

A Review of Milled Rice Demand and Supply of Some ASEAN Countries and Lesson Learnt for Cambodia

Em Sros¹, Serey Mardy², Try Chanthuch³

^{1,3}Asia Euro University, Phnom Penh, Cambodia

²Svay Rieng University, Svay Rieng, Cambodia

Article Info

Article history:

Received : 02 July 2024

Revised : 19 July 2024

Accepted : 25 July 2024

Available online : 29 July 2024

Keywords:

Demand, Supply, Rice
Production, Rice Market, Lesson
Learnt

ABSTRACT

Rice is a vital crop for ASEAN countries, serving as a primary source of food security and playing a significant role in the regional economy. To draw lessons for rice supply and demand in Cambodia, this article will examine and briefly describe the rice markets in different ASEAN nations, including import and export, rice milling technology, government policy, obstacles, and opportunists. In Cambodia, a program utilizing the sustainable rice cluster (SRC) approach has been developed and put into action by the government in order to maintain the rise of rice production. Compared to traditional approaches, SRC has enhanced rice cultivation by about 40%. The key lessons Cambodia can learn are boosting domestic production, diversifying rice varieties, improving storage and distribution, practicing climate-smart practices, strengthening regional cooperation, improving market access, and farmer empowerment. By analyzing rice demand and supply dynamics in ASEAN and applying the lessons learned, Cambodia can strive to achieve self-sufficiency in rice production and reduce reliance on imports, increase the profitability and competitiveness of the rice sector, enhance food security for its population, and contribute to regional food security within ASEAN.



This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

Corresponding Author:

Em Sros

PhD Program, Asia Euro University, Phnom Penh, Cambodia

Email: sros_em@hotmail.com

INTRODUCTION

For Cambodia, agriculture is essential to the country's economy and way of life (Chung et al., 2019). The Royal Cambodian Government (RCG) declared its goal to make the nation the world's leading exporter of "rice-white gold" (That, 2016). The RCG seeks to advance agricultural development on a new scale and at a new pace in order to improve people's quality of life, accelerate the reduction of poverty, and enhance the basis for economic growth (Royal Government of Cambodia, 2010). Among agricultural products, rice is a necessity for day-to-day existence. It plays a major role in Southeast Asia's rural economy and food security. Rice is a vital crop for ASEAN countries, serving as a primary source of food security and playing a significant role in the regional economy (Rath et al., 2022). How significant a role does rice play in Southeast Asia? In addition to reviewing and briefly describing the rice markets in several ASEAN nations, this article will offer takeaways regarding the supply and demand for rice in Cambodia.

This review analyzes milled rice demand and supply dynamics in some ASEAN countries and explores potential lessons for Cambodia.

Since rice accounts for more than 76% of a Southeast Asian's calorie intake, rice is essential to food security ([Fitzgerald et al., 2009](#)). As they say, "it's not a meal without rice" in many parts of Southeast Asia. Thus, the loss of rice will have an effect on food security, particularly leading to hunger and health problems. This viewpoint offers some insights into how El Niño can affect Southeast Asia's rice production and food security, and it makes recommendations for short- and long-term steps that can be done to improve agri-food resilience.

What is El Niño?

A natural occurrence that happens every two to seven years is called El Niño (ASEAN Specialised Meteorological Center, n.d.). It is brought on by the Pacific Ocean's warming sea surface temperatures, which also affect surface winds and rainfall patterns, which in turn affect ocean currents and sea surface temperatures. Although each El Niño event is unique, El Niños usually last a year (Golden Gate Weather Service, n.d.). When sea surface temperatures in the tropical eastern Pacific rise above the long-term average, an El Niño event is declared. The Nino3.4 index is used to monitor El Niño conditions. An event is declared when the 3-month average value of the index, which is the average of SST anomalies over the region 5N-5S, 120W-170W, is above 0.65 °C for five or more consecutive months (ASEAN Specialised Meteorological Center, n.d.). El Niño causes Southeast Asia's surface air pressure to rise above normal, resulting in drier circumstances that raise the danger of smoke pollution from land and forest fires in the area. Depending on the strength of the El Niño phenomenon, heatwaves and droughts may become more frequent because warmer temperatures usually follow drier periods. Although El Niño is not caused by climate change, its effects are thought to be amplified by it (Dickie, 2023).

