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THAILAND RURAL INCOME DIAGNOSTIC

CHALLENGES AND OPPORTUNITIES FOR RURAL FARMERS

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Overview

In the past three decades, Thailand has made remarkable progress in reducing poverty, though inequality remains high. Driven by high growth rates and structural transformation, the national poverty rate fell from 58 percent in 1990 to 6.8 percent in 2020. Income inequality also declined over this period but remains high. With an income Gini coefficient of 43.3 percent in 2019, Thailand had the highest income inequality level in East Asia.

The progress in poverty reduction started slowing from the early 2010s onwards, and poverty differences between regions remain large. From 2015 and onwards, Thailand's progress in poverty reduction slowed, with poverty increasing in the years 2016, 2018 and 2020. This mirrored a slowing economy, stagnating farm and business incomes, and the COVID-19 crisis. In 2020, the poverty rate was over 3 percentage points higher in rural areas than in urban zones and rural poor outnumbered urban poor by almost 2.3 million. The distribution of poverty is also uneven across geographic regions with the poverty rate in the South and Northeast almost double the national level.

The rural sector plays an important role in the economy but is also home to most of the poor. In 2020, the proportion of Thailand's rural population (49 percent) remains significantly higher than upper-middle income countries and world averages. The rural economy employs about 21 million people (55 percent of total employment). The gross provincial product (GPP) of provinces with large rural populations accounted for about 48 percent of the national gross domestic product (GDP) in 2019. However, the majority of the poor (79 percent) live in rural areas, mainly in agricultural households. In 2019, the average monthly income of rural households was around 68 percent of urban households, and people in rural households continue to suffer from low levels of formal education, a larger number of dependents, and difficult living conditions.

Agriculture plays a key role in Thailand's economy, but the persistent decline in net farm incomes poses serious challenges to poverty reduction efforts. Over the past decade, farm income has persistently decreased, thereby offsetting progress in reducing poverty. While the farm sector accounts for only eight percent of GDP, it employs around one-third of the country's labor force and contributes 15 to 20 percent to total exports. Thailand is a key supplier of agricultural products to the world market. It is a major exporter of rice and sugar, and the world's leading exporter of frozen shrimp, canned tuna, canned pineapple, cooked poultry, and cassava.[1] However, this admirable performance at a global level conceals several challenges that local farmers face across the country, especially in the North and Northeast regions.

This rural income diagnostic (RID) examines the challenges and explores the opportunities to improve the incomes and productivity of poor and vulnerable households in rural Thailand. The analysis considers rural farm and nonfarm activities and is disaggregated at the spatial level to evaluate specific challenges and opportunities for the regions as well as for small, medium and large producers. The diagnostic also examines how to facilitate income growth in the short to medium term, while remaining consistent with a sustainable development trajectory over the longer term. The analysis focuses on farming households given their higher poverty rate and vulnerability. The findings from this report are synthesized from several national data sets and analyses and benchmarked against other upper-middle income country peers in Southeast Asia. The diagnostic also builds on extensive consultations with academia and relevant government ministries.

The RID uses four steps to identify and prioritize opportunities and constraints faced by rural farming households and to assess policy options to address the constraints. The first step consists of examining

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[1] USDA FAS (2019) Thailand 2019 Export Highlights.

the income and living conditions of people in rural households. The second step assesses opportunities to increase the income of rural farm households. The third step investigates the key constraints that prevent rural farm households from taking advantage of these opportunities and explores the main drivers of these constraints. The final step examines feasible policy solutions that would help these households overcome their constraints and increase their incomes. The potential for policy solutions to address these constraints, their feasibility, and the size and breadth of their impact are rated based on a review of the evidence and discussions with experts in the field.

Incomes and challenges of rural households

Wages and salaries are the largest sources of income for both urban and rural households, but the latter rely more on income from farming businesses. The average share of income from farming business – a often precarious source of income – reaches 23 percent among rural households in the poorest income decile compared to 13 percent for those in the richest decile. In 2020, 35 percent of rural households were exclusively farm households (i.e., all their members work in agriculture), 12 percent were diversified (i.e., at least one member was employed in agriculture and one member employed in non-agriculture), while 40 percent had all their members working exclusively in the non-farm sector. About 14 percent are elderly households without economically active members. Rural farm households, where all members work in agriculture, are the poorest while non-farm households are better-off economically. In 2020, the poverty rate exceeded 11 percent among rural farm households compared to about 6 percent among non-farm households. Rural farm households are also more vulnerable as they have greater income volatility and a higher risk to fall into poverty.

Net profit from farming has been deteriorating since 2011 due to the decline in global agricultural commodity prices and destructive climatic events. During 2011–2019, poverty declined faster among rural farm households. This decline was driven largely by income transfers from remittances and government social assistance, whereas real farm incomes, excluding transfers, decreased by about 7 percent. In particular, net farm profit fell by about 14 percent during the same period, slowing income growth of rural households. This decline was due to extensive losses of productive farmland caused by floods and droughts during 2011–2015, and the significant drop in global agricultural and food prices since 2011.

Rural households in the Northern regions have the lowest average income. The average income level of rural households in the Central region (excluding transfers) is over 60 percent higher than that of rural households in the North and Northeast. In the South, it is about 50 percent higher than in the North and Northeast. While incomes in the rural North improved slightly in 2019, they continued to decline in the Northeast. Low levels and a declining trend of farm incomes contributed to the persistence of low incomes and poverty in the Northern regions.

Rural farm households face several challenges. Farmers suffer from limited and unequal access to water and irrigated land as well as limited access to agriculture services and markets. They face increasing input costs as well as high and rising indebtedness. Farm households are mostly smallholders, lack crop diversification in their farms, and lack secure land tenure. They are highly exposed to climate shocks and were severely affected by the COVID-19 crisis. This report identifies the main opportunities for enhancing rural farm incomes and the key constraints hindering income growth, and suggests policy options to address these constraints.

Opportunities for inclusive rural income growth

Evidence in the report points to three sets of opportunities to enhance income growth of rural households. These include: increasing agriculture productivity, supporting diversification to higher value crops, and improving access to markets.

- **Increasing agriculture productivity**. Improving productivity in agriculture not only boosts farm incomes but also increases food security. Boosting agricultural productivity is also important for rural non-farm income growth through its multiplier effects in manufacturing (food processing) and services (food service economy and domestic trade/marketing), and for reducing income disparities across the country.

  o *Improved access to irrigation water.* Irrigation water is an important factor in increasing agricultural productivity and crop diversification. In Thailand, high investment costs have prevented the development of large and medium-scale irrigation systems to provide greater access to irrigation water to a larger number of farmers who continue to be dependent on dryland agriculture. Only 42 percent of farm households are able to access water resources and only 26 percent have access to irrigation systems.[2] Farm households dependent on rain grow crops only in the rainy season and leave their farmland fallow during the dry season. Improved access to irrigation systems offers opportunities for farmers to cultivate year-round, increase their crop yields, diversify to horticulture and other high value crops, and thus increase their farm returns.

  o *Use of improved inputs and modern technologies.* This includes the use of improved climate resilient seeds and fertilizers and good agriculture practices, especially for rice. With the migration of youth to non-farm sectors and cities, low birth rates and an aging rural population as well as the increased minimum wage, rural labor shortages and costs have increased. Increased access to agricultural machinery can help farmers overcome some of these problems and increase their productivity and efficiency. This would also enable farmers to achieve higher margins while allowing them to release labor for other activities to diversify their incomes. Despite these potential benefits, the large upfront costs associated with modern machinery could act as a constraint to its adoption, particularly among smallholder farmers. Digital technology could enable greater adoption of modern machinery as it can provide a platform for farmers to participate in a sharing economy, which allows the sharing of production factors such as tractors and other farm equipment among many actors. The increased entry of machinery service providers could also facilitate access to much needed farm equipment. This allows farmers to access productivity-enhancing equipment that would otherwise be too expensive. The geographically concentrated nature of crop production in Thailand provides a conducive environment for a sharing economy, and the increasing emergence of tractor services in the country is one example of the potential benefits of a sharing economy in agriculture.

  o *Improved agriculture extension and information services.* Improved training and information services can be critical to promote the adoption of modern technologies. Increased use of digital technologies can help promote the use of precision agriculture approaches and e-extension. Agricultural extension workers could use digital applications to efficiently serve a larger number of farmers. Extension services, such as soil testing geo-tagged to the farm location, combined with weather information, could provide customized information on optimal fertilizer applications. Agriculture extension systems can leverage digital applications,

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[2] [Thai Ag Sector UN 2020](#).

