EAST-WEST CENTER

AsiaPacific

ISSUES

Drought, Flood, and Rice Security in Central Thailand

PHANWIN YOKYING

ARUNEE PROMKHAMBUT

Analysis from the East-West Center
Vol. 27, No. 163
March 2024

About the Author

Phanwin Yokying, Ph.D., is a Fellow at the East-West Center. As an applied microeconomics researcher, she studies development and gender issues affecting livelihoods and well-being of marginalized populations in South and Southeast Asia. She contributed conceptualization, methodology, investigation, validation, writing, and writing review for this article. Her email address is yokyingp@EastWestCenter.org.

Arunee Promkhambut, Ph.D., is an Assistant Professor in System Approaches in Agriculture for Sustainable Development in the Department of Agricultural Extension and Agricultural Systems at Khon Kaen University, Thailand. She contributed reviewing, editing and validation for this article. Her email address is arunee@kku.ac.th.

Research in Central Thailand for this article was made possible by the Henry Luce Foundation.

ABSTRACT With roughly 63 percent of the country's agricultural area allocated for rice farming, rice has long been a key food staple and export crop for Thailand. As with other crops, rice is heavily dependent on water, whether it is from precipitation or irrigation, and is also sensitive to changing temperatures. The impacts of droughts and floods on rice farming are a fundamental source of concern for Thai farmers and the government. This article focuses on the effects of droughts and floods on rice quality and quantity, as well as on farmers' rice income and prospects for livelihood diversification. Based on our interviews with rice farmers in Uthaithani, Chainat, and Ayutthaya, droughts and floods diminish rice yields and increase incidences of crop failures, both partial and complete. They also lower the quality of rice and further depress net head rice yields by altering rice grain dimensions and moisture levels, as well as increasing the amount of cracked and immature grains. These outcomes contribute to a significant decline in farmers' earnings and investment losses in the case of crop failures. Reduced access to government subsidies together with increased input costs due to droughts and floods are also crucial factors decreasing farmers' earnings. Off-farm and on-farm livelihood diversification becomes an inevitable survival strategy for many rice-farming households to manage weather related challenges, stabilize their income, and smooth consumption. Our findings point out the need to bolster on-farm adaption capacities of rice farmers at the household, provincial, and national levels to ensure domestic and global rice security and ameliorate dangers to Thai farmers' livelihood and well-being.

Keywords: Thailand; rice; agriculture; climate change; drought; flood

Rice continues to play a fundamental role in income generation and ensuring food security for millions of households in Thailand and abroad. As a key global rice supplier (USDA, 2023), Thailand exported 5.27 million metric tons of rice from January through August 2023 and, due to increased global rice prices and India's rice export ban, its shipment is projected to reach at least eight million metric tons this year (USDA, 2023). The top export markets include Indonesia, Iraq, South Africa, the US, and China (Ministry of Commerce, 2023). Rice exports account for about 16 percent of Thailand's total export revenue derived from agricultural-related products (Ministry of Commerce, 2023). The Central region, with its fertile soil and more developed irrigation systems, remains the key producer of domestic and exported rice in the country. Samut Prakan and Nakhon Pathom were the two provinces with the highest rice yields in Central Thailand in 2022 (Ministry of Agriculture and Cooperatives, 2022). Most farmers in this region cultivate non-glutinous rice on two hectares of land, yielding 4,487.5 kilograms per hectare for the 2021/2022 crop year on average (Ministry of Agriculture and Cooperatives, 2022). Depending on weather patterns and water availability, rice farmers in Central Thailand typically cultivate twice a year during the wet and dry seasons (Promkhambut et al., 2023).

"Rice farmers from female-headed households and households with no working-age men have reported they are disadvantaged because they lack physically-capable male household workers to deploy the heavy water pumping machines and connect them to the nearby canal to pump water into their rice fields."