El Niño and its impact on rice production

The majority of agriculture, including rice production, depends heavily on a favorable environment. Rice planting season was delayed by the recent heat wave that lasted from March to May 2023 in Thailand, Myanmar, and Laos, and above 40°C in Cambodia, Vietnam, and Malaysia ([Bhandari, 2023](#)). El Niño is predicted to extend the warm, dry weather from mid-2023 to mid-2024, putting plants under heat stress that affects growth and, eventually, yield. Plants can suffer from the same harmful effects as humans, such as heat stroke, dehydration, and cramping (WHO, n.d.). Plants under heat stress lose water, grow more slowly, pollinate less, grow less well, have yellowed or withered leaves, have fewer tillers (grain-bearing branches), and eventually die as seedlings. Reduced rice yields have often been observed at temperatures higher than 33°C ([Arshad et al., 2017](#)). Research conducted in the Philippines by the International Rice Research Institute (IRRI) revealed that, on average, there has been a 10% yield loss for every 1°C increase in average nighttime temperatures during the dry season ([Peng et al., 2004](#)). Yields are predicted to decline

as El Niño is forecast to bring record-breaking temperatures. The development of drought- and thermo-resistant variants has been the focus of much research ([Schiermeier, 2015](#)). In order to mitigate the effects of heat stress on rice yields, research into developing climate-resilient varieties is crucial because these effects depend on the timing, severity, and duration of the heating event during the crop's growth and developmental stages ([Arshad et al., 2017](#)). For instance, rice prefers a temperature of 25–28°C (Xu et al., 2021) for seedling stage and 28–30°C ([Sarsu et al., 2018](#)) for germination; temperatures higher than that lower production by, among other things, increasing sterility, delaying flowering, and reducing fertilisation periods ([Arshad et al., 2017](#)). Later (grain filling) stages of heat stress diminish starch accumulation and may cause an increase in chalkiness in grains, which manifests as a decrease in rice translucency and milling quality ([Arshad et al., 2017](#); [Liu et al., 2021](#)). It affects not just the amount but also the quality of rice produced; lower-quality rice has a lower market value, which means farmers lose money. Therefore, all phases of the plant's development must be addressed in any genetic modification made to rice types. Additionally, the different eco-geological races of rice react differently to heat stress. Indica rice can withstand higher temperatures and is more suited for high-temperature settings than Japonica rice ([Shrestha et al., 2022](#)). While Japonica rice, or short grain rice, is primarily grown in the region's highlands, while a tropical version called Javanica is well-liked in Indonesia, Indica rice, or Jasmine, Phka Rumduol, and other fragrant and non-fragrant types, is the predominant rice grown across Southeast Asia. Thus, rice yields in highlands may be more sensitive to abnormally warm temperatures than those in lowlands (UNDP, 2018a; UNDP, 2018b).

Implications for rice production for 2023-2024

Towards the end of 2023, El Niño might be deemed “very strong” in light of the record-breaking ocean temperatures ([Harvey, 2023](#)). El Niño usually brings milder temperatures to Thailand, Myanmar, Laos, and North Vietnam during this period, whereas Indonesia, the Philippines, South Vietnam, Cambodia, and Malaysia see warmer and drier weather (NOAA, n.d.). All of the major rice-growing zones are located in regions that probably influence the winter and spring paddy seasons ([Han et al., 2021](#)).