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for example, a disease identification app that uses a smartphone camera and artificial intelligence (AI) technology to identify pests and diseases and provide advice on how to control them.

   o *Improved tenure security.* Empirical evidence shows that promoting farmland tenure security in Thailand could improve rice yields by 116–127 kg/hectare for small-scale farms and by 52–71 kg/hectare for midsize farms. The land rental market in Thailand is typically on an annual lease basis, which creates disincentives for renting farmers or those who only have use rights to the land to make long term investments This would include using modern machinery and equipment and on-farm irrigation systems (e.g. drip irrigation). For example, certificates of land tenure with SPK401, NS2, STK and PBT status give the right of a farm household to use the land, but ownership is not attached to the household and the land cannot be used as collateral. With an SPK401 certificate, farm households are not allowed to sell their land and it can only be transferred to an heir of the farm household. If farmers are not able to use these lands as collateral, they have limited access to much-needed credit. Although the certificate of land tenure with SPK401 can be used as collateral in a special case, farm households generally obtain a loan of 50 percent of the appraisal value from the Bank for Agriculture and Agricultural Cooperatives. Improving tenure security can therefore improve farmers' access to finance and medium to long-term farm improvement and investments.

- **Diversification to higher value crops**. Rice production has played a dominant role in the Thai economy, generating close to USD 3.7 billion of export revenues in 2020.[3] However, the country's rice yields have been low relative to other global rice producers over the past decade.[4] In addition, data on farming profits from 2006 to 2019 reveals that growing rice resulted in lower profits compared to other crops, including cassava and maize.[5] Despite its relatively low productivity and profitability, rice production has continued to dominate the use of limited irrigated land, with the planting of paddy rice accounting for two-thirds of total irrigated areas. While improving rice productivity is still critical, particularly in areas that are agro-ecologically suited and have a comparative advantage for growing rice, there remains considerable opportunity to raise farm incomes through crop diversification and crop rotation. In Vietnam, for instance, many farmers grow rice for one season and produce vegetables or other agricultural products in other seasons. Alternatively, farmers could move out of rice production and grow high-value crops, especially in areas unsuited for rice production to maximize returns on the use of relatively scarce and productive land.

- **Improving access to markets**. Expanding farmers' access to markets is critical to raising farm incomes, as it could allow farmers to obtain better prices and sell higher volumes. E-commerce and online trading could help widen access to markets by providing a platform that facilitates the efficient matching of buyers and sellers. The expansion of market access could benefit both farm and non-farm rural enterprises. It has the potential to raise employment and incomes, thereby contributing to the development of the rural economy. A study that surveyed enterprises using e-commerce platforms showed they contributed to improved trade connections, especially in rural areas.[6] It is important to note that the potential benefits of e-commerce could be further

[3] UN COMTRADE 2021.
[4] USDA 2021. TFP Indices and Components for Countries, Regions, Countries Grouped by Income Level, and the World, 1961-2019.
[5] Attavanich et al. 2019. Farms, Farmers and Farming: A Perspective through Data and Behavioral Insights (No. 122). Puey Ungphakorn Institute for Economic Research.
[6] Sathirathai and Nakavachara. 2019. Connecting locals to locals: market discovery through ecommerce. PIER discussion paper no 118.

bolstered if coupled with efforts to strengthen logistics systems to allow rural enterprises to expand their input and output markets, realize the gains that could accrue from shortening the value chain, and provide opportunities for farmers to move up the agricultural value chain to agro-processing and distribution.

The ripple effects of the pandemic and the war in Ukraine on food markets bring additional concerns and opportunities to farmers. The prolonged COVID-19 crisis, coupled with climate shocks, the war in Ukraine and, most recently, food protectionism by many countries have disrupted agricultural production and the food supply chain, causing a surge in food prices and imperiling food security. While inflation and disruptions to food markets pose serious challenges for Thai households, particularly the poor, they may also open up opportunities to the agricultural industry and smallholder farmers. For instance, farmers may benefit from increasing food prices but they need to address several challenges to turn a crisis into opportunities. Climate change, environmental degradation, an ageing population, labor shortages, and a lack of resources are among the many problems the farming sector needs to address to increase productivity and respond to the ongoing food crisis.[7]

Key constraints hindering income growth

Evidence in the report identifies constraints which need to be addressed to fully realize the potential to increase rural farm incomes. These constraints are grouped with opportunities and are categorized as: 1) constraints to improving agricultural productivity, 2) constraints to diversification, and 3) lack of access to markets. However, it is important to note that many of these constraints have broad and cross-cutting impacts. Notably, climate change will be highly impactful on agricultural productivity, but will also influence planting decisions and farmers' decisions to diversify crops. Similarly, water access and water use are closely linked to both increased productivity as well as farmers' ability to diversify to more water-intensive and high-value crops.

- **Constraints to improving agricultural productivity**. These include: 1) limited access to irrigation systems and water sources, 2) small farm size and weak tenure security, 3) risks from climate change, 4) ineffective crop insurance, and 5) low levels of agricultural research and development (R&D) investment.

  - *Limited access to irrigation systems and water sources.* Thailand ranked 31st out of 49 countries on a water security index constructed by the Asian Development Bank (ADB), lower than its peers with similar gross national income per capita.[8] Farmers in the South and Northeast of Thailand suffer the most from limited access to irrigation water. Farmers in the South have the lowest access, but the problem is partially mitigated by higher rainfall, whereas farmers in the Northeast face high exposure to droughts. Even in regions with better access to irrigation water, less than half of farm households have access. As a result, many farm households are not able to maximize the use of their farmland and face limited options for growing suitable higher value crops.

  - *Farm size and tenure security*. Most farm households in Thailand are smallholders. Roughly half of the farming households own less than 10 rai (1.6 ha) of land, which limits the economic viability of their farms. Around 40 percent of farm households lack secure land tenure with full land-use rights, and they can benefit only from "*land tenure with*

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[7] https://www.bangkokpost.com/business/2321318/.

[8] Asian Development Bank. 2020. Asian water development outlook 2020: Advancing water security across Asia and the Pacific.

limitations".[9] Small farm size and weak tenure security reduce farmers' ability and incentives to access credit and to undertake appropriate investments to improve their productivity and resources management.

- o *Risks from climate change*. Thailand is projected to face large losses in GDP due to climate change. The country ranked among the top five countries expected to have the largest decline in GDP by 2048[10] and ranked 68th on the ND-GAIN country index of vulnerability to climate change and readiness to improve resilience in 2020.[11] The frequency of flooding, droughts and other natural disasters will increase, making farming more risky and yields more variable. Estimates of the effects of climate change on agriculture production (assuming no adaptation or adoption of new technologies) show that rice production could decline by 10 to 13 percent, sugarcane by 25 to 35 percent and cassava by 15 to 21 percent.[12, 13] Climate change could also affect the incomes of non-farm households due to increased input costs for non-farm enterprises as well as flooding, which limits economic activity.

- o *Ineffective crop insurance.* Insurance is available for farmers through the nationwide rice insurance program. However, it is expensive for insurers to offer insurance cover to farmers due to the lack of information on the specific risks to farms and the difficulty in assessing losses. The government provides subsidies to reduce premium costs and contributes to payouts but there is limited demand for insurance policies beyond those supported by government expenditures. These policies do not meet the urgent needs of farmers after a coverage trigger, insurance payouts can take three to six months, and often do not fully cover losses, thus offering only a limited cushion for shocks. With these challenges in insurance markets, taking risks to improve productivity is difficult, especially for smallholder farmers who have limited margins for safety.

- o *Low levels of agricultural R&D*. Investments in research and development are below what is needed to develop technologies and practices to increase yields and build greater agriculture climate resilience. Thailand's public R&D spending on agriculture remained below 1 percent of agricultural GDP over the past two decades, significantly below levels in large agricultural-exporting countries. With the increasing threats from climate change, investment in R&D is becoming more important to develop more climate resilient crops and other climate smart agriculture technologies and practices to sustain yields in the face of climate change.

- ▪ **Constraints to diversification.** The opportunity to raise farm incomes through crop diversification is affected by an incentive structure which favors farmers growing crops that have relatively low returns (e.g. rice). These include some unconditional farm assistance programs as well as the water pricing structure.