According to the World Bank and Asian Development Bank's Climate Risk Profile for Thailand (2021), weather-related challenges pose serious obstacles to rice cultivation and to Thai farmers' livelihoods. All regions are affected by erratic weather patterns via slow onset shifts or extreme weather events, especially droughts and floods, that have been accelerating in terms of both frequency and intensity. Precipitation, which was once predictable and consistent, has been more volatile and less common during the wet season. Floods and droughts are becoming more frequent, lasting longer, and are more intense and damaging. For instance, in 2011, 66 provinces (out of 77) experienced severe flooding that damaged homes, destroyed farmland, and lasted approximately six months from July 2011 through January 2012 (Gale and Saunders, 2013). In early 2020, rivers had low water levels and half of the country's key reservoirs had below 50 percent of capacity, causing Thailand to experience its worst drought in the last 40 years. In late 2022, the monsoon weather brought heavy rainfall and strong winds over Thailand, resulting in flash floods, landslides, and overflowing riverbanks in at least 25 provinces. In 2023, however, rainfall is expected to be about 10 percent below average, especially in the Central Plains region, and widespread drought is predicted for 2024. Local authorities are asking rice farmers in Central Thailand to limit their rice planting to one crop to preserve water (Ratcliff and Siradapuvadol, 2023; Thaipublica, 2023).

This article provides novel and detailed insights into the implications of droughts and floods on the quality and quantity of rice as well as on rice farmers' income and livelihood. Based on the Ministry of Agriculture and Cooperatives' 2022 statistics on rice farming and susceptibility to natural disasters, we chose three provinces in Central Thailand—Uthaithani, Chainat, and Ayutthaya—for their high concentrations of rice farmers. We further selected two districts from each province based on vulnerability to floods and droughts. We conducted qualitative interviews with three randomly selected rice farmers from each district. In total, we interviewed 18 rice farmers from six districts.

In Uthaithani, Chainat, and Ayutthaya, rice farmers consistently emphasized that they have noticed an increase in temperature and unpredictable variations in precipitation in the last decade. In particular, droughts have increasingly been a major challenge for rice farmers in Uthaithani, causing nearby dams and canals to run dry. The resulting decline in water levels led to water shortages and competition for the limited water within the communities. Rice farmers from female-headed

households and households with no working-age men have reported they are disadvantaged because they lack physically-capable male household workers to deploy the heavy water pumping machines and connect them to the nearby canal to pump water into their rice fields. This results in limited or no access to water for their rice fields. In 2020, farmers in Sawanarom, Uthaithani experienced drought for the entire year, resulting in complete crop failure.

Conversely, floods are becoming more frequent and pose a significant livelihood threat for rice farmers in Chainat. Interviewed farmers explained that they have witnessed a dramatic increase in rainfall during the past seven to eight years, creating a serious challenge for those who depend on rice farming as their primary income source. Also, farmers in Nong Ma Mong District of Chainat engage in rainfed rice farming because they lack access to irrigation systems. When faced with floods, farmers in this province rely on water pumping machines to drain the water out of their rice fields. When the water levels are extremely high, the nearby water reservoirs and canals lack the capacity to take up additional water from rice fields. Consequently, the fields become inundated.

Similar to those in Chainat, farmers in Ayutthaya are highly vulnerable to floods. But in this province, farmers and their rice farming are well protected against crop and investment losses thanks to well-planned and extensive irrigation systems and elevated road systems. Although rice farmers in this province experience flooding yearly, their crops are either not affected or minimally impacted by such shocks because, in most cases, the irrigation systems are able to absorb and maneuver the excess water to protect rice fields and the elevated roads are able to prevent floods from reaching rice fields. Local government agencies also have an effective flood warning system that communicates to farmers in advance (roughly three to seven days prior). This gives farmers time to harvest their rice crops and procure flood prevention barriers.

A water pumping machine (*left*), and its connecting pipe made of heavy metal.

Rice Quality and Quantity

The adverse effects of weather-related challenges on crop production have been well studied and documented. For instance, the work of Buan et al. (1996) predicted that increased temperature and decreased rainfall will reduce rice and corn yields. Recent work by Jagermeyer et al. (2021) that used an updated climate model simulation and climate data shows a more pessimistic result, predicting that global production of maize, soybean, and rice will decline dramatically due to rising temperature and higher levels of greenhouse gas emissions and carbon dioxide. Felkner et al. (2009) show

"When faced with floods, farmers in this province rely on water pumping machines to drain the water out of their rice fields. When the water levels are extremely high, the nearby water reservoirs and canals lack the capacity to take up additional water from rice fields. Consequently, the fields become inundated."

