchie 2019; Goeb et al. 2022). When the pandemic emerged in late 2019, its widespread impact intensified global hunger, particularly in regions already vulnerable to food insecurity (Arouna et al. 2020). Nearly half of the population in Asia lives in poverty, where hunger levels in low-income households doubled during lockdowns, underscoring the fragility of food systems under crisis conditions (Pandey and Bhandari 2018; Laurent et al. 2025; Sanusi et al. 2025). While existing literature extensively addresses global food security challenges, there is limited empirical focus on how systemic shocks specifically affect staple crop value chains in Asia. This gap is critical because rice remains the cornerstone of food security for billions in the region, and understanding its value chain resilience under pandemic conditions provides actionable insights for future crisis preparedness. These realities highlight the urgent need to examine staple food systems such as rice value chains, as their resilience is fundamental to mitigating the effects of future global shocks.

The pandemic disrupted agricultural supply chains, affecting both farmers and consumers (Zahrah et al. 2021). Border closures, transportation restrictions, and market shutdowns hindered the movement of goods and labor, creating bottlenecks in food distribution (Belton et al. 2021). These disruptions not only reduced food availability but also jeopardized the livelihoods of farmers and fishers (OECD 2020). Rice value chains (RVCs), which were among the most affected during the pandemic, encompass the interconnected stages of rice production, processing, distribution, and consumption, forming the backbone of food security in Asia. These chains involve upstream activities such as input supply and farming, midstream processes like milling and marketing, and downstream retail and consumption. Their efficiency and resilience are critical because rice is the primary staple for billions of people in the region. Despite rice being a staple food for billions in Asia, there is limited understanding of how COVID-19 specifically impacted RVCs compared to other crops. This lack of clarity poses challenges for designing targeted interventions to strengthen food system resilience.

Rice-producing countries in Asia faced unique challenges during the pandemic (Mobarok et al. 2021). Lockdowns and mobility restrictions forced nations to rely heavily on domestic rice systems due to limited imports (Olvian et al. 2022). This reliance exposed structural weaknesses in local production, processing, and distribution networks. However, existing literature primarily addresses general agricultural impacts or food security trends, leaving a research gap in analyzing the differential effects of COVID-19 across upstream (input supply and production), midstream (processing and marketing), and downstream (retail and consumption) segments of RVCs. Few studies provide comparative insights across countries, making it difficult to identify which stages were most vulnerable and why. The core problem lies in the absence of comprehensive evidence on how COVID-19 disrupted RVCs in Asia and the extent to which these disruptions affected food security, pricing, and farmer livelihoods. Without such knowledge, policymakers and stakeholders lack the data needed to develop effective strategies for mitigating future shocks. Understanding these dynamics is essential for building resilient food systems capable of withstanding global crises.

Addressing these gaps, this study aims to conduct a systematic review of peer-reviewed journals published between 2020 and 2022, indexed in Scopus, Google Scholar, PubMed, and Clarivate Analytics. It also aims to synthesize policy, management, and scientific literature to rigorously identify and compare how COVID-19 disrupted the RVC across upstream (input supply and production), midstream (processing and marketing), and downstream (retail and consumption) stages. Although previous studies and reviews have examined COVID-19's impact on agriculture and global food systems, these analyses often lack a focused synthesis on staple crop value chains in Asia. This gap necessitates a systematic review to consolidate fragmented evidence, identify patterns across upstream, midstream, and downstream segments, and provide actionable insights for resilience-building. In particular, this study aims to (1) identify and analyze the disruptions caused by COVID-19 in the upstream segment of the RVC, including input supply and production; (2) examine the effects of the pandemic on midstream activities such as processing, transportation, and marketing; (3) assess the consequences of COVID-19 on downstream components, particularly retail distribution and consumer access; and (4) synthesize findings and propose recommendations for strengthening RVC resilience against future global shocks. The review aims to examine the pandemic's impact on the RVC across its three major segments: upstream (input supply and production), midstream (processing and marketing), and downstream (retail and consumption). By synthesizing evidence from multiple sources, this research seeks to identify patterns of disruption, quantify their effects where possible, and propose actionable recommendations for enhancing resilience in Asian rice systems.

This study seeks to address the following questions:

1. How did COVID-19–related disruptions (e.g., mobility restrictions, labor shortages, and logistics bottlenecks) affect input supply and farm-level rice production in terms of the availability and cost of inputs, production

volumes, yields, and production costs across different geographies and time periods?

2. What were the effects of the pandemic on rice processing and marketing— including milling throughput, storage, quality, wholesale prices, market access, and trader behavior— and through which mechanisms (e.g., supply chain interruptions, credit constraints, policy measures) were these impacts mediated?
3. How did COVID-19 influence retail availability, consumer prices, purchasing patterns, dietary substitution, and household food security for rice, and how did these outcomes vary by country income level, urban–rural setting, and the phases of the pandemic? Which adaptations or policies (e-commerce, trade facilitation, social protection) mitigated adverse effects?

STUDY DESIGN

This research employed a systematic review approach to synthesize evidence on the impacts of the COVID-19 pandemic on rice value chains (RVCs) in Asia. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and rigor.

SEARCH STRATEGY

A comprehensive literature search was conducted across four major databases using the Harzing's Publish or Perish 7 software program. The researchers conducted a cross-database search (Scopus, Google Scholar, PubMed, and Clarivate Analytics), employed keywords and Boolean operators, and ran searches to extract articles using the following search terms: ("rice" AND "COVID-19"), ("pandemic impact"), ("rice production AND Asia"). The search covered peer-reviewed articles published between January 2020 and December 2022. A manual search of journal articles was also conducted following the Publish or Perish search, using the terms ("rice" AND "production" AND "COVID-19"). Filters were applied, such as the English language, full-text availability, and relevance to RVCs.