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[9] In Thailand, there are several types of land ownership rights. These are: 1) full ownership rights such as land types with a tile deed and a certificate of utilization (NS5 or NS.3K); 2) other types of ownership which have restrictions on sale or transfer such as a certificate of agricultural land reform (SPK401, NS2, STK and PBT); 3) rented land; and 4) land without a document of identified rights. Except for the first type, households have weak property rights. For example, rented lands are usually for an annual lease, with very few to no long-term lease contracts.

[10] Swiss Re Institute. 2021. Economics of climate change: no action not an option.

[11] Notre Dame Global Adaptation Initiative. 2020. https://gain.nd.edu/our-work/country-index/rankings/

[12] Pipitpukdee et al. 2020a. Climate change impacts on sugarcane production in Thailand. Atmosphere, 11(4), 408.

[13] Pipitpukdee et al. 2020b. Impact of Climate Change on Land Use, Yield and Production of Cassava in Thailand. Agriculture, 10(9), 402.

o *Unconditional farm assistance programs.* One-third of the total farmland used for growing the 13 main economic crops in the country have low soil or water suitability.[14] The mismatch in planted crops and the suitability of soil could result in lower crop yields, with the additional cost of exacerbating land degradation leading to lower farm incomes. Some unconditional farm assistance programs, which include price and income guarantees for farmers as well as subsidies for farm inputs, are contributing factors in preventing farm households from switching to crops more suitable to their farmland.[15] In addition, an evaluation of the impact of farm assistance policies on farm performance found that these policies have either no effect or reduce net farm income as they negatively impact farmers incentives to improve their productivity.[16] For instance, policy support to rice farming influences farmers' planting decisions and reduces their incentive to diversify to higher value crops which could provide higher profits.

o *Inefficient use of water resources.* Rural areas suffer from irrigation water shortages due to competition for water from non-farm sectors and the high and inefficient use of water in some economic sectors, as water is provided free of charge or at a low price. In addition, government support programs to farmers encourage cultivation of water-intensive crops with low profitability, essentially rice, which exacerbates the inefficient use of water.

▪ **Lack of access to markets**. Around 40 percent of villages in the country, including 44 percent in the Northeast, lack year-round access to main roads. This constrains farmers (and other non-farmer producers) capacity to access inputs, increases their cost of production and marketing and reduces their ability to sell their outputs and improve their potential incomes. Where processing facilities are distant from rice fields and without good connections to multiple facilities and buyers, farmers have lower bargaining power and receive less for their rice due to the high transportation costs. In addition, limited internet access, particularly in remote areas, affects connections to buyers as it makes coordinating more difficult, which raises transaction costs while also limiting opportunities to connect with a wider range of buyers.

Priority actions to overcome key constraints in the next 5–10 years

Policy options to increase rural farm income include: 1) measures to increase farm productivity, 2) measures to support market access, 3) policy and institutional reforms, and 4) cross-cutting policy measures.

(i) **Measures to increase agricultural productivity.** Policy measures to increase agricultural productivity include: 1) expanding access to irrigation and promoting the adoption of water efficient irrigation methods, 2) promoting risk mitigation strategies to cope with increasing weather volatility among farming households, 3) facilitating access to finance, and 4) strengthening agricultural R&D.

• *Expanding access to irrigation and promoting the adoption of water efficient irrigation methods*. Precision irrigation, in contrast to large-scale irrigation, is one of an emerging set of irrigation techniques which can help reduce water use while delivering the required amounts of water to

[14] Land Development Department. 2019. Cultivated land in various suitability classes. Agri-Map database. https://agri-map-online.moac.go.th/
[15] Attavanich et al. 2019. Farms, Farmers and Farming: A Perspective through Data and Behavioral Insights (No. 122). Puey Ungphakorn Institute for Economic Research
[16] Attavanich, W. 2021. Impact evaluation of multi-public policies on economic well-being of Thai farmers. Funded by National Research Council of Thailand. Contract No. 575/2563.

crops. This technology can measure the moisture present in soil, allowing farmers to use the exact amount of water specific to a crop and soil type. This can increase yields and reduce overuse of water. These methods are well-suited to adjust to drier climates which will become a greater concern in the future due to climate change.

- *Promoting risk mitigation strategies to cope with increasing weather volatility among farming households*. With the production of major crops projected to be adversely affected by climate change, developing more effective and sustainable risk mitigation strategies could help reduce volatility and income loss among households. These strategies could include strengthening risk management systems, particularly early warning systems, as well as promoting the development and adoption of more effective and sustainable crop insurance.

- *Facilitating access to finance*. Improving access to finance could widen opportunities for farmers to invest in the use of higher quality inputs, modern machinery, and other productivity-enhancing tools which could help raise agricultural yields and farm incomes.

- *Strengthening agricultural R&D*. Investments in agricultural R&D need to be strengthened to increase productivity, raise competitiveness in export markets and to adapt to climate change. This could be coupled with expanded private-sector participation which can help develop varieties and agricultural technologies tailored to conditions in Thailand.

(ii) **Measures to support access to markets.** Policy measures to support access to markets include: 1) expanding rural infrastructure to strengthen the connection between farmers and markets and 2) promoting the development of e-commerce to create new opportunities to raise incomes

- *Expanding rural infrastructure to strengthen the connection between farmers and markets*. Investing in farm-to-market roads would improve the connectivity of rural areas, benefiting both farm and non-farm enterprises by reducing transport and logistic costs, reducing marketing margins, and expanding their reach to new customers.

- *Promoting the development of e-commerce to create new opportunities to raise incomes*. The participation of farmers in e-commerce would allow for easier matching with buyers. It could also allow producers to sell directly to consumers, removing steps along the value chain. Additionally, there remains great potential for the development of digital platforms and applications which bring together the processing and distribution stages of the supply chain, reducing transaction costs even further. E-commerce also provides women with an opportunity to earn additional income with the flexibility to better balance work and duties in the home.

(iii) **Policy and institutional reforms to enhance efficiency of resource use and productivity.** Some policies create inefficiencies in the use of land and water resources, which result in lower productivity and incomes for farmers. Policy measures to address these challenges include: 1) strengthening tenure security, 2) adopting optimal water pricing schemes and 3) reviewing the use of policies which provide unconditional farm assistance.

- *Reviewing policies that weaken tenure security and constrain longer land rental tenure.* Having land tenure with limitations (i.e., lacking the ability to use, control or transfer ownership of the land) could have broad and cross-cutting effects which affect agricultural productivity, crop diversification and farmers' decisions to use new technologies or modern machinery that would enhance productivity. On rented farmland, short rental contracts, which are more common than long-term leases, act as a constraint for farmers to invest in the land, given the uncertainty of being able to benefit from long-term investments. In addition to incentivizing longer-term investments in farmland, tenure security also widens access to credit and mitigates liquidity

constraints, as it enables farmers to use their farmland as collateral. As such, crafting policies to strengthen tenure security and reviewing policies that constrain long-term leases of farmland could provide cross-cutting benefits to farmers.

- *Adopting optimal water pricing schemes, particularly in water stressed areas to reduce the inefficient use of water*. Limited farm household access to water partially stems from the inefficient use of water due to its free or very low pricing. As such, institutional reforms are needed, particularly in water stressed areas. In the short term, one approach would be to establish regulations that allow water user groups to collect water fees in local funds that could then be used to maintain irrigation canals.[17]

- *Reviewing the use of policies which provide unconditional farm assistance*. Unconditional farm assistance is not always effective in increasing farmer incomes, particularly when it reduces incentives for farmers to improve their productivity. Reviewing the effectiveness of these unconditional policies and shift away from ineffective assistance, where appropriate, could motivate farmers to adjust their farming practices.

(iv) **Cross-cutting policy measures related to skills development.** It is important to build the skills of farmers to enable them to use inputs more efficiently and adopt productivity-enhancing technologies and machinery. Policy measures to address these challenges include: 1) strengthening the knowledge and capacity of farmers, 2) promoting digital literacy and strengthening the adoption of digital technologies, and 3) leveraging existing farmer institutions to enhance social learning.

- *Strengthening the knowledge and capacity of farmers*. Building the skills and reducing the knowledge gap of farmers is critical in seizing available opportunities and mitigating constraints on increasing agricultural yield, diversifying to higher value crops and ultimately, raising income for rural farm households. This can be done through a range of approaches which include extension services, vocational training, and skills development programs. Through these programs, farmers could gain knowledge on more efficient input management and climate adaptation. They also could learn about i) the benefits of planting crops that have high soil and water suitability to their farmland, ii) the gains to be had from the use of improved seeds and fertilizers, and iii) the tools and equipment that are available to help them raise agricultural yields and increase their professional capacity to operate a farm as a sustainable business. They could receive training on operating modern machinery to help raise rates of adoption, as well as develop other pertinent skills which include financial literacy and business management.