El Niño is therefore expected to cause a decrease in rice output, especially in the winter and spring seasons. Countries in Southeast Asia are reacting with both direct intervention and policy. In order to save water and prevent loss, Thailand asked its farmers in May 2023 to limit rice growing in 2023 to the summer and fall and to replace it with alternative drought-tolerant crops ([Wipatayotin, 2023](#)). In order to reduce rice exports from the current 7.1 million tonnes to 4 million tonnes by 2030, Vietnam has proposed a strategy to switch to higher grade rice, which will be gradually implemented starting in 2023 ([Vu, 2023](#)). A million tonnes of rice will be imported by Indonesia from India in order to make up for shortages and price increases ([Ghifari, 2023](#)). This is a dangerous time for the supply of rice to be reduced. After Russia invaded Ukraine in 2022, wheat supplies were limited, which

increased the demand for rice around the world. In China and India, the two countries that produce the most rice worldwide, severe weather has also resulted in crop losses. In September 2022, due to a drop in production, India, the world's top rice exporter, banned broken rice shipments and levied a 20 per cent levy on rice exports ([ET Online, 2022](#)). Over half of the world's rice exports (around 21, 6, and 5 million tons, respectively, in 2021) come from Thailand, Vietnam, and India combined (FAOStat, n.d.). Reductions in production will have a significant impact on the availability of rice, not just in Southeast Asia but worldwide ([Hong, 2023](#)).

METHODS

This research focuses on examining existing knowledge on a topic by analyzing various sources like books, articles, reports, and online news. The research emphasizes understanding the "why" and "how" behind a topic through in-depth descriptions and interpretations, rather than relying on numerical data and statistical analysis.

The analysis process involved several steps:

1. Organizing the information: Categorizing and structuring the gathered materials for efficient analysis.
2. Close reading and note-taking: Meticulously examining the sources and extracting key points and relevant information.
3. Describing the findings: Summarizing the information gleaned from the sources.
4. Drawing conclusions: Synthesizing the findings to reach a comprehensive understanding of the topic based on the reviewed literature.

RESULTS AND DISCUSSION

ASEAN Rice Production

The predicted 2022 crop year (2022–2022) yield of ASEAN paddy was 197.73 million tons, up 4.98 million tons or 2.58% from 2021 crop year (2020–21) yield of 192.76 million tons. Increases in planted and harvested areas were the cause of the growth. Bangladesh, Indonesia, Lao PDR, Myanmar, the Philippines, Thailand, and Cambodia all showed increases in output ([AFSIS, 2022](#)).

Table 1. Paddy production in ASEAN countries, 2021- 2023 (Unit: 1,000 tons)

Country	2021	2022	Change 2022		2023	Change 2023	
	(2020/21)	(2021/22)	Quantities	(%)	(2022/23)	Quantities	(%)
ASEAN	192,759.59	197,734.77	4,975.18	2.58	199,861.99	2,127.22	1.08
Brunei	4.11	3.98	-0.13	-3.17	4.18	0.20	5.00
Cambodia	10,935.62	12,206.99	1,271.37	11.63	12,223.09	16.10	0.13
Indonesia	54,415.29	57,449.83	3,034.53	5.58	56,153.15	-1,296.68	-2.26
Lao PDR	3,660.05	3,769.21	109.16	2.98	3,907.20	137.99	3.66

Malaysia	2,441.60	2,399.67	-41.93	-1.72	2,418.40	18.73	0.78
Myanmar	25,982.53	26,274.73	292.20	1.12	*26,590.03	315.30	1.20
Philippines	19,708.04	19,903.98	195.94	0.99	*20,593.73	689.75	3.47
Singapore				N/A			
Thailand	31,734.27	32,977.78	1,243.51	3.92	34,084.83	1,107.06	3.36
Vietnam	43,878.08	42,748.61	-1,129.47	-2.57	43,887.38	1,138.77	2.66

For Brunei, the decline in yield is the cause of the production decline. When the rice was almost mature, rainy, windy weather caused the paddy plants to collapse, which in turn caused pests, diseases, and poor weather conditions to produce a loss in yield ([AFSIS, 2022](#)).