ELIGIBILITY CRITERIA

The eligibility criteria for this review were established to ensure the inclusion of relevant and high-quality studies. Only peer-reviewed articles published between 2020 and 2022 were considered, as these years capture the peak period of COVID-19 impacts on rice value chains. Studies were required to focus specifically on disruptions in rice production, processing, marketing, or consumption within Asian countries, given the region's heavy reliance on rice as a staple food. Sources such as blogs, opinion pieces, and non-peer-reviewed materials were excluded to maintain academic rigor and reliability. Additionally, studies unrelated to rice or those that did not address any component of the rice value chain were omitted to keep the review aligned with its core objectives.

STUDY SELECTION

The screening and selection of studies for this systematic review were conducted by a single reviewer, who applied the predefined inclusion and exclusion criteria during both the title and abstract screening and full-text review stages. To ensure consistency and minimize bias, the reviewer followed a structured protocol and documented all decisions using a PRISMA flow diagram. While multiple reviewers are often recommended for systematic reviews, this study relied on one reviewer due to resource constraints, with careful adherence to standardized procedures to maintain rigor and reliability.

To ensure accuracy and consistency, data extraction was validated through a double-checking process, in which all extracted information was cross-referenced with the original articles before final inclusion. Each paper underwent a two-stage review process, beginning with title and abstract screening followed by full-text assessment based on predefined inclusion and exclusion criteria. During extraction, key details such as study characteristics, methodological approaches, and rice value chain segments were verified against the source material to minimize errors. Any ambiguities or missing data were resolved through a follow-up review of the original publication. This systematic approach ensured that only high-quality, relevant studies were included in the final synthesis. Refer to Figure 1 for the PRISMA flowchart used in this study.

A total of 1,000 records were identified through database searching, and 23 additional records were retrieved from other sources. After removing duplicates, 996 records remained for screening, of which 978 were excluded: 955 were unrelated to the effects of the pandemic on the rice value chain, 19 were not focused on Asia, and 4 were not journal articles. Finally, 18 full-text articles were assessed for eligibility, and 3 were excluded (2 were not journal articles and 1 lacked references), resulting in 15 studies included in the systematic review.

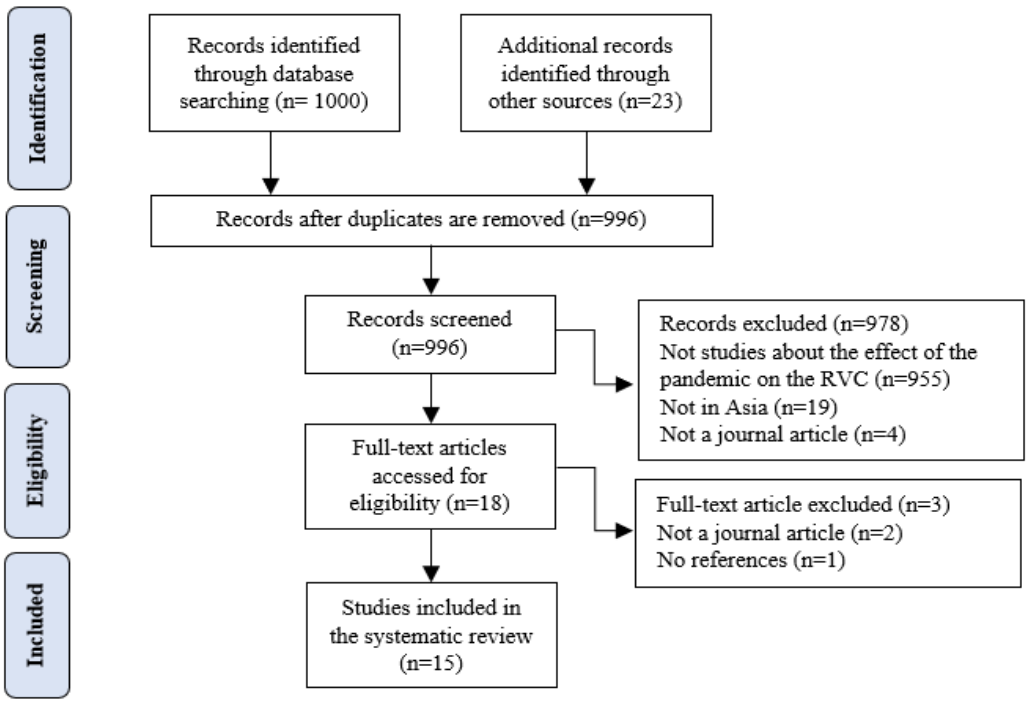

Figure 1. PRISMA Flowchart.

DATA EXTRACTION

The following data were extracted from each study: study characteristics (title, authors, authors' institution/s, database sources, research theme, research type, funding sources, and study location), study overview, and the RVC segment/s discussed in each paper. In addition, information on the year of publication, methodological approach, and key findings related to upstream, midstream, and downstream disruptions was recorded to ensure comprehensive coverage of the value chain impacts. A follow-up search was also conducted to identify the economic status of each country and whether it is rice-producing or non-rice-producing. Data were organized using a standardized extraction form in Microsoft Excel, allowing for systematic categorization and comparison across studies. Where available, quantitative indicators such as percentage changes in production, price fluctuations, and labor shortages were also documented to strengthen the analysis.