- Promoting *digital literacy and strengthening the adoption of digital technology*. The application of digital technology for farming opens up several possibilities to raise agricultural productivity and increase farm incomes: i) it provides a platform for the sharing economy, which allows even smallholder farmers to use modern equipment that would otherwise include large upfront costs; ii) it provides a platform for e-commerce, which provides broader access to both input and output markets; iii) it can act as a mechanism for the transfer of information and knowledge that could be critical factors in planting decisions such as the market price of crops, weather information and the costs of processing and transportation; iv) it can be used as a platform for farmer extension services; and v) it could also be used as a mechanism for early warning systems. Despite the enormous potential that digital applications could have in raising farmer productivity and

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[17] Thailand Development Research Institute. 2018. Analyzing the development of irrigation and water management projects suitable for Thailand and its impact on the gross domestic product. The Royal Irrigation Department.

incomes, farmers' adoption of digital technology has been low relative to supply.[18] To raise the adoption of digital technology in farming, promoting digital literacy is a critical first step. In addition, in raising farmers' digital literacy, it is important that older farmers are not left behind, particularly as one-fifth of the rural farm population are workers aged 60 and above. Additional support can be given to ensure that older farmers are able to benefit from the use of digital technology.

- *Leveraging existing farmer institutions to enhance social learning*. Analysis in this report reveals that the likelihood of adoption of productivity enhancing practices rises when farmers are members of agricultural institutions or some form of membership organization. As such, promoting the use of digital technology and modern farm equipment through membership organizations could raise the adoption of productivity enhancing practices.

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[18] Rattanavararak et al. 2019. Digital technology and development of Thai agriculture. PIER aBRIDGEd.

I. Introduction and scope of the diagnostic

Thailand recorded a remarkable reduction in poverty in the past decades, but the progress started slowing down from early 2010s onwards. The national poverty rate plunged from 58 percent in 1990 to 6.8 percent in 2020—based on the upper middle-income class poverty line of US$5.50/day/person (in 2011 Purchasing Power Parity— PPP), the decline was from nearly 65 percent to 6.4 percent (Figure 1). Thailand's progress in poverty reduction has slowed from 2015 onwards— with poverty increasing in 2016, 2018 and 2020— mirroring a slowing economy, stagnating farm and business incomes and the COVID-19 crisis. The decline in poverty was coupled with a reduction in inequality—— the consumption-based Gini coefficient fell from 45.3 percent in 1990 to 35 percent in 2020, but income inequality remains very high. With an income Gini coefficient of 43.3 percent in 2019, Thailand has the highest income inequality rate in the East Asia and Pacific (EAP) region. In 2019, The top 1 percent of earners captured 21 percent of national income, while the income share of the bottom five deciles constitutes only 14 percent. Estimates from the Global Wealth Report by Credit Suisse similarly show that despite a decline in the wealth share of the top 1 percent from 67 percent in 2018 to 40 percent in 2020, it remains higher than the EAP average of 38 percent.

Figure 1. Poverty Rate, 1990– 2020, Percent.

Figure 2. Poverty Rate at National Poverty Line by Area, 1990 – 2020, Percent.
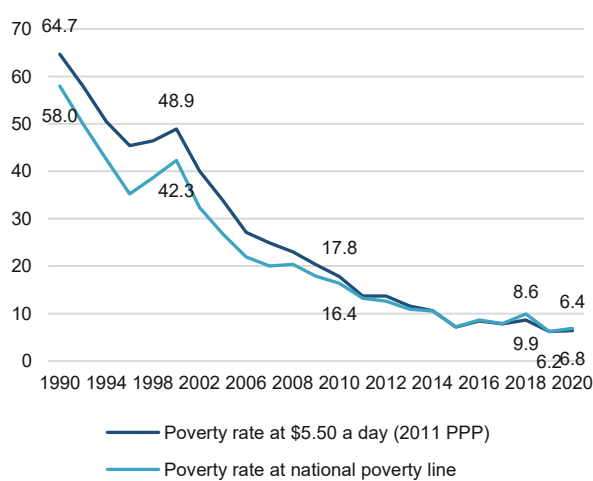
Source: Thailand Socio-Economic Survey (SES) 1990-2020.
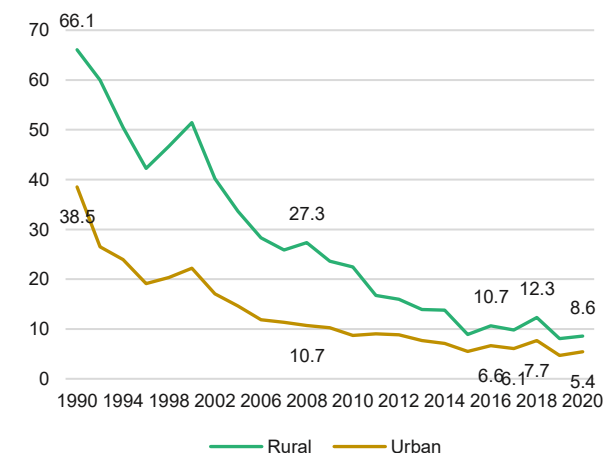
Source: SES complied by NESDC (2021).

Poverty remains much higher in rural than in urban areas. Rural[19] areas achieved a faster decline in poverty over 1990-2020, where poverty dropped from 66.1 percent to 8.6 percent, than urban areas, where poverty fell from 38.5 percent to 5.4 percent. However, the progress in reducing poverty and in closing the rural-urban gap considerably slowed down in 2015 (Figure 2). In 2020, the poverty rate was over 3 percentage points (pp) higher in rural areas than in urban zones and the number of poor people almost 2.3 million larger (3.1 million poor people in rural areas compared with 0.8 million in urban zones).

The reduction in poverty was uneven across geographical region, with poverty remaining prevalent in the Northeast and the South. Until early 2010s, the Northeast and the South experienced the fastest decline in poverty, where the national poverty rate fell by over 50 pp (Figure 3). However, these regions experienced a considerable slow-down in poverty reduction over the past decade. Poverty started a sustained increase in the South since 2011 and in the Northeast since 2015, increasing particularly in rural zones of these regions. By 2020, the South and the Northeast had the highest poverty rates at over 11.5 percent – reaching 14.7 percent in the rural South. There are also large variations in poverty incidence at

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[19] In Thailand, urban areas correspond to municipal areas and rural areas to non-municipal areas.

the provincial level. During 2011-20, 14 out of 77 provinces faced an increase in poverty and most of these provinces are in the South (Figure 4A). Ranong experienced the largest increase in poverty, from 9.2 percent in 2011 to 21.3 percent in 2020, followed by Pattani, where poverty rose from 33.4 to 44.4 percent. In 2020, the poverty rate exceeded 20 percent in seven provinces— three of them are in the South: Pattani (44.4 percent), Narathiwat (24.7 percent) and Ranong (21.3 percent). [20] The poorest provinces are at over 80 percent rural and about 40 percent or more of their workforce is employed in agriculture.

Figure 3. Poverty Rates at National Line by region, 1990-2020, Percent.
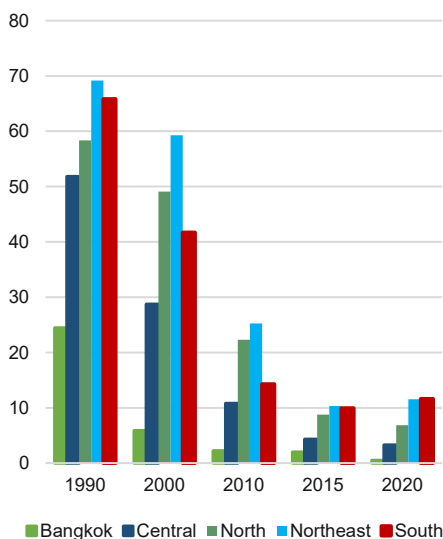
Figure 4. Poverty Rates at National Line by Provinces, 2011-20, Percent.