For Cambodia, the rise in yield, harvested area, and planted area was the cause of the production growth. Farmers' responses to price rises and changes in government policy resulted in an increase in planted area. Because of superior rice crop management practices, increased fertilizer use, and excellent weather, farmers were able to increase harvested area and production ([Chan & Kim, 2017](#)).

For Indonesia, due to government policies and fortunate weather, the increased output is ascribed to an increase in planted and harvested area ([Rice Processing, 2024a](#)).

For Lao PDR, the rise in planted area and productivity is credited with the production boost. Farmers' responses to price hikes and government policy were the main causes of the increase in planted area. The excellent weather was the cause of the yield rise ([AFSIS, 2022](#)).

For Malaysia, the decline in planted area and yield is the reason for production decline. Unfavorable weather, along with floods, pests, and diseases, was the cause of the decline ([Farah et al., 2017](#)).

For Myanmar, the rise in yield, harvested area, and planted area is responsible for the growth in production. The farmers' response to price rises resulted in an increase in cultivated area. The favorable weather was the cause of the rise in harvested area and yield ([Rice Processing, 2024c](#)).

For the Philippines, because farmers used more improved cultivars in conjunction with excellent weather, there was an increase in both planted and harvested area, contributing to the country's increased production ([Rice Processing, 2024b](#)).

For Thailand, due to farmers' responses to price increases, pleasant weather, and adequate irrigation and water supply, the production increased as a result of increased planted area, harvested area, and yield ([Sundram, 2023](#)).

For Vietnam, the reduced planted area, harvested area, and yield are the reasons behind Vietnam's declining production ([AFSIS, 2022](#)).

Discussion on rice production in Southeast Asia:

1. *Decreases in Production:*

- a. **Brunei:** A decline in yield caused by pests, diseases, and unfavorable weather conditions (heavy rain and strong winds) during the crucial

ripening stage led to collapsed paddy plants ([AFSIS, 2022](#)). This emphasizes the vulnerability of crops to environmental factors and disease outbreaks.

- b. **Malaysia:** Both planted area and yield decreased due to unfavorable weather, floods, pest infestations, and diseases ([Farah et al., 2017](#)). This case highlights the compounding effect of multiple challenges on production.
 - c. **Vietnam:** A decrease in planted area, harvested area, and yield suggests a complex situation requiring further investigation ([AFSIS, 2022](#)). Factors like policy changes, economic conditions, or resource limitations could be at play.
2. ***Increases in Production:***
- a. **Cambodia:** A combination of factors contributed to the rise in production. Increased planted area due to government policies and farmer responses to price hikes was complemented by a rise in harvested area and yield due to improved practices (fertilizer use, better care) and favorable weather ([Chan & Kim, 2017](#)). This showcases the positive impact of government support, farmer incentives, and favorable climate.
 - b. **Indonesia:** Similar to Cambodia, government policies promoting increased planted and harvested areas, coupled with favorable weather, led to production growth ([Rice Processing, 2014a](#)). This reinforces the significance of government intervention and climate in rice production.
 - c. **Lao PDR:** Increased planted area due to attractive prices and government policies, along with favorable weather conditions, contributed to the production rise ([AFSIS, 2022](#)). This again highlights the interplay of economic incentives and climate.
 - d. **Myanmar:** Production growth stemmed from a rise in planted area due to price incentives, along with increased harvested area and yield due to favorable weather ([Rice Processing, 2014c](#)). Price increases motivated farmers to expand planting, while good weather conditions ensured a successful harvest.
 - e. **Philippines:** Increased planted and harvested areas due to the adoption of improved rice varieties, combined with favorable weather, led to production growth ([Rice Processing, 2014b](#)). This emphasizes the importance of technological advancements like improved crop varieties in boosting production.
 - f. **Thailand:** A rise in planted area due to price incentives, favorable weather, sufficient irrigation, and water supply resulted in increased production ([Sundram, 2023](#)). This case highlights the crucial role of proper water management alongside other factors.