DATA ANALYSIS

This study conducted a systematic review through rice value chain analysis of each Asian country represented in the selected studies. A descriptive analysis was then performed to examine the extracted data by summarizing key points and identifying variables, actors, and activities contributing to understanding the effects of the pandemic on each rice value chain segment. Data were extracted using a standardized form that captured study characteristics, methodological approaches, and quantitative indicators such as production changes and price fluctuations. Findings were synthesized narratively and organized by upstream, midstream, and downstream segments to highlight patterns of disruption and resilience strategies across countries.

RICE VALUE CHAIN SITUATION IN SOUTHEAST ASIAN COUNTRIES

This paper reviewed fifteen (15) journal articles, examining the effect of the present COVID-19 pandemic on the three segments of Asian RVCs (see Table 1). Fourteen out of fifteen (93%) papers explored the impact of the pandemic on the input supply and production in the upstream segment of the RVC. Conversely, only six papers (40%) analyzed the condition of the constituent elements of the midstream segment, namely the processing, marketing, and logistics. Regarding downstream consumption and retail, ten papers (66%) examined the significant effects of the pandemic on these elements. This review also aligns with global assessments by FAO and IRRI, which emphasize that pandemic-related disruptions were uneven across regions, highlighting systemic vulnerabilities in RVCs (Wilson et al. 2015).

Table 1. Summary of studies meeting the inclusion criteria for the present systematic review.

Title	Published Date and study location	Authors and Author's institution	Types of Databases	Research Theme and type	Funding Resources
Reviewing Rice Tariffication in the Time of COVID-19: Rationale and Road to Rice Self-Sufficiency in the Philippines	26 April 2021- Philippines	San Juan DM. (De La Salle University, Philippines)	Social Science Research Network (SSRN)	Socio-Ecological Aspect; descriptive survey research	De La Salle University-Manila
Monitoring the impact of COVID-19 in Myanmar: Rice millers – July 2020 survey round	July 2020- Myanmar	Goeb J. et al. (Department of Agricultural, Food, and Resource Economics of Michigan State University Department of Economics, Harvard University Development Strategy and Governance Division of the International Food Policy Research Institute)	International Food Policy Research Institute	Socio-Ecological Aspect; descriptive survey research	CGIAR Research Program on Policies, Institutions, and Markets US Agency of International Development Livelihoods and Food Security Fund International Growth Center
Big Boro rice harvest during COVID-19 pandemic: an optimism for resilient rice system in Bangladesh	02 November 2021- Bangladesh	Jamal MR. (School of Environmental and Rural Science, University of New England, Australia Department of Agriculture Extension, Ministry of Agriculture, Bangladesh)	Journal of Bioscience and Agriculture Research	Socio-Ecological Aspect; descriptive survey research	School of Environmental and Rural Science & Department of Agriculture Extension
Effect of COVID-19 on Logistics of Thai Rice Export	10 October 2021- Thailand	Songsang JK. et al.	International Journal of Current Science Research and Review	Socio-Ecological Aspect; descriptive survey research	Chulalongkorn University
COVID-19 and Policy Impacts on the Bangladeshi Rice Market and Food Security	26 May 2021- Bangladesh	Mobarok MH. et al.	Multidisciplinary Digital Publishing Institute	Socio-Ecological Aspect; descriptive survey research	
Multi-faceted impact and outcome of COVID-19 on smallholder agricultural systems: Integrating qualitative research and fuzzy cognitive mapping to explore resilient strategies	29 December 2021- Eastern India (Sunandar areas)	Goswami R. et al. (Integrated Rural Development and Management Faculty Center, Ramakrishna Mission Vivekananda Educational and Research Institute, India African Plant Nutrition Institute, Polytechnic University, Morocco CSIRO Land and Water. Black Mountain Science and Innovation Park, Australia Global Evergreening Alliance, Melbourne, and Institute for Study and Development Worldwide, Australia)	Scopus	Socio Ecological Aspect; qualitative research	
How COVID 19 effect Malaysian paddy industry? Adoption of green fertilizer a potential resolution	30 September 2020-Malaysia	Adnan N and Nordin SM. (Universiti Teknologi Petronas, Seri Iskandar, Malaysia)	Scopus	Socio Ecological and Policy Aspect; quantitative and descriptive research	