A. Changes in poverty rates by provinces from 2011 to 2020.

B. Poverty rates by provinces, 2020.
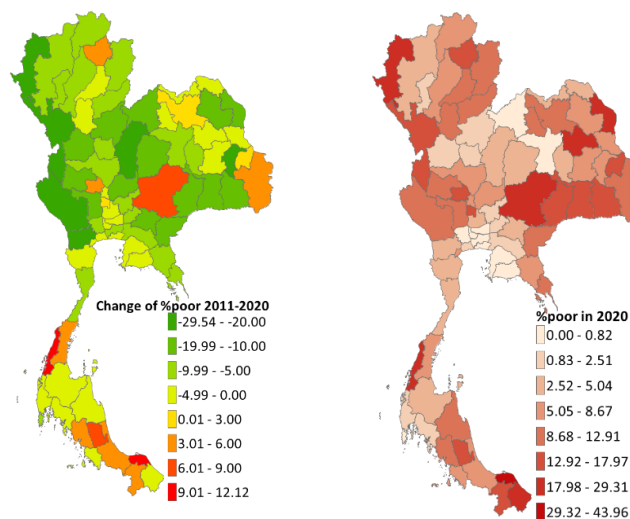
Source: NESDC (2021)

Source: NESDC (2021)

The rural sector continues to be home to a large share of the population and of the poor. Thailand is one of the upper middle-income countries where the rural economy continues to play an important contribution to the national economy. As shown in Figure 5, the proportion of the Thai population living in rural areas has gradually declined from 70 percent in 1991 to 49 percent in 2020, but remains significantly higher than the world average (44 percent) and upper-middle income countries average (34 percent). Thailand's rural economy contributes significantly to employment and to value creation of good and services. In 2020, the rural economy employed 20.7 million people, accounting for nearly 55 percent of total employment. The gross domestic product (GDP) of provinces with large rural populations (more than 50 percent of their total population) accounted for 47.6 percent of the national GDP in 2019 (NESDC 2021). The rural economy has also played a significant role in Thailand's financial sector. Around 49 percent of borrowers from formal institutions are in rural areas and they account for about 40 percent of total debt outstanding (National Credit Bureau 2020). However, rural areas remain home to a large share of the country's poor. In 2020, 79 percent of the poor lived in rural areas compared to 96 percent in 1990 (Figure 6). Most of the poor remain concentrated in agriculture. In 2020, 75 percent of the poor were in households whose head is employed in agriculture, declining by a mere 10 percent in three decades.

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[20] Three are in the Northeast: Kalasin (23.8 percent), Nakhon Ratchasima (21.2 percent) and Nakhon Phanom (20.3 percent); and one in the North: Mae Hong Son (29.3 percent).

Figure 5. Rural Population in Thailand and Comparator Countries, 1991-2020, Percent of Total Population.
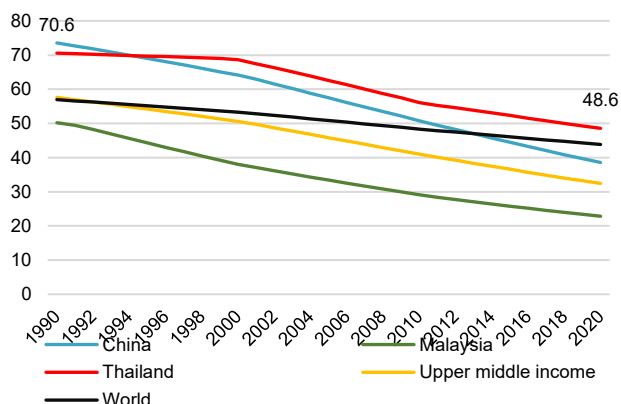
Figure 6. Distribution of the Poor by Area and Sector, 1990-2020, Percent.
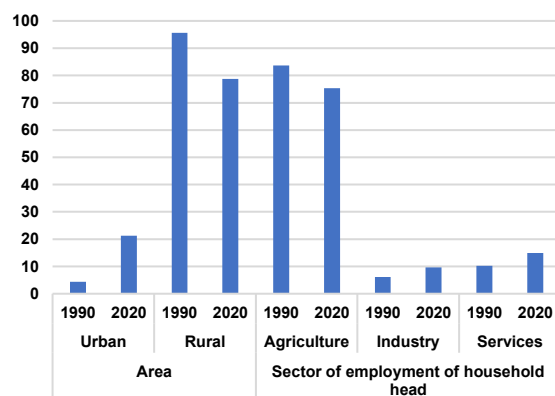
Rural households still lag behind urban households in many living condition dimensions. In 2020, the average monthly per capita expenditures of rural households were 66 percent of urban households; in 2019 rural households' average monthly income was around 68 percent of urban ones. Rural households suffer from low education, a large number of dependents and difficult living conditions. They also suffer from climate change effects, coupled with limited access to irrigation systems and water resources. The lack of access to digital infrastructure and low adoption of digital technology poses the second most important challenge to the rural economy followed by limited and inefficient use of farmland. These major challenges result in persistently low farm productivity as well as unstable and declining incomes and profits. Subsequently, rural households face high indebtedness— the incidence of debt is 7 pp higher among rural households than in urban ones, with the debt incidence being highest among farm households (Chantarat et al., 2020). In addition, rural enterprises face several challenges related to increasing input costs and limited access to input and output markets, as well as employment seasonality and low labor productivity.

Decline in farm income continues to offset the progress in poverty reduction. In 2020, agriculture employed around 55 percent of the rural population and in 2019 net farm incomes accounted for 17 percent of rural household's incomes. However, low productivity in the agricultural sector and persistent reduction in net farm incomes pose serious challenges to poverty reduction efforts. While value added per worker in industry and services registered a steady increase over the past two decades, the progress was minimal in agriculture (Figure 7). From 2017 to 2019, poverty declined by 1.2 pp nationally and the decline was faster in rural areas (1.5 pp) than in urban areas (0.9 pp).[21] However, the reduction in farm income partly offset this progress and the effect was stronger in rural areas: farm income offset a reduction in poverty by 0.3 pp in rural areas and by 0.24 pp in urban areas (Figure 8).[22]

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[21] Changes in poverty are based on the $5.5 a day poverty line (2011 PPP). NESDC estimates, using the national line, show a reduction of 1.6 pp (from 7.87 percent in 2017 to 6.24 percent in 2019) with a larger decline in rural areas (1.8 pp vs 1.4 pp).

[22] The decomposition uses the method of Azevedo et al. (2013) and Inchauste et al. (2014) to estimate the contribution of changes in demographic factors and in income from different sources to changes in poverty. Figure 8 shows the sources of changes in poverty during 2017–19. The y-axis shows the percentage point contribution to the change in the poverty rate. When the contribution is positive, that component contributed to an increase in poverty, and the opposite for a negative contribution.

Figure 7. Labor Productivity by Sector, 1991-2019.

Figure 8. Sources of Changes in Income-based Poverty, 2017-2019, Percentage Points.
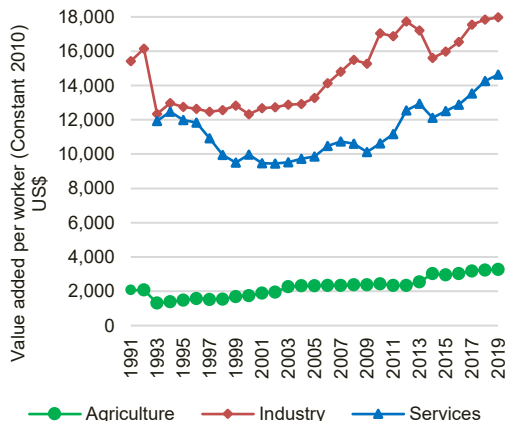
Source: World Development Indicators (WDI) 2022.
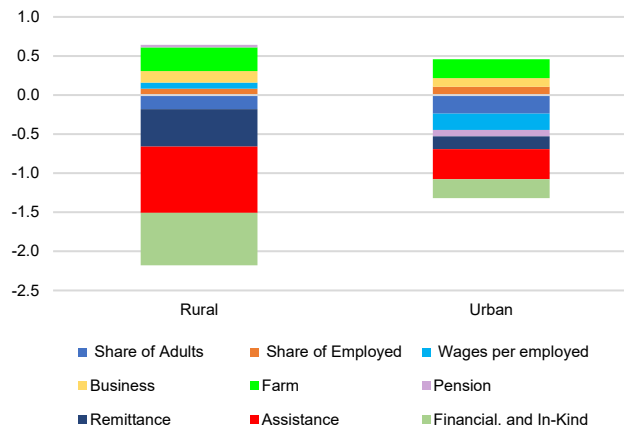
Source: SES 1990 and 2020.
Note: Changes in poverty are based on the $5.5 (2011 PPP) line.