ASEAN Rice Utilization and Stock

In the ASEAN, domestic use of rice (milled rice) was projected to be 113.38 million tons in 2022 (calendar year), down from 113.44 million tons in 2021. A reduction of almost 0.06 million tons, or 0.05 percent, was seen ([AFSIS, 2022](#)).

Table 2. Rice balance sheet of ASEAN countries, 2023 (milled rice) (Unit: tons)

Country	Supply				Demand			
	Beginning Stock	Production	Imports	Total	Domestic Utilization	Exports	Ending stock	Total
ASEAN	32,573,884	128,602,538	6,387,871	167,564,294	114,829,831	18,586,145	34,148,318	167,564,293
Brunei	18,208	2,719	30,446	51,373	32,859	-	18,514	51,373
Cambodia	7,335,114	7,822,776	-	15,157,891	3,775,262	2,532,751	8,849,877	15,157,891
Indonesia	5,855,620	35,781,915	18,909	41,656,444	36,331,643	3,044	5,321,757	41,656,444
Lao PDR	148,155	2,344,320	71,000	2,563,475	2,335,692	70,000	157,782	2,563,475
Malaysia	-	1,547,775	1,160,224	2,707,999	2,610,791	97,208	-	2,707,999
Myanmar	*10,709,751	*16,780,490	-	27,490,241	*16,528,036	*493,169	*10,469,036	27,490,241
Philippines	*1,606,930	*13,640,605	*3,524,640	18,772,176	*16,811,293	-	*1,960,882	18,772,176
Singapore	-	-	363,010	363,010	223,037	139,973	-	363,010
Thailand	*3,883,000	22,155,140	*10,000	26,048,140	*14,815,140	8,200,000	*3,033,000	26,048,140
Vietnam	3,017,105	28,526,798	1,209,642	32,753,546	21,366,077	7,050,000	4,337,469	32,753,546

The self-sufficient ratio, or the ratio of output to domestic use, for ASEAN in 2022 was projected to be 112.32 percent, up from 109.46 percent in 2021. This showed that ASEAN's total rice production in 2022 will meet the region's rice consumption needs. Cambodia, Indonesia, Lao PDR, Malaysia, and Thailand all saw increases in their self-sufficient ratios of production to domestic consumption. Vietnam, the Philippines, Burma, and Brunei had a decline in their ratio of self-sufficiency. Nonetheless, some nations in the region still require rice imports to meet their local needs. Brunei had the lowest ratio, while Cambodia, Thailand, and Vietnam had the highest ratios. ASEAN's beginning stock for 2022 (January 2022) was predicted to be 31.19 million tons, a 0.50 percent decrease of 0.16 million tons from 31.34 million tons in 2021. Following Myanmar with 11.23 million tons, or 36.02 percent of the ASEAN stock, were Indonesia and Cambodia with 5.27 and 5.25 million tons, or 16.91 and 16.82 percent of the ASEAN total stock, respectively. For the entirety of ASEAN, the predicted 2022 food security ratio – the initial stock to domestic use ratio – was 27.51 percent, down roughly 0.12 percent from the year before. The ratios are higher than 20% of the ideal level in Brunei, Cambodia, Myanmar, and Thailand. For the overall production, the data from major crop namely rice, the staple food of ASEAN region, demonstrates that many countries in the region have self-dependency in terms of food production and have food security. However, they still have to deal with the problem of high food prices due to higher cost and inputs prices which resulted from either the Russia-Ukraine war or climate changes, which are the determinants that cause food insecurity. As most of the producing countries in ASEAN are developing countries, the majority of populations in the countries have low-income and middle-income which will affect the most from high food prices crisis. This might raise the concerns of food insecurity in the future. On the other hand, this situation can be advantages for rice export of ASEAN countries, especially for countries that have excessive supply for generating income from export ([AFSIS, 2022](#)).