Title	Published Date and study location	Authors and Author's institution	Types of Databases	Research Theme and type	Funding Resources
The Impact of COVID-19 pandemic on food sufficiency in Bantul Yogyakarta – Indonesia	February 2021-Indonesia	Fitriana L. et al. (Education and Training Human Resources Agency of Kutai Timur Kawasan Perkantoran Bukit Pelangi, Indonesia Department of Agricultural and Biosystem Engineering Faculty of Agricultural Technology Universitas Gadjah Mada, Indonesia)	Scopus	Socio Ecological Aspect; quantitative and descriptive research	Rekognisi Tugas Akhir (RTA) Grant of Universitas Gadjah Mada
Agricultural labor, COVID-19, and potential implications for food security and air quality in the breadbasket of India	21 September 2020-India	Singh B. et al. (International Maize and Wheat Improvement Center (CIMMYT) CGIAR Research Program on Climate Change, Agriculture & Food Security (CCAFS) Soil and Crop Sciences Section, School of Integrative Plant Science IRRI South Asia Regional Center (ISARC) International Rice Research Institute (IRRI) Indian Council of Agricultural Research (ICAR) CAR-Central Soil Salinity Research Institute (CSSRI) ICAR-Agriculture Technology Applications Research Institute (ATARI))	Scopus	Socio Ecological Aspect; quantitative and descriptive research	Indian Council of Agricultural Research (ICAR) Government of India CGIAR Research Programs (CRPs) on Climate Change Agriculture and Food Security (CCAFS) Wheat Agri-Food Systems (WHEAT)
Does the COVID-19 pandemic affect the social-ecological resilience of the organic rice production system in Chiang Mai Province, Thailand?	23 June 2021-Thailand (rural area)	Panpakdee C and Palinthorn F. (Department of Agricultural Extension and System Approaches, Faculty of Agriculture, Khon Kaen University)	Forest and Society-Journal Article	Socio Ecological Aspect; descriptive survey research	Research Administration Division of Khon Kaen University
Impact of COVID-19 Pandemic On Local Rice Supply Chain FlowPatterns In Kapuas Regency, Central Kalimantan, Indonesia	June 2021-Indonesia	Erlina Y and Elbaar EF. (Agribusiness, Faculty of Agriculture, Palangka Raya University)9 Indonesian Agricultural Technology Assessment and Development South Kalimantan, Indonesia Indonesian Center for Agricultural Technology Assessment and Development, Indonesia)	ResearchGate	Socio Ecological Aspect; descriptive survey research	Institute for Research and Community Service
Marketing analysis of "Siam" local rice in South Kalimantan during the pandemic of COVID-19	24 September 2021- Indonesia	Sabur A. et al. (Indonesian Agricultural Technology Assessment and Development South Kalimantan, Indonesia Indonesian Center for Agricultural Technology Assessment and Development, Indonesia)	ResearchGate	Socio Ecological Aspect; quantitative and descriptive research	
Increasing rice production: a proposed strategy during and after COVID-19 pandemics	August 2021-Indonesia	Sunandar N. et al. (Indonesia Center for Agricultural Technology Assessment and Development)	IOP Conf. Series: Earth and Environmental Science 803	Socio Economic Aspect; quantitative and descriptive research	

Title	Published Date and study location	Authors and Author's institution	Types of Databases	Research Theme and type	Funding Resources
The Effect of Labor Utilization and Rice Farming Income Due to COVID-19 in Kendal Regency	07 May 2018- Indonesia (Kendal Regency, Central Java)	Aldillah R. et al. (Indonesia Center for Socio Economy and Policy Studies)	Socio Economy and Policy Studies (SEPS)	Socio Economic Aspect; quantitative and descriptive research	
The implications of the COVID-19 pandemic on rice market performance in Java, Indonesia	2021- Indonesia (Jakarta, Semarang, & Surabaya)	Nasir MA. et al. (Department of Agricultural Socioeconomics Faculty of Agriculture, Universitas Gadjah Mada, Indonesia)	IOP Conf. Series: Earth and Environmental Science 637	Socio Economic Aspect; quantitative and descriptive research	Ministry of Research and Technology / National Agency for Research and Innovation

In terms of study location, seven Asian countries were covered by this pool of papers. This included four lower-middle-income countries namely, the Philippines, Myanmar, Bangladesh, and India, together with three upper-middle-income countries specifically Thailand, Malaysia, and Indonesia. Following the first confirmed COVID-19 case on December 31, 2019, these countries reported their first cases in the first quarter of 2020 (Adnan and Nordin 2020). This was followed by the announcement of lockdowns in each country as preventive measures. All seven countries, except Thailand and Indonesia, imposed lockdowns as early as March 2020. These two countries declared lockdowns a month later. Thus, all the papers were conducted and published between April 2020 and November 2021. As of May 2022, these countries were reported by the WHO Coronavirus (2019) dashboard as having a PHSM Severity Index (Public Health and Social Measures) of "Severe" to "Most Severe." Bangladesh and Thailand had a PHSM Severity Index of "Severe." On the other hand, "Severe to Most Severe" characterized the Philippines, India, and Indonesia, while Myanmar and Malaysia had a "Most Severe" PHSM Severity Index. To examine how the severity of public health and social measures impacted the RVC, the methodologies used in these studies included descriptive survey research, qualitative research, and quantitative research. These journal articles examined the complex interplay between ecology (in terms of rice as a natural resource), social actors and processes, and economic activities, during this global health issue. Cross-country differences were evident, as nations with stronger local input systems (e.g., Thailand) showed greater resilience compared to those reliant on imports (e.g., Bangladesh). These variations underscore the role of governance and pre-existing infrastructure in mitigating shocks.

IMPACTS OF COVID-19 ON UPSTREAM SEGREMENT OF THE RVC

The analysis of the papers yielded diverse findings. However, it was determined that the COVID-19 pandemic had a substantial impact on the input supply and output in the upstream portion of the RVC in several ways. Table 2 presents the results of the scholarly literature regarding the influence of COVID-19 on the upstream segment of the RVC. Only individuals engaged in discussions pertaining to the upstream segment were included in this section. The findings were categorized based on the actors and activities in the input supply and production, which are the two constituents of the upstream segment. Regarding input supply, there was only a small impact observed on the actors and activities involved, particularly in terms of seed and machinery availability, as well as fertilizer costs. Conversely, the pandemic significantly disrupted labor patterns. Nevertheless, with improved governance coupled with government assistance, several regions demonstrated successful adaptation to these issues.