lower aggregate Thai rice yields in a high-emissions climate without any adaptation or adjustment strategies. However, while it is clear that climate variability and change will continue to change rice productivity, the process of how droughts and floods alter the rice yields is not fully understood. To help enrich our understanding of the implications of these weather-related challenges, this section describes the effects of droughts and floods on rice yields through changes in the physical properties of rice grains. Rice quality is the comprehensive outcome of not only genetic characteristics, but also environmental conditions. Our discussions with farmers in Uthaithani, Chainat, and Ayutthaya reveal that both droughts and floods have an adverse and interrelated effect on four key physical properties of rice grains: moisture content, cracking, immature grains, and grain dimensions. Focusing first on the impact of climate shocks on moisture content, farmers stress that rice grains should be at the moisture level of 15 percent before being milled to maximize the head rice yield or the quantity of whole and intact kernels after the milling process and ensure safe grain storage. A higher moisture content implies that grains are too soft while a lower moisture content means the grains are too dry. Both scenarios lead to breakages and pulverization during the hulling process. In Central Thailand, dry spells and droughts that cause water scarcity decrease the moisture level of rice grains drastically. On the contrary, heavy rainfall and floods increase the water supply in rice fields, raising moisture content above the optimal level.

The lack of water caused by drought also causes rice grains to develop cracks in their kernels. This finding is consistent with previous studies (Krishnan et al., 2011; Shi et al., 2018).

Left: this rice grain from an inundated field broke during milling.
Right: skinny and darkened rice grains harvested from a drought-stricken field.

Cracked grains typically cannot withstand the milling pressure and are thus more likely to break, reducing both the price the farmers receive for the crop and the net head rice yield (Lyman et al., 2013).

Farmers in Central Thailand further emphasize that environmental stresses caused by droughts and floods, especially during the flowering periods, have a harmful impact on pollination, causing poor seed setting and reduction in grain size (e.g. skinny grains) (Kumar et al., 2006; Davatgar et al., 2009; Zhou et al., 2020). As another adverse effect of these weather-related challenges, reduced grain dimensions also lead to grain breakages during the milling process and yield loss (Rahman et al., 2002). When harvested grains vary in size and shape, adjustments of the hullers, whiteners, and polishers during the milling process become a challenge. This causes declined efficiencies, increased risk of recirculated grains, uneven whitening, and ultimately lower profits for farmers.

Drought and flood, particularly during the ripening period, have been damaging problems for the rice farmers we interviewed in Central Thailand. Abnormally high temperatures have also decreased the share of ripened grains and lowered yields, while flooding or the anticipation of floods prompt many farmers to harvest their rice crops prematurely to minimize crop loss. These scenarios lead to a decline in growing period, resulting in green grains or immature kernels of rice. These grains exhibit inferior quality, which considerably lower their market value.

Farmers' Income and Livelihood Diversification

Weather-related challenges pose a major hurdle to livelihood, especially for farmers who lack access to irrigation systems and are dependent on rain-fed rice cultivation. With limited adaptation capabilities, diversification of on-farm production systems and off-farm income sources become important ways to self-manage weather-related risks, reduce market uncertainty, increase or stabilize household income, and smooth consumption. As highlighted in the previous section, droughts and floods have a direct effect on household livelihood through the evidenced decline in rice quality and thus quantity. Such reduction places a downward pressure on farmers' earnings and heightens the unpredictability and volatility of their future income from rice production. Diversification of livelihood ultimately helps rice-farming households to reduce their vulnerability to droughts and floods and increase their resilience to such risks. This section discusses weather-induced factors depressing farmers' income and how farmers have responded through livelihood diversification strategies.

In Central Thailand, both droughts and floods decrease rice farmers' earnings through three key pathways. The first is increased input costs (water pumping machines, fertilizers, and pesticides). Given that water pumping machines are powered by oil and that oil prices have been on the rise, the growing utilization of these machines because of droughts and floods substantially increases farmers' fuel expenses. Farmers also intensify the application of chemicals, namely pesticides, on their fields to mitigate the increased prevalence of pests and diseases associated with droughts and floods, thereby curtailing significant yield losses. Russia's ongoing war in Ukraine has disrupted fertilizer supplies, driving up prices of fertilizers in Thailand more than threefold. The increased cost of fuel and chemicals reduces farmers' profit margins and, thereby, earnings.