ASEAN Rice Trade, Prices and Damaged Area

The total amount of milled rice exported by ASEAN in 2022 was 18.52 million tons, up 2.26 million tons, or 13.90 percent, from 16.26 million tons exported in 2021. About 8.08 million tons and 7.60 million tons, respectively, were exported by Vietnam and Thailand, the two main exporting nations. It is projected that ASEAN will import 5.94 million tons in total in 2022, up 0.56 million tons, or around 10.40 percent, from 5.38 million tons in 2021. With 3.23 million tons of milled rice imported, the Philippines ranked as the region's largest importer. An estimated 0.52 million hectares of damage were done to the paddy land in ASEAN during the crop year 2021–2022. Of the overall devastated area, 94.68 percent, or 0.49 million hectares, were damaged by flooding. 89.64 percent of the ASEAN region, or 0.44 million hectares, were affected by the flood, with Thailand suffering the most damage. Drought, bugs, and illnesses were only a few of the many variables that exacerbated the devastation ([AFSIS, 2022](#)).

Challenges and Opportunities in Rice Production

Rice is the lifeblood of ASEAN, serving as a critical food source and a cornerstone of the regional economy. However, the region faces numerous challenges in maintaining and increasing rice production. Here's a breakdown of the key issues and potential opportunities:

1. *Challenges in rice farming areas*

- a. *Limited arable land suitable for rice cultivation:* As the nation's population grows, more commercial land is required for habitation, which leads to a major decrease in arable land for agriculture. Meanwhile, grain output declines as a result of farmers' illogical usage of cultivated land, which causes nutrients to be lost from the soil.
- b. *Lack of good & effective agricultural crop extension programs:* This has led to a serious shortage of knowledgeable and skilled extension agents as well as a dearth of contemporary technology for teaching and support on post-harvesting and farming techniques.
- c. *The lack of a farm credit system:* This has negative impact on rice farmers as well as the rice milling sector, which leads to reduced fertilizer use and a decrease in the adoption of farm mechanization at both the production (planters and harvesters) and processing (mills, grain dryers, storage facilities) stages of the process. Inadequate road, rail, and milling and handling equipment, as well as transportation and related infrastructure for the rice industry.
- d. *Stagnant yields:* While ASEAN is a major rice producer, average yields have stagnated or even declined in some countries. This limits the ability to meet growing demand.
- e. *Resource constraints:* Land and water scarcity pose significant challenges for expanding rice production. Additionally, rising input costs like fertilizers and energy can strain farmers' budgets.

- f. *Climate change*: Extreme weather events like droughts and floods disrupt rice production, impacting both yield and quality. Climate change also threatens water availability for irrigation.
- g. *Labor shortage*: An aging rural population and migration to cities create a shortage of agricultural labor, hindering rice production and farm maintenance.
- h. *Price fluctuations*: Volatile rice prices can discourage farmers from investing in production and create food security concerns for consumers.

2. **Opportunities for rice production area**

Despite these production obstacles, there are plenty of opportunities to overcome them. For example, more high-yielding variety development and deployment can counteract the urbanization-related decline in rice area, and better crop management technologies may be able to prevent soil degradation, as described following:

- a. *Technological innovation*: Adoption of new technologies like drought-resistant rice varieties, precision agriculture techniques, and improved irrigation systems can boost yields and resource efficiency.
- b. *Value addition*: Focusing on high-value rice varieties with unique characteristics or organic production methods can create new market opportunities and increase profitability for farmers.
- c. *Improved storage and distribution*: Investments in efficient storage and transportation infrastructure can minimize post-harvest losses and ensure rice availability throughout the year.
- d. *Regional cooperation*: Collaboration among ASEAN countries on research, technology transfer, and trade can improve regional food security and rice market stability.
- e. *Sustainability practices*: Promoting sustainable farming practices like crop rotation, soil conservation, and integrated pest management can protect the environment and ensure long-term rice production.