In a study authored by Goswami et al. (2021), it was observed that most farmers in the Sundarbans Areas in eastern India were not challenged in securing inputs such as seeds and fertilizers or obtaining them at high prices because they had kept them in reserve in preparation for expected lockdowns and societal restrictions. This is in line with the availability of their machinery. Aside from the fact that tractors and other machinery were not constantly used by marginal farmers, some were already available locally, such as power tillers. Thus, the only challenge for them was the increasing fuel prices; however, it was observed that there were no changes in the imposed charges by operators. Erlina and Elbaar (2021) also reported similar results. Farmers in Indonesia, specifically in Kapuas Regency, Central Kalimantan, had also stocked sufficient seeds for one planting season. Additionally, the transportation of inputs during the pandemic was noted to remain stable. In Chiang Mai Province in Thailand, as reported by Panpakdee and Palinthorn (2021), the stable supply of farming inputs was mainly due to self-dependency on local organic rice systems, using locally available inputs. In contrast, dependency on exported fertilizers, such as in Thailand, as stated by Songsang and

Suthiwartnarueput (2021), resulted in higher input costs.

As regards labor patterns, the pandemic has greatly disrupted farmer labor patterns due to restrictions. According to a descriptive survey conducted by Goeb et al. (2020), there was a decrease in the number of workers in rice paddies in Myanmar by 28%. This was further aggravated by the implementation of health protocols that rice millers needed to follow, such as hygienic practices (four-fifths of rice millers) and temperature screening (one-third of rice millers) (Borras et al. 2017). Similarly, a reduction of workers was also noted in Kendal Regency in Indonesia. As explained by Aldillah et al. (2021), paddies were normally maintained by non-family members. However, during the pandemic, non-family labor decreased to 69%, mainly due to precautions against virus transmission and the scarcity of resources that would otherwise be used as wages for workers within the family. In two other studies focusing on India, authored by Singh et al. (2020) and Goswami et al. (2020), the pandemic was shown to affect migratory labor. Before the pandemic, labor during both planting and harvesting stages mainly relied on migratory workers. Thus, due to ongoing societal restrictions, the workforce in these areas was challenged.

In terms of production, as one of the components of the upstream segment of the RVC, most of the papers reported positive results despite the ongoing health crisis. According to Erlina and Elbaar (2021) and Sabur et al. (2021), who studied rice paddies in Indonesia, production continued in the central and southern areas of Kalimantan. In two separate studies, production was found to be supported by adaptive strategies implemented by farmers. In the case of the study presented by Jamal (2021), the production of Boro rice in Bangladesh in 2021 recorded the highest yield ever (4.29 t/ha), which was 6% higher than the previous year, due to better farm management and government support. Similarly, according to Panpakdee and Palinthorn (2021), an increase in production was also observed in Chiang Mai Province in Thailand, attributed to farmers exploring adaptive strategies and increased autonomy in managing local food supply.

Table 2. Impact of COVID-19 on the actors and activities in the input supply and production of the upstream segment. (Note: [1] = raw materials, labor, and goods for rice cultivation; actors: seeds, fertilizers, machinery, farmers, suppliers; millers activities: seed collection, seed supply, fertilizer supply; [2] = series of activities and processes in cultivation, pre-harvesting, and harvesting; actors: yield, farmers, millers, mills; activities: growing, harvesting, threshing, drying).

References	Upstream Segment			
	Input Supply[1]		Production[2]	
	ACTORS	ACTIVITIES	ACTORS	ACTIVITIES
Goswami et.al. (2020)	(-) fertilizer (imported) (+) seed & fertilizer (+) machinery (-) farmers (-) millers	(+) seed collection (+) seed supply (+) fertilizer supply	(+) farmers (family labor) (-) farmers (hired labor)	(-) growing
Erlina and Elbar (2021)	(+) seed & fertilizer	(+) seed collection (+) seed supply		(+) growing (+) harvesting
Palinthorn and Panpakdee (2021)	(+) seed & fertilizer (+) machinery (-) farmers (-) millers	(+) seed supply (+) fertilizer supply		(+) growing (+) harvesting
Songsang and Suthiwartnarueput (2021)	(-) seed & fertilizer	(-) fertilizer supply		
Goeb et al. (2020)	(-) millers			
Aldillah et al. (2021)	(-) farmers (-) millers			
Singh et al. (2020)	(-) farmers			(-) growing (-) harvesting
Sabur et al. (2021)	(+) seed & fertilizer	(+) seed supply (+) fertilizer supply		(+) growing (+) harvesting (+) threshing (+) drying
Jamal (2021)	(+) seed & fertilizer (+) farmers (+) millers	(+) seed supply (+) fertilizer supply		(+) growing (+) harvesting

One common variable among the papers analyzed is that the countries are all categorized as rice-producing countries. Therefore, these countries theoretically have strong knowledge of the processes and components of the rice value chain. In the paper of Goswami et al. (2020), the study location is in the Sundarbans areas of east India, which belong to West Bengal— a state that has consistently been among the top rice-producing regions in the country (Pathak et al. 2020). According to key biophysical factors (temperature, rainfall, and soil type), rice farms in West Bengal are categorized as suitable to very suitable zones for rice production. From 1990 to 2018, despite a decreased in farming land, the region showed positive changes in rice production and productivity (Pathak et al. 2020). Therefore, as a major rice production area contributing about 15% of India's output (National Food Security Mission, 2016), it was expected to have sufficient reserves of seeds and fertilizers, thereby contributing to resiliene in input supply. Also, the presence of tractors, local power tillers, and other machinery was of no surprise because India has been implementing this development called Farm Mechanization for its agricultural production, with a goal to achieve a sustainable increase in both farm yield and income (Bhattarai et al. 2018; Shukla et al. 2019; Gulati et al. 2020). The same applies to a rice estate in Kapuas Regency, Central Kalimantan, Indonesia where seeds stocked for another planting season (Erlina and Elbaar 2021). Historically, Central Kalimantan was a part of the failed Mega Rice Project in 1995, where converted peatlands were found unsuitable for major crop production (IPS 2020). However, more recent findings (Wardie & Sintha, 2018) indicate that, at the household level, farming systems in the region have become highly sustainable. This suggest that the local rice system in the regency is self-sufficient, explaining the minimal negative effect of the pandemic on their RVC. Self-sufficiency and local dependency also contributed to Thailand's stable rice production during the pandemic. Thailand is one of the largest rice producers (FAO 2019) and the second-largest exporter after India (Asia Pacific Foundation of Canada 2021). As a result, there is a well-established domestic market for farming inputs, particularly in Chiang Mai Province. Several suppliers of fertilizers and seeds are located within the area, and irrigation concerns are minimal due to presence of the Ping River, a major tributary.