The second downward pressure on rice farming income is through reduction in yields or crop failures. Most of the farmers we spoke to reveal that they had experienced at least one total crop loss in the past three years (2019-2022) due to either drought or flood. With the increasing frequency of severe droughts and floods in Central Thailand, farmers lack alternative and collective means and solutions to cope with extreme water shortages and inundated rice fields. As an example, farmers are unable to pump water into their fields due to depleted water reservoirs or struggle to drain excess water out of their flooded fields. In these scenarios, farmers have to let their rice crops perish, resulting in an unrecoverable total loss of their investments and earnings and higher household debt.

The third effect on farmers' earnings reduction for rice is through reduced access to government rice price subsidies. The Thai government provides generous and consistent subsidies to help improve rice farmers' productivity and earnings. Most recently, its Rice Policy and Management Committee in 2022 allocated 150 billion Baht to guarantee the earnings of more than 4.6 million rice farmers for their 2022–2023 crops. This budget is allocated for different rice subsidy programs. One popular program sets the floor market price that is updated weekly, and the government pays the price difference to rice farm-

ers who cannot sell their crops at the set prices. However, the moisture level of the rice grains cannot exceed 15 percent under this program, and during droughts and floods, rice farmers are unable to meet the moisture content threshold, making them ineligible for price-difference subsidies. They receive a lower price for their outputs, creating a loss in their earnings.

In response to the weather-induced income losses, many rice farmers in Central Thailand, especially those in their working-age years (18 to 60), engage in a wide variety of farm and non-farm livelihood diversification strategies. For instance, some farmers become on-farm and off-farm wage laborers while some sell baked goods, fruits, or vegetables at local markets or to middlemen. Others raise small or large livestock (ducks, goats, cows, and buffaloes) or work fish farms. In Uthaithani, many raise cows and buffaloes raising, along with trading cattle and buffalo manure to either supplement or replace their rice earnings since these activities are less sensitive to climate variability and shocks and are more lucrative than rice farming. Many farmers use parts of their rice fields to grow other crops, such as banana, bean, corn, dragon fruit, cassava, eucalyptus, mango, or sugarcane. In Ayutthaya, which is part of Thailand's industrial estates and factory zones, many rice-farming households supplement their rice income by sending other household members to work for the government agencies or in nearby factories.

Given that Thailand is among the fastest aging countries in the world, a relatively large share of rice farmers are elderly, and many of them indicate that they do not engage in any income or crop diversification strategies, as they lack the energy and skills for alternative income-generating activities. Consequently, in households with no working-age members (which is widespread in farm communities due to outmigration), elderly farmers generate no earnings and sustain their lives simply through subsistence agriculture, fishing, and small livestock raising (e.g. pigs, ducks, and chickens) for household consumption during droughts and floods.

"Given that Thailand is among the fastest aging countries in the world, a relatively large share of rice farmers are elderly, and many of them indicate that they do not engage in any income or crop diversification strategies, as they lack the energy and skills for alternative income-generating activities."

Left: rice farmer selling fruits along Chao Praya River in Chainat. *Right:* sugarcane cultivation alongside rice paddies.

Conclusion and Policy Implications

This article describes how droughts and floods impact Thai rice farmers' earnings and influence income diversification strategies. Based on our qualitative interviews with 18 rice farmers in Uthaithani, Chainat, and Ayutthaya provinces in Central Thailand, droughts and floods reduce not only the quantity of harvested rice, but also the quality of rice grains by changing their moisture level and grain dimensions and increasing the harvesting of immature and cracked grains. This in turn further hinders the head rice yield. Both droughts and floods also increase input costs (through increased fuel and chemical expenses),

heighten incidences of crop failure and household debt, and reduce farmers' eligibility for government rice subsidies. These factors together lower farmers' earnings and motivate them, especially working-age farmers, to engage in on-farm and/or non-farm livelihood diversification approaches to stabilize their income.

"One adaption strategy that has been well supported by the Thai government is in research and development of new weather-resistant rice varieties that can better withstand the irregular weather patterns. These newly developed varieties produce higher yields, have reduced growing periods, or require less water or chemicals, while some can survive floods, thrive in salty soils, or can resist certain pests and diseases."