Lesson Learnt for Cambodia

Cambodia, a significant player in ASEAN's rice sector, can glean valuable insights from the region's experiences to improve its own rice production. Here are some key lessons Cambodia can learn:

- a. *Boost domestic production*:
Cambodia can prioritize increasing domestic rice production to achieve self-sufficiency and reduce reliance on imports. Cambodia can focus on research and adoption of high-yielding rice varieties suited to local conditions. This can help overcome yield stagnation and ensure food security.
- b. *Diversify rice varieties*
Exploring and promoting high-value rice varieties can cater to changing consumer preferences and potentially increase export opportunities.
- c. *Improve storage and distribution*

Investments in efficient storage and distribution systems can minimize post-harvest losses and ensure rice availability nationwide. Modernize irrigation systems to improve water efficiency and reduce reliance on rainfall. Additionally, invest in storage and transportation infrastructure to minimize post-harvest losses and ensure rice availability nationwide.

d. *Climate-smart practices*

Adopting climate-resilient rice varieties and agricultural practices can mitigate the impact of climate change on production. Implement and promote climate-smart agricultural practices to adapt to changing weather patterns and protect long-term soil health. This includes techniques like water conservation, integrated pest management, and crop rotation.

e. *Regional cooperation*

Collaboration with other ASEAN countries on research, technology transfer, and trade can benefit Cambodia's rice sector. Actively participate in ASEAN initiatives for research collaboration, technology transfer, and knowledge sharing to benefit from regional expertise and resources.

f. *Market access*

Improving market access for Cambodian rice through trade agreements and quality standards can expand export opportunities. Explore and promote high-value rice varieties like aromatic or organic rice to cater to growing niche markets and potentially fetch premium prices.

g. *Farmer empowerment*

Strengthen agricultural extension services to provide farmers with training on new technologies, improved farming practices, and market information. Develop accessible credit schemes and financial incentives to encourage farmers to invest in modern technology and inputs. Ensure clear land ownership rights and provide support services for smallholder farmers to improve their bargaining power and livelihoods.

CONCLUSION

Rice is a vital crop for ASEAN countries, serving as a primary source of food security and playing a significant role in the regional economy as well as in ASEAN countries. Cambodia is one of the significant player in ASEAN's rice sector which can glean valuable insights from the region's experiences to improve its own rice production. By analyzing rice demand and supply dynamics in ASEAN and applying the lessons learned, Cambodia can strive to achieve self-sufficiency in rice production and reduce reliance on imports, increase the profitability and competitiveness of the rice sector, enhance food security for its population, and contribute to regional food security within ASEAN.

REFERENCES

- AFSIS (2022). *ASEAN agricultural commodity outlook*. ASEAN Food Security Information System. Bangkok, Thailand.
- Arshad, M. S., Farooq, M., Asch, F., Krishna, J. S., Prasad, P. V., & Siddique, K. H. (2017). Thermal stress impacts reproductive development and grain yield in rice. *Plant Physiology and Biochemistry*, 115, 57-72.
- Bhandari, S. R. (2023, May 18). *Asia's heatwaves 30 times more likely due to climate change, scientists say*. Radio Free Asia.
- Chan, S., and Kim, M. (2017). *Understanding stagnation of Cambodia's rice export*. Phnom Penh, Cambodia.
- Chung, S., Takeuchi, J., Fujihara, M. and Oeurng, C. (2019). Flood damage assessment on rice crop in the Stung Sen river basin of Cambodia. *Paddy and Water Environment*, 17(2): 255-263.
- Dickie, G. (2023, June 9). How El Niño could impact the world's weather this year and next. The Japan Times.
- ET Online. (2022, September 9). India may see up to 12 million tonnes slump in rice production, food Secretary says.
- FAOStat (n.d.) United Nations Food and Agriculture Organisation.
- Farah, H.A.R, Nurul, N.H., Norhaslinda, Z.A. (2017). Supply and demand of rice in Malaysia: a system dynamics approach. *Int. J. Sup. Chain. Mgt*, 6(4): 234-240.
- Fitzgerald, M.A, McCouch, S.R., & Hall, R.D. (2009). Not just a grain of rice: the quest for quality. *Trends in plant science*, 14(3), 133-139.
- Ghifari, D. (2023, June 16). RI to import 1 million tonnes of rice from India, citing El Niño concerns. The Jakarta Post.
- Han, J., Zhang, Z., Luo, Y., Cao, J., Zhang, L., Cheng, F., ... & Zhang, J. (2021). AsiaRiceMap10m: High-resolution annual paddy rice maps for Southeast and Northeast Asia from 2017 to 2019. *Earth Syst. Sci. Data Discuss*, 211, 1-27.
- Harvey, F. (2023, April 26). Record ocean temperatures put earth in 'uncharted territory', say scientists. the Guardian.
- Hong, L. (2023, June 10). Malaysia establishes monitoring and warning system to predict level of fire risk for south-east Asia. The Straits Times.
- Liu, W., Yin, T., Zhao, Y., Wang, X., Wang, K., Shen, Y., ... & Tang, S. (2021). Effects of high temperature on rice grain development and quality formation based on proteomics comparative analysis under field warming. *Frontiers in Plant Science*, 12, 746180.
- NOAA (n.d.) El Niño Theme Page. NOAA Pacific Marine Environmental Laboratory.
- Peng, Shaobing, Jianliang Huang, John E. Sheehy, Rebecca C. Laza, Romeo M. Visperas, Xuhua Zhong, Grace S. Centeno, Gurdev S. Khush, and Kenneth G.