As agriculture is a principal sector in many Asian economies (APFC 2021), ensuring safety during food processing became vital. This created additional challenges for worksites as the pandemic emerged, and therefore restrictions were implemented. In Southeast Asia alone, there was an estimated 116 million workers affiliated with the agriculture and food industry, with 10 million being migrant workers (APFC 2021). Therefore, agriculture was not only a source of food for these countries, but it also served as the driving force for employment and their respective economies. The availability of labor for agricultural activities varied from place to place. The labor workforce available for rice fields in Myanmar, Indonesia, and India was found to be challenged by fewer workers available for rice production (Goeb et al. 2020; Singh et al. 2020; Aldillah et al. 2021; Goswami et al. 2021). India announced its first COVID cases in late January 2020, Indonesia in the first week of March 2020, and Myanmar in the last week of March 2020. Since then, necessary restrictions were implemented across Asian countries to ease the transmission of the virus. The leading cause for this decrease in workers was the health protocols mandated by the government, most notably physical distancing. In a report on Myanmar migrant workers, 66% of the interviewees either lost their jobs due to decreased operations at their worksites or left voluntarily due to the threat of the virus. From this, it can be inferred that migrant workers from other countries likely faced similar situations and therefore reduced the workforce in their previous jobs. Some workers engaged in agriculture left their jobs not only due to the virus but also because of decreasing wages and increasing living costs, which left them unable to support their families and forced them to return to their respective countries (ILO 2021). Therefore, rice field owners who were dependent on migrant workers shifted to local household laborers, which sometimes resulted in reduce or earlier rice production operations. This was the case in Bangladesh (Jamal 2021). The country shifted to local village laborers since the mobility for city farm laborers was reduced. However, this benefited them, as some workers returned home, leading to an increased farm workforce.

Even with the challenges to labor availability the rice sector across different Asian countries, it was notable that production not only maintained its rate but, in some cases, even surpassed pre-pandemic levels. Indonesia was still able to sustain its rice production amid COVID-19 stresses (Erlina and lbaar 2021; Sabur et al. 2021). This is an expected outcome, as the country is one of the top rice-producing nations in the world. Among ASEAN countries, Indonesia has the highest employment related to the agriculture and food industry (APFC 2021). Therefore, although affected by a decrease in workforce, the country still had sufficient local labor. Additionally, since Indonesia has local farming input reserves such as seeds, rice production did not cease. In Bangladesh, rice production not only continued but also reached the highest yield of Boro rice in history (Jamal 2021). One factor contributing to this increase was the rise in market prices of rice, which motivated farmers, supported by government subsidies such as farming inputs and machinery. Thailand also showed resilience

to COVID-19 restrictions on rice production (Panpakdee and Palinthorn 2021), mainly due to its autonomy in farm inputs and reliance on local supply. Farmers also implemented adaptive strategies during pandemic rice production stresses, such as adjusting harvesting dates based on available resources. In conclusion, Asian countries were able to cope with and continue rice production during the pandemic. It has been reported that despite various agricultural stresses, the food supply chain, including the RVC, remained robust and resilient (CGIAR 2020). On the other hand, while the agricultural sector has been less affected by the pandemic, the greater challenge lies in how this produce reaches consumers (FAO 2019).

The study of Goeb et al. (2020) revealed that due to pandemic restrictions, there was a reduction in operating hours in 56% of mills, while 36% stopped milling activities for at least one week. Similarly, post-harvest processing of rice was reduced in Chiang Mai Province, Thailand due to an inadequate workforce (Panpakdee and Palinthorn 2021).

As regards other actors in the midstream segment, specifically the traders and wholesalers, most of them resorted to buying directly from farmers, which, aside from faster commerce, resulted in lower costs in buying and selling their produce. As stated by Erlina and Elbaar (2021), rice milling owners in Central Kalimantan bought unmilled rice directly from farmers and paid them immediately (Sabur et al. 2021). On the contrary, farmers in Sunandar areas in eastern India are reported to be challenged by disruptions in marketing and logistics. Unlike farmers from Indonesia, they are forced to sell their produce to local and neighboring markets at lower prices because no wholesalers buy their produce.

Another activity in the midstream segment that was found to be greatly affected was the transport of rice produce, both within and outside the areas of study. In a study by Goswami et al. (2020), it was reported that farmers resorted to using bicycles to transport rice produce in small quantities. Some used rickshaws and motor vans, which were observed to be more costly. Restrictions in trading from country to country have also caused delays in transport. As explained by Songsang and Suthiwartnarueput (2021), since Chinese traders reduced the number of containers for transport, there was an increase in sea freight. As a result, local traders waited in the hope of lower sea freight, delaying the transport and storage of rice produce, which resulted in a shortage of space for the new harvest. In parallel with these delays, Erlina and Elbaar (2021) reported that this caused wholesalers and retailers alike to experience inaccurate transport schedules.