With rice being Thailand's key export commodity and essential mainstay for the domestic and global populations, strengthening adaptation capabilities of Thai rice farmers will be indispensable. One adaption strategy that has been well supported by the Thai government is in research and development of new weather-resistant rice varieties that can better withstand the irregular weather patterns. These newly developed varieties produce higher yields, have reduced growing periods, or require less water or chemicals, while some can survive floods, thrive in salty soils, or can resist certain pests and diseases. To effectively counter the climate-induced deterioration in rice quality and quantity, there is a pressing need for increased investments, cross-sector collaborations, and innovations to advance new commercial rice varieties.

Although many rice fields in the provinces centrally located along the Chao Praya River are irrigated, especially those located near Bangkok, rice fields in elevated or remote areas in this region continue to lack access to an irrigation system and are vulnerable to water crises and crop loss. In Uthaithani and Chainat, some rice farmers still rely on rain-fed rice farming and have no access to irrigated water since they live further away from an irrigation system. As a result, they face significant decline in yields during drought and flood. On the other hand, most farmers in Ayutthaya, which is approximately 50 miles north of Bangkok, have access to well-planned and widespread irrigation systems that can minimize the adverse effects of droughts and floods on rice crops. Policies intended to strengthen rice productivity in Central Thailand and increase adaptation capacity and resilience should aim to expand the availability and accessibility of irrigation systems in isolated rice-farming communities in the region.

Even though the Thai government has various subsidy programs for farmers, such as drought/flood relief programs, these programs predominantly provide relief during severe and widespread droughts and floods. Rice farmers in the Central Plains do experience crop failure because of moderate and area-specific droughts and floods, but they often lack assistance from the government and are self-dependent to manage risks and adverse effects. To ensure domestic food security and improve farmers' livelihood and well-being, it is essential to create an impact-based assistance program that insures farmers against all types and severity of climate shocks with damaging outcomes.

Since July 2023, global rice prices skyrocketed and reached their highest level since September 2011. Such a surge is due to India's non-basmati rice export ban and to climate shocks that hamper rice production worldwide, such as flooding in Pakistan and the potential impacts of El Nino in Thailand, Vietnam, and Pakistan. The highest price increases came from Thailand, which is fulfilling the unmet demand from rice-importing countries and thus hugely benefiting from India's rice export ban. Nonetheless, the future of Thailand's rice production remains uncertain as rice farming systems are sensitive and vulnerable to weather-related challenges. Without effective and long-term adaptation strategies, climate change, variability, and shocks will continue to threaten the global supply of rice and jeopardize the well-being of both producers and consumers of this staple food worldwide.

References

Buan, R. D., Maglinao, A. R., Evangelista, P. P., & Pajuelas, B. G. (1996). Vulnerability of rice and corn to climate change in the Philippines. *Climate Change Vulnerability and Adaptation in Asia and the Pacific: Manila, Philippines, 15–19 January 1996*, 41-51.

Davatgar N., Neishabouri M. R., Sepaskhah A. R., & Soltani A. (2009). Physiological and morphological responses of rice (Oryza sativa l.) to varying water stress management strategies. *Int. J. Plant Prod 3*, 1735–8043.

Felkner, J., Tazhibayeva, K., & Townsend, R. (2009). Impact of climate change on rice production in Thailand. *American Economic Review*, 99(2), 205-210.

Gale, E. L., & Saunders, M. A. (2013). The 2011 Thailand flood: climate causes and return periods. Weather, 68(9), 233-237.

Jägermeyr, J., Müller, C., Ruane, A. C., Elliott, J., Balkovic, J., Castillo, O., ... & Rosenzweig, C. (2021). Climate impacts on global agriculture emerge earlier in new generation of climate and crop models. *Nature Food*, 2(11), 873-885.

Krishnan, P., Ramakrishnan, B., Reddy, K. R., & Reddy, V. R. (2011). High-temperature effects on rice growth, yield, and grain quality. *Advances in agronomy*, 111, 87-206.

Kumar, R., Sarawgi, A. K., Ramos, C., Amarante, S. T., Ismail, A. M., & Wade, L. J. (2006). Partitioning of dry matter during drought stress in rainfed lowland rice. *Field Crops Research*, 96(2-3), 455-465.