- Cassman (2004). "Rice yields decline with higher night temperature from global warming." *Proceedings of the National Academy of Sciences* 101, no. 27: 9971-9975.
- Rath, B., Wonginta, T. and Amchang, C. (2022). Risk analysis of the rice supply chain in Cambodia. *Journal of International Logistics and Trade*, 20(2): 58-77.
- Rice Processing (2024a). *Rice market in Indonesia*. Rice Processing. <https://rice-processing.com/rice-market-in-indonesia.html>
- Rice Processing (2024b). *Analysis on rice market in Philippines*. Rice Processing. <https://rice-processing.com/analysis-on-rice-market-in-philippines.html>
- Rice Processing (2024c). *The role of rice in Thailand and Myanmar*. Rice Processing. <https://rice-processing.com/the-role-of-rice-in-thailand-and-myanmar.html>
- Rice Processing (2024d). *Rice market in Southeast Asia area*. Rice Processing. <https://rice-processing.com/rice-market-in-southeast-asia-area.html>
- Royal Government of Cambodia (2010). *Policy paper on promotion of paddy production and milled rice export*. Royal Government of Cambodia, Phnom Penh, Cambodia.
- Sarsu, F., Ghanim, A. M., Das, P., Bahuguna, R. N., Kusolwa, P. M., Ashraf, M., ... & Sarsu, F. (2018). Screening protocols for heat tolerance in rice at the seedling and reproductive stages.
- Schiermeier, Q., (2015). Hunting the Godzilla El Niño. *Nature* 526, 490-491.
- Shrestha, S., Mahat, J., Shrestha, J., Madhav, K. C., & Paudel, K. (2022). Influence of high temperature stress on rice growth and development. A review. *Heliyon*, e12651.
- Sundram, P. (2023). Food security in ASEAN: progress, challenges and future. *Front. Sustain. Food Syst.* 7:1260619. doi: 10.3389/fsufs.2023.1260619
- Thath, R. (2016). *Potentials and constrains of Cambodian rice export*. MPRA Paper No 71490.
- UNDP. (2018). *Enhancing Resilience to Extreme Climate Events: Lessons from the 2015-2016 El Niño Event in Asia and the Pacific*. UNDP.
- Vu, K. (2023, May 27). Vietnam to cut annual rice exports by 44% to 4 million tonnes by 2030. U.S.
- Wipatayotin, A. (2023, May 11). Farmers urged to reduce rice crops. Bangkok Post.
- Xu, Y., Chu, C., & Yao, S. (2021). The impact of high-temperature stress on rice: Challenges and solutions. *The Crop Journal*, 9(5), 963-976.