The COVID-19 crisis has spawned new challenges to the rural economy. Thailand's economy was hit hard by the pandemic with the GDP contracting by 6.1 percent in 2020. Repetitive waves severely disrupted the economy, reducing the growth prospects for 2021 to 1.6 percent, and economic activity is not expected to return to its pre-pandemic levels until 2023. Cash infusion and emergency transfers helped attenuate the impacts of the crisis on households' welfare, but the generous social protection program was not sufficient to offset substantial income declines. At its onset, the COVID-19 pandemic severely affected the urban sector due to strict mobility measures, business closure and jobs layoffs. However, the urban sector is expected to rebound faster while the impact of the crisis will be long-lasting in the rural economy. According to the Office of Agricultural Economics (2022), the debt of farm households is predicted to increase by 16.5 percent in 2020-21. Using survey data for June-October 2021, Attavanich et al. (2022) show that 81 percent of farming households experienced a reduction of their incomes due to the pandemic, though 91 percent reported moderate negative effects on their income.[23] Results from Thailand's COVID-19 monitoring phone survey revealed that 70 percent of rural households reported a reduction in their income since March 2020 (Belhaj Hassine & Arayavechkit 2021).[24] Female informal workers, in particular, faced large income shocks due to limited social insurance that could help mitigate these losses (Paweenawat forthcoming).

This report aims to examine the challenges and opportunities to improve incomes and productivity in the rural sector and suggests feasible policy options. The diagnostic aims to identify the main opportunities and constraints for a faster, sustained income growth for poor and vulnerable households in rural Thailand. The analysis considers rural farm and nonfarm activities and households. It is disaggregated at the spatial (regional/provincial) level and by size of farmers/producers to distinguish the specific challenges, opportunities and policies for some regions, and for small, medium and large producers. The diagnostic seeks to examine how to facilitate income growth in the next five years, while remaining consistent with the sustainable development trajectory over the long term.

The report places a particular focus on farming households given their higher poverty and vulnerability. The incidence of poverty is two times higher among farming households than nonfarming ones and the

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[23] The survey uses the Likert scale with 5 levels (i.e., very low, low, moderate, high, very high) to assess the impact of the pandemic on the incomes of interviewed farmers.

[24] https://blogs.worldbank.org/eastasiapacific/impact-covid-19-thailands-households-insights-rapid-phone-survey.

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former continue to face a sustained decline in their incomes and profits. Therefore, this diagnostic focuses essentially on the analysis of the challenges faced by farming households and opportunities to improve their incomes.

Literature review, new analysis and consultations underpin the findings. The diagnostic reviews the existing body of evidence on rural incomes in Thailand and adds analysis from existing national data sets— i.e., SES, Labor Force Surveys (LFS), Farmers' Registration from the Department of Agricultural Extensions (DOAE), Household and Agricultural Labor Socio-Economic Survey from Office of Agricultural Economics (OAE), Agricultural Census. Results are benchmarked against upper-middle income country peers in Southeast Asia. The diagnostic also builds on extensive consultations with academia and relevant government ministries. More details on main data sources are in the appendix.

The analysis employs a common framework used across different countries undertaking rural income diagnostics. The framework developed by Hill (2018) provides a structure and set of questions that draw on the literature on structural transformation, agricultural growth, and rural non-farm growth.[25] The diagnostic identifies three broad types of labor income growth for rural households—growth in agricultural incomes, growth in non-farm incomes and rural to urban migration.[26] Within these types, it considers more specific sources of income growth that are presented in Figure A1 in the appendix. In order to maximize their incomes and reduce their volatility to external shocks, rural households are often engaged in more than one type of activity. Therefore, growth of income from one source affects the opportunities and constraints of income growth from other sources.

This report applies the framework to diagnose the opportunities and constraints faced by the rural economy and households and to assess policy options to address these constraints. The approach builds on four steps. The first step consists in examining the socio-demographic profile and living conditions of rural households. The second step assesses opportunities to increase the income of rural households. The third step investigates the key constraints preventing rural households from taking advantage of these opportunities and explores the sequencing and overlap of the constraints. The final step examines the feasible policy actions that would help rural households overcome the key constraints to increasing their income. Details are provided in Figure 9. The analysis selects the key constraints that prevent households from taking advantage of identified opportunities. Prioritization of constraints requires assessing the likely benefits of pursuing the opportunities compared against the costs of relaxing the constraints. There are four criteria suggested by Hill (2018) that are used to identify the priority constraints that need to be address: (1) the constraint limits several important sources of income; (2) strength of evidence that addressing the constraint will help income growth, (3) the constraint has a stronger impact on poorer households or regions, and (4) existing evidence on the need to address the constraint first before other constraints can be addressed. Potential feasible policy solutions are suggested to the prioritized constraints. The potential for the policy solutions to address the constraints, their feasibility, and the size and breadth of their impact is graded based on the review of evidence and discussion with experts and stakeholders operating in the field.

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[25] This literature includes Christiaensen and Martin (2018), Barrett et al. (2017), Dercon and Gollin (2014), Haggblade, Hazell and Reardon (2007), Timmer and Akkus (2008), and Lanjouw and Feder (2001).

[26] As in many rural diagnostics, the identification of the sources of income growth are based on the frameworks set out in Timmer (2008), Foster and Rosenzweig (2004), and McCulloch et al. (2007).

Figure 9. Diagnostic of Constraints Faced by Rural Households.

Diagnostic of constraints faced by rural households

Step 1: Diagnostic of rural households living conditions.

The key analysis examines how rural households allocate time and assets across activities, the socio-economic profile of farming households, their access to markets, infrastructure and capital as well as the risks and constraints they face in both maximizing and reducing variability of their income. The analysis covers both farm and non-farm rural households and considers spatial differences as well as differences according to the size of the farm/business/activity.

Step 2: Identify opportunities to increase income of rural households.

The analysis examines opportunities for sustainable agricultural and non-farm growth, the role of migration in economic mobility, the potential gains from crop diversification, improving matching between crop types and land suitability, and the broader utilization of digital technology in farming. This step also explores how market access and conditions, trade and value chains can offer opportunities to increase rural household incomes.

Step 3: Priority constraints to achieving higher income growth.

This step investigates the key constraints preventing rural households from taking advantage of opportunities to increase their income, and explores the sequencing and overlap of the constraints. The identification of the constraints builds primarily on empirical analysis of existing data, and is complemented by literature review, benchmarking and consultations.

Step 4: Identification of feasible policy solutions.

The analysis examines the feasible policy actions that would help rural households overcome the key constraints to increasing their income. It builds on successful initiatives in Thailand, discussion with field experts, and available country experiences. This is cross-referenced with the literature review of evidence on the effectiveness of the proposed approaches. The key focus is on the potential effectiveness of the proposed policy interventions and their feasibility.

Findings are disaggregated regionally to reflect the variability of production and market conditions across Thailand. Thailand has different climate zones, irrigation zones and soil suitability in areas. Also, there is considerable variation in access to markets across the country. Households in the Central region are more urbanized and closer to domestic and regional markets. Farm households can more easily diversify to non-farm activities in this region. In contrast, households in the North, Northeast, and South have less access to markets and services. Opportunities and constraints thus vary across regions and this variation needs to be reflected in the analysis. The analysis covers the four main regions in Box 1, and when data is available a more detailed analysis at the provincial level.

Box 1: Regions used in the analysis
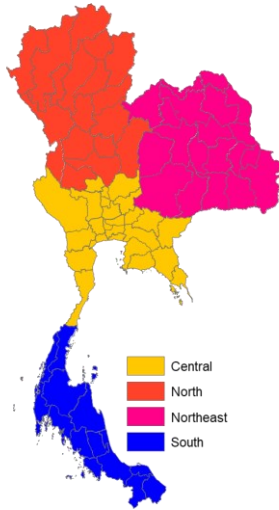
The Central is the most urbanized and has the highest population density. Rural households in this region have good access to markets and irrigation systems. Rice is the main planted crop (planted more than two times a year) but farmers also cultivate horticulture and fruit crops. The share of households using modern machines and technology for farming is higher than in other regions. Farm households partially rent out their farmland and engage in part-time non-farm jobs. Tourism provides an important source of income for farmers in the region. However, this region faces severe scarcity of water due to high demand from manufacturing, service, agriculture and household sectors.

The North has lower population density, larger mountainous areas, and colder temperature than other regions. Households in the North have less access to irrigation systems and markets. Rice is the major field crop in the region, planted more than one time a year in irrigated areas.

The Northeast also has low population density with large part of rainfed areas. Field crops and seasonal rice are planted together with growing livestock. People in this region usually move out to search for jobs in urban areas during non-growing seasons.