The COVID-19 pandemic intensified concerns about the security of food supplies in the Asian and Pacific countries. As health risks increased, travel restrictions also increased. With the introduction of unanticipated stresses, it created immediate challenges for individuals wordwide. According to Kim et al. (2020), the disruptions mentioned in the upstreamsegment delayed and even postponed many processes in the midstream-processing, logistics, and marketing. According to the OECD, the global health crisis undoubtedly disrupted processes in food industries (CGIAR 2020). Due to illness and lockdown measures, there was a workforce shortage and an inadequate number of workers. In the case of vegetable and meat processing facilities, social

Table 3. Impact of COVID-19 on the actors and activities in the processing, marketing, and logistics in the midstream segment. (Note: [1] = series of post-harvesting activities and processes; actors: millers, collectors, traders, wholesalers, milling; activities: milling, paddy collection, drying, trading, wholesaling. [2] =delivery and transport of harvest from paddy to market; actors: traders, transporters, importers, exporters; activities: trading, transport, import, export).

References	Midstream Segment			
	Processing[1]		Marketing & Logistics[2]	
	ACTORS	ACTIVITIES	ACTORS	ACTIVITIES
Goeb et al. (2020)	(-) millers	(-) milling		
Panpakdee and Palinthorn (2021)	(-) millers	(-) paddy collection (-) paddy selling (-) drying (-) milling		
Erlina and Elbaar (2021)	(+) collectors (+) millers	(+) paddy collection (+) paddy selling (+) milling	(-) traders	(-) transport
Sabur et al. (2021)	(+) collectors	(+) paddy collection (+) paddy selling (+) drying (+) milling		(+) trading (+) selling
Goswami et al. (2020)				(-) transport (-) trading (-) selling

Table 4. Impact of COVID-19 on the actors and activities in retail and consumption in the downstream segment. (Note: [1]=selling of rice produce to consumers; actors: rice produce, price, wholesalers, retailers, consumers; activities: wholesaling, retailing, selling, buying; [2] =use and value of goods to consumers or households; actors: price, demand, buyers, suppliers; activities: supply, demand.)

References	Downstream Segment			
	Retail[1]		Consumption[2]	
	ACTORS	ACTIVITIES	ACTORS	ACTIVITIES
Goswami et al. (2020)	(-) wholesalers (-) retailers (+) consumers	(-) wholesaling (-) retailing	(+) consumers (-) suppliers	(-) supply (+) demand
Nasir et al. (2021)				(-) supply (rice deficit areas) (+) supply (riced surplus areas)
San Juan (2021)	(-) wholesalers (-) retailers (-) consumers	(-) wholesaling (-) retailing	(-) consumers (-) suppliers	
Goeb et al. (2020)	(-) wholesalers (-) retailers (-) consumers	(-) wholesaling (-) retailing	(-) suppliers	(-) demand
Fitriana et al. (2021)			(+) consumers (-) suppliers	(-) supply (+) demand

distancing measures had to be applied to protect employees from the virus. In relation to this, processing and logistics operations were disrupted due to high rates of work absences. In a study by the ICLEI Southeast Asia Secretariat (2020), countries in Southeast Asia were found to have experienced major adverse effects of the pandemic. In the Philippines, the transportation of goods suffered delays due to strict inspections and border restrictions. Due to disruptions in transportation, a large volume of fresh produce became oversupplied, and to prevent waste, farmers decided to lower prices. Countries like Indonesia and the Philippines developed online delivery services that greatly helped in transporting supplies without risking lives.

In the study by Sabur et al. (2021), social constraints due to COVID-19 led to significant disruptions in the logistics and marketing sectors in South Kalimantan, Indonesia. The respondents of the study were individuals who experienced rice marketing firsthand--local traders, wholesalers, and farmers. Based on the result, the marketing of Siam local rice remained efficient despite the pandemic. In another study by Erlina and Elbaar (2021), the focus was on the impacts of COVID-19 on the local rice supply chain in Central Kalimantan, Indonesia. The study indicated that farming activities were not significantly affected during the pandemic. However, COVID-19 had noticeable effects on the rice industry, particularly in the distribution process. In addition, the likelihood of incorrect product delivery due to restrictions and delays was high. In the study conducted by Goeb et al. (2020) in Myanmar, 60% of rice mills were expected to experience a revenue drop compared to 2019. The results showed that almost all mills considered sales as beneficial to business, and approximately half reported no changes in byproduct prices, especially compared to 2019. Therefore, mills producing large volumes of high-quality rice may have experienced negative effects on lower-value outputs.

Following these adverse effects, another study by Panpakdee and Palinthorn (2021) investigated the effects of rice production systems in four districts in Chiang Mai, Thailand. The study found that the pandemic did not significantly influence organic rice production in terms of social-ecological resilience. Even with labor conflicts due to COVID-19 restrictions, the impact on the midstream segment was minimal. In conclusion, the impacts of COVID-19 on the midstream varied by location and country resilience. Some countries adapted effectively, while others struggled.

In a study by Goswami et.al. (2020), it was revealed that although farmers in the Sunandar areas resorted to selling their produce at low prices, some produce remained unsold. Farmers brought this unsold produce back to their homes; some were consumed, while some were sold to private intermediaries, thereby incurring losses.