Lyman, N. B., Jagadish, K. S., Nalley, L. L., Dixon, B. L., & Siebenmorgen, T. (2013). Neglecting rice milling yield and quality underestimates economic losses from high-temperature stress. PloS one, 8(8), e72157.

Ministry of Agriculture and Cooperatives. (2023). *Statistics of rice cultivation by region and province crop year: 2021/22*. https://www.nabc.go.th/home.

Ministry of Commerce. (2023). *Export markets for Thai rice 2023*. https://tradereport.moc.go.th/Report/Default.aspx?Report=MenucomTopNRecode&Option=3&Lang=Th&ImExType=1.

Promkhambut, A., Yokying, P., Woods, K., Fisher, M., Yong, M. L., Manorom, K., ... & Fox, J. (2023). Rethinking agrarian transition in Southeast Asia through rice farming in Thailand. *World Development*, 169, 106309.

Rahman M. T., Islam M. T., Islam M. O. (2002). Effect of water stress at different growth stages on yield and yield contributing characters of transplanted aman rice. *Pak. J. Biol. Sci. 5*, 169–172.

Ratcliffe, R., & Siradapuvadol, N. (2023). 'Major disruptor': El Nino threatens the world's rice supplies. *The Guardian*. https://www.theguardian.com/global-development/2023/sep/07/major-disruptor-el-nino-threatens-the-worlds-rice-supplies.

Shi, W., Li, X., Schmidt, R. C., Struik, P. C., Yin, X., & Jagadish, S. K. (2018). Pollen germination and in vivo fertilization in response to high-temperature during flowering in hybrid and inbred rice. *Plant, Cell & Environment*, 41(6), 1287-1297.

Thaipublica. (2023). *Super El Nino: How will we survive*. https://thaipublica.org/2023/08/super-el-nino-how-will-we-survive03/.

United States Department of Agriculture. (2023). *Global rice trade forecastes for 2023 and 2024 lowered based on export ban by India*. https://www.ers.usda.gov/webdocs/outlooks/107164/rcs-23g.pdf?v=4873.7.

United States Department of Agriculture. (2023). Rice sector at glance. https://www.ers.usda.gov/topics/crops/rice/rice-sector-at-a-glance/.

World Bank and ADB (2021). *Climate risk country profile: Thailand*. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-08/15853-WB_Thailand percent20Country percent20Profile-WEB_0.pdf.

Zhou, W., Chen, F., Meng, Y., Chandrasekaran, U., Luo, X., Yang, W., & Shu, K. (2020). Plant waterlogging/flooding stress responses: From seed germination to maturation. *Plant Physiology and Biochemistry*, 148, 228-236.

About this Publication

The AsiaPacific Issues series reports on topics of regional concern.

Series Editor: Denny Roy

East-West Center
1601 East-West Road
Honolulu, Hawai'i 96848-1601

Publications@EastWestCenter.org
http://eastwestcenter.org/publications/series/asia-pacific-issues
ISSN: 1522-0966

Recent AsiaPacific Issues

No. 162 "The Consequences of Taliban Policies on Human Rights in Afghanistan (August 2021–August 2023)" by Zakia Adeli. February 2024.

No. 161 "Why North Korean Nuclear Blackmail is Unlikely" by Denny Roy. November 2023.

No. 160 "Community Driven Development, Climate Change, and Resiliency: Lessons from Solomon Islands" by Bobby Anderson. September 2023.

No. 159 "China's 5G Mobile Technology in Asia: US Security Concerns and Regional Economic Priorities" by Eric Harwit. May 2023.

No. 158 "Valuing Longer, Healthier Lives: Assessing the Productivity of Health Spending in South Korea" by Karen Eggleston. March 2023.

About the East-West Center

The East-West Center promotes better relations and understanding among the people and nations of the United States, Asia, and the Pacific through cooperative study, research, and dialogue. Established by the US Congress in 1960, the Center serves as a resource for information and analysis on critical issues of common concern, bringing people together to exchange views, build expertise, and develop policy options. The Center is an independent, public, nonprofit organization with funding from the US government, and additional support provided by private agencies, individuals, foundations, corporations, and governments in the region.

EastWestCenter.org