The South has the highest rainfall and grows more horticulture and fruit crops as well as palm oil and natural rubber than the other regions. Tourism and fisheries are the most important sources of income for farmers. Similar to the Northeast, access to irrigation systems is low in the South.

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II. Income and Challenges of Rural Households

Understanding the potential for inclusive income growth in rural Thailand requires an analysis of the sources and trends of rural incomes, and of the factors that shape their patterns. This section examines the sources and trends of rural incomes in Thailand, and explores the factors that shape incomes disparity and vulnerability. The section draws on this evidence to address some critical questions for policy decisions, in particular: what are the main sources of incomes of rural households, and how do they vary across their sociodemographic profiles and over time, what are the main challenges faced by rural households, and what factors would help to increase their income gains?

2.1 Income of rural households

Wages and salaries are the largest source of income for both urban and rural households, but the latter rely more on income from farming business. In 2019, wages and salaries accounted for 31 percent of rural households total income and 46 percent of urban households' total income (Figure 10). While households in both areas rely on diversified sources of incomes, rural households rely more heavily on income from farming business. The average share of income from farming business – a vulnerable source of income— reaches 23 percent among rural households in the poorest income decile— compared to 13 percent for those in the richest decile (Figure 11).

Figure 10. Main Income Sources by Area, 2019, Percent
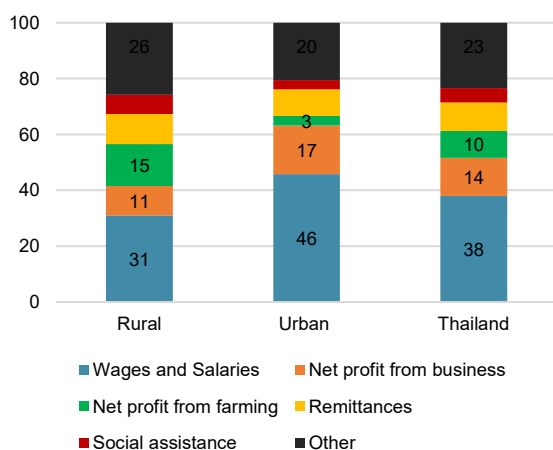
Figure 11: Main Income Sources in Rural Area, by Decile, 2019, Percent

Source: SES 2019.
Note: Other include in-kind, pension and financial incomes.
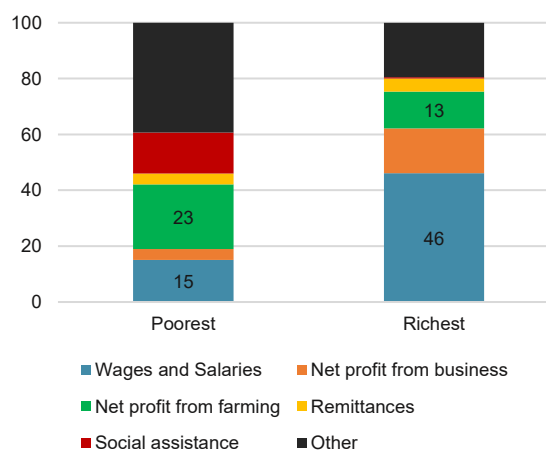
Source: SES 2019.

Besides their higher dependence on farming income, rural households have average lower incomes from other sources than urban households. In 2019, the average annual household income from farming business was estimated at USD 2,394 nationally – about three times lower than the average annual income from wages and salaries and that from nonfarm business.[27] The larger dependance of rural households on farming income contributes to their vulnerability. In addition, average incomes from wages and salaries, nonfarm business and remittances are much lower (about 50 percent lower) among rural households than urban ones (Figures 12 and 13). While average incomes from social assistance are higher for rural households, they remain low. These differences contribute to the significant gap in incomes and poverty between urban and rural households.

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[27] In 2011 constant prices- deflated by the CPI of 2011- to facilitate comparison with figures below.

Figure 12. Average Value of Household Annual Income by Source, Rural Areas, USD
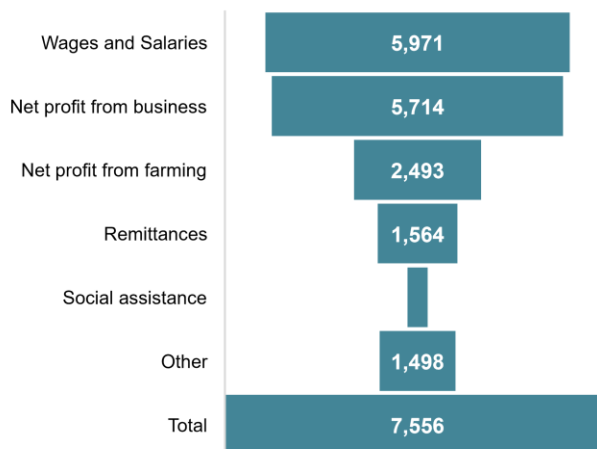
Wages and Salaries	5,971
Net profit from business	5,714
Net profit from farming	2,493
Remittances	1,564
Social assistance	
Other	1,498
Total	7,556

Figure 13. Average Value of Household Annual Income by Source, Urban Areas, USD

Wages and Salaries	9,066
Net profit from business	7,790
Net profit from farming	1,997
Remittances	2,240
Social assistance	
Other	2,124
Total	10,731

Source: SES 2019.
Note: Other include in-kind, pension and financial incomes.
Values are in 2011 constant prices.
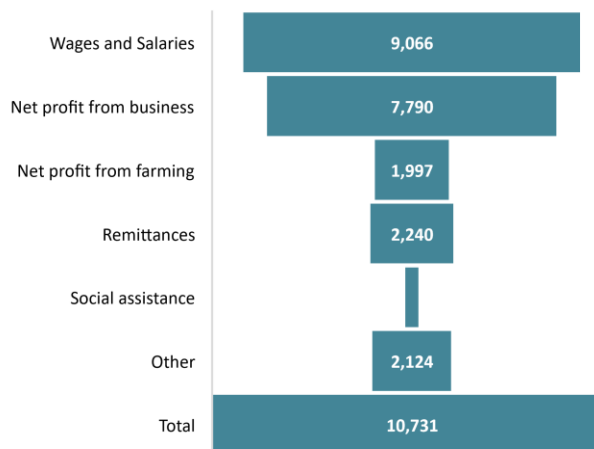
Source: SES 2019.

Among rural households, those whom all members operate in the farming sector are the most vulnerable. In 2020, 35 percent of rural households were exclusively farm households (i.e., all their members work in agriculture) and 12 percent were diversified (i.e., at least one member employed in agriculture and one member employed in non-agriculture), while 40 percent had all their members working exclusively in the non-farm sector (Figure 14). About 14 percent of rural households did not have any working members.[28] These are generally elderly households who rely mostly on income from remittances, social assistance and in-kind sources. The highest proportions of farm households are in the Northeast (53 percent) and in the North (40 percent). In the rural Center, most households operate only in non-farm activities (68 percent), while in the rural South, 40 percent are non-farm but 19 percent are diversified. Most rural households, except the ones with non- working members, are headed by men: 68 percent of farm households, 69 percent of diversified households, 61 percent of non-farm households and 43 percent of those with non-working members. The COVID-19 pandemic and subsequent economic crisis have induced movements from urban to rural areas. As a result, the number of rural households increased from 10 million in 2019 to 10.5 million in 2020. This led to an increase in the proportion of diversified households by about 2 percentage points. Rural farm households are the poorest while the non-farm ones are better-off: the poverty rate exceeds 11 percent among farm households compared to about 6 percent among non-farm households. Income inequality is also highest among farm households (Figure 15).

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[28] Excluding servants.

Figure 14. Distribution of Rural Household by Activity and Region, 2019, Percent
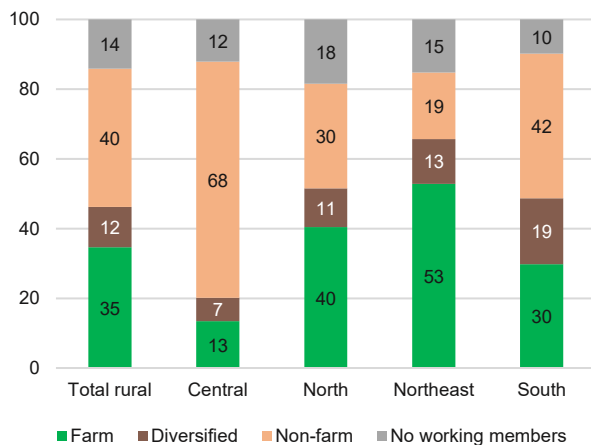
Source: SES 2019.