Several studies reported that increases in rice prices were largely influenced by the pandemic. In a study by Nasir et al. (2021), rice prices in Indonesia increased in deficit areas such as Jakarta, while they decreased in surplus areas like Semarang and Surabaya. A similar pattern was observed in Eastern India, where surplus supply combined with low demand forced rice prices to decrease (Goswami et al. 2021). In another study by San Juan (2021), the price increase of exported rice in the Philippines was attributed to the imposition of tariffs on imported rice.

Finally, since the pandemic brought undesirable effects to the upstream and the midstream segments of the RVC, consequently, it also affected the endpoint of the RVC--retail and consumption. In a survey by Goeb et al. (2020), rice prices in Myanmar increased in 2020 compared to 2019, mainly due to reduced milling operations. In contrast, prices

declined in Sunandar areas in Eastern India. According to Goswami et al. (2020), limited market hours and an excess of sellers over buyers led to lower prices, with some produce retained for household consumption. While this benefited consumers, it was unfavorable for farmers. This finding is consistent with a study by Fitriana et al. (2021), which examined rice supply and demand in Bantul Regency, Indonesia. In 2020, the production was 115,988.47 tons, while demand rose to 145,131.25 tons, resulting in a supply deficit.

The Philippines also experienced a price increase during the pandemic; however, this was mainly due to tariffs on imported rice (San Juan 2020). Myanmar also reported higher rice prices in 2020 compared to 2019 (Goeb et al. 2020), largely due to the challenges faced by milling companies, some of which were forced to close due to health restrictions. Rice millers had already anticipated a decrease in revenue, especially for those small milling company owners.

Therefore, it is important to note that the effects of the pandemic on the downstream segment of the RVC varried by location, depending on whether a country had enough rice production and effective market flow. Although global food prices remained relatively stable, exceptions occurred, especially for rice produce, as Thailand—a major rice exporter—experienced drought, which reduced production (Papademetriou et al. 2020; Songsang and Suthiwartnarueput 2021). Nevertheless, international market flows continued, supported by commitments from countries such as Myanmar, Brunei, and Singapore (Mobarok et al. 2021). This ensured that rice was successfully transported and delivered to consumers (Mobarok et al. 2021; Bhandari 2020). However, these findings should be interpreted with caution due to limitations: the evidence base is small, only English-language journals were included, and gray literature was excluded, which may omit critical local insights.

CONCLUSION

The COVID-19 pandemic remarkably influenced Asian rice value chains (RVC). Overall, the analysis reveals significant disruptions concentrated in midstream and downstream activities, while upstream operations demonstrated relative stability. This contrast emphasizes the critical role of preparedness and adaptability in agricultural systems. Global health issues such as COVID-19 affect not only public health, but also the economy. The findings underscore the need for integrated strategies that combine government support, private sector engagement, and farmer resilience to maintain continuity in production and trade. Collaboration between farmers and government is essential to reduce costs and strengthen local rice systems. Future efforts should focus on policy innovation, infrastructure development, and digital solutions to enhance connectivity and efficiency. In addition, tariffs on imported goods may help protect the domestic market, while generating government revenue that can be used to subsidize farmers. Ultimately, these measures can stabilize the rice value chain and build long-term resilience against future global disruptions.

Only the midstream and the downstream segments were severely affected. Evidence shows mixed outcomes in input supply and production, with stability in some contexts and declines or cost increases in others; results vary by country, pandemic phase, and policy environment. Therefore, collaboration between the farmers and government remains critical. In times of crisis, government and private sectors should enhance support systems for farmers and ensure continuous market flow.

Across studies, upstream outcomes were heterogeneous: some contexts reported stable input access due to logistics exemptions and domestic sourcing, while others experienced higher input prices, delivery delays, and labor shortages. Midstream processing and marketing showed mixed throughput changes, influenced by mobility restrictions, working capital constraints, and market access, with price transmission varying by policy regime and market structure. Downstream retail and consumption effects ranged from temporary availability gaps and price volatility to rapid shifts toward e-commerce and smaller-package purchases, with stronger household food security impacts in lower-income, urban, or import-dependent settings. Where comparable quantitative indicators were available, we applied random-effects models, finding substantial heterogeneity (I^2/τ^2) and moderation by pandemic stringency, trade dependence, and digital readiness. These findings underscore that RVC outcomes are context-specific, and policy effectiveness depends on baseline capacities, timing, and complementarities.

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All ideas, analyses, data interpretations, and written content were originally produced by the authors without any assistance in generating or developing the paper's substance. No generative AI was used to create, expand, or modify the intellectual content, findings, or conclusions presented in this work.

ETHICAL CONSIDERATIONS

This study was reviewed by the Cebu Normal University-Ethics Research Committee. This study was exempted from review because it was a systematic review paper which did not involve human participants.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper. All authors confirm that no conflicts of interest exist and that the research was conducted independently.

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ROLE OF AUTHORS: CAAJA*: Data Curation, Writing Original Draft Preparation, Methodology, Formal Analysis, Investigation, VIsualization;* LMO*: Data Curation, Writing Original Draft Preparation, Methodology, Formal Analysis, Investigation, Visualization*; EMSC*: Data Curation, Writing Original Draft Preparation, Methodology, Formal Analysis, Investigation, Visualization*; SLLB *: Data Curation, Writing Original Draft Preparation, Methodology, Formal Analysis, Investigation, Visualization*; RRN*: Data Curation, Writing Original Draft Preparation, Methodology, Formal Analysis, Investigation, VIsualization;* JJCG*: Conceptualization, Data analysis, Data validation, Writing, Reviewing & Editing, Validation. All authors read and approved the final manuscript.*

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