Figure 15. Poverty and Inequality Among Rural Households by Activity, 2019, Percent
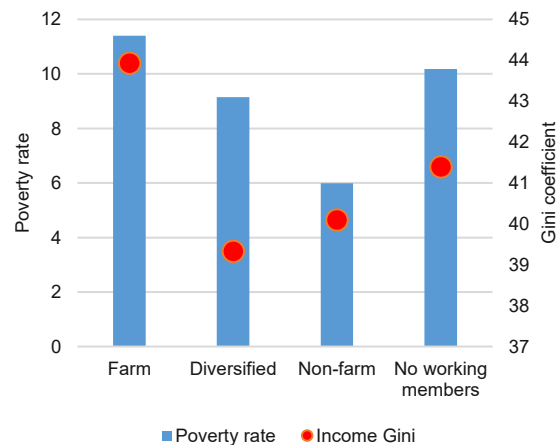
Source: SES 2019.

Poverty has declined among rural farm households but their real annual income, excluding transfers, deteriorated overtime. During 2011-2019, the poverty rate among farm households declined 15 percentage points, while it declined 9 percentage points among diversified households and 7 percentage points among non-farm households (Figure 16). Despite a faster reduction in poverty among farming households, their average real annual income— excluding transfers from remittances and social assistance— has deteriorated (Figure 17). It fell by about 7 percent, declining by 8 percent in 2011-15 and increasing by less than 2 percent in 2015-19. This suggests that improvements in the living standards of farmers were driven only by assistance from government programs and private sources rather than an increase in their productivity. In contrast, the average real annual income of non-farm households (excluding transfers) increased by 13 percent in 2011-19. The income of diversified households rose at a slower pace (4 percent), though it remains significantly higher than the income of non-farm households. In 2019, the income of diversified rural households was two times higher than the income of farm ones and the income of non-farm households was 75 percent higher.

Figure 16. Average Income of Rural Household by Activity, USD
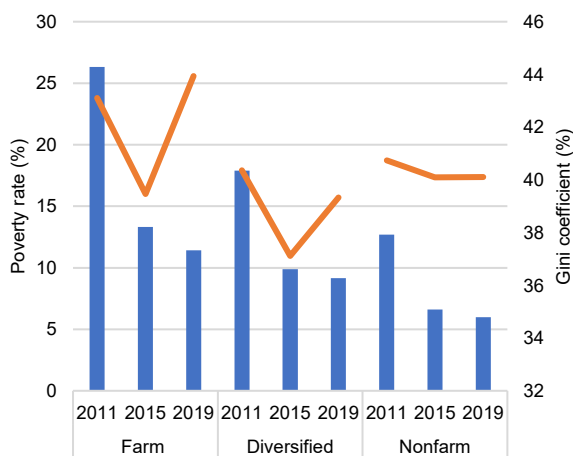
Source: SES 2019.
Note: Other include in-kind, pension and financial incomes. Values are in 2011 constant prices.

Figure 17. Average Annual Income of Rural Households, Excluding Transfers, 2011-2019, USD
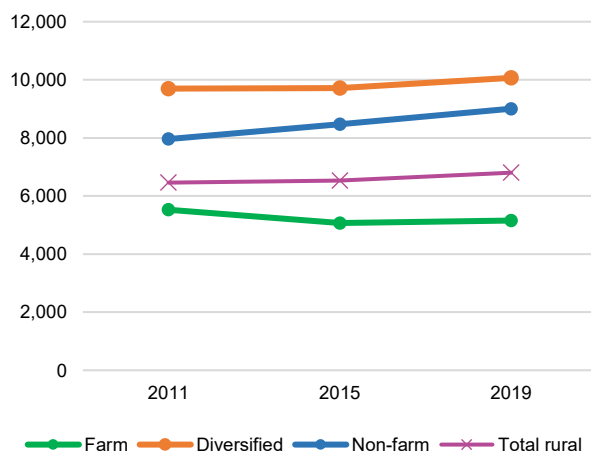
Source: SES 2011, 2015, 2019.
Note: Values in 2011 constant prices using Bank of Thailand official exchange rate.

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Net profit from farming is the most vulnerable source of income for rural households. Net profit from farming business is, on average, over two times lower than income from wages and salaries and from net profit from non-farm business. While wages and salaries and net profit from non-farm business increased, on average, between 25 to 30 percent during 2011-19, net profit from farming business fell by about 14 percent, dragging down rural households' income growth (Figure 18). The decline of farming income was highest among diversified rural households (- 18 percent vs -12 percent for farm households) but its effect on overall income (excluding transfers) was more severe on farm households who rely more farming business as their source of income – net profit from farming business accounts, on average, for 43 percent of farm households income (excluding transfers) compared to 24 percent for diversified households and 39 percent for all rural households.

Figure 18. Average Annual Income of Rural Households Excluding Transfers by Source, 2011-2019, USD
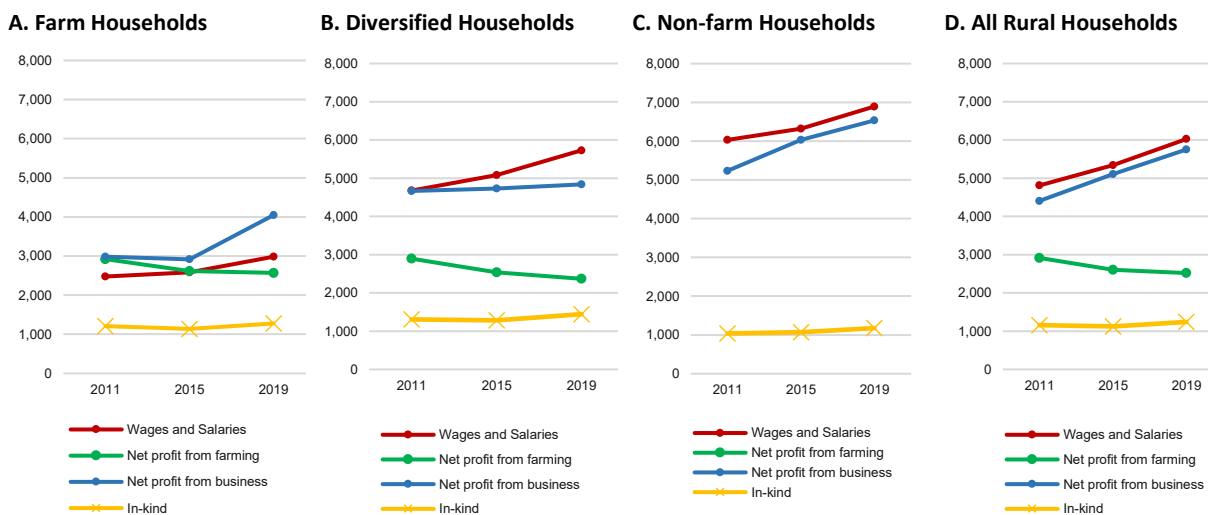
Source: SES 2011, 2015,2019.
Note: In-kind income includes income from unpaid consumption goods & services and free-occupied housing.
Values are in 2011 constant prices using Bank of Thailand official exchange rate.

The decline of world agricultural and food prices and natural events are among the main causes of the deterioration of net profit from farming business. After the historical peak in 2011, world agricultural and food prices (especially the price of para rubber) fell dramatically. Thailand witnessed several natural disasters during 2011-15 (e.g., the great flood in the fourth quarter of 2011 to the first quarter of 2012, the prolonged drought in 2015), which led to extensive damages of farm production. In addition, farmers suffer from increasing costs of inputs due to low competition in the inputs market, aging problem which affects their productivity and limited use of technology. The regular use of unconditional assistance policies (i.e., subsidies, price and income guarantee) in agriculture, which do not incentivize farmers to improve their productivity, contribute to the decline in net profit from farming.

The increase in the minimum wage contributed to the growth of income from wages and salaries. The rise of the minimum wage applied during 2012 and 2017, and the restructuring of minimum civil servant salary in 2012 were the two main factors explaining the rising trend in wages and salaries. This increase helped to offset the deterioration of farm incomes, particularly among diversified households.

Although net profit from non-farm business increased, the growth was minimal for diversified households. During 2011-19, net profit from non-farm business rose, on average, 30 percent for all rural households, 25 percent for non-farm households and 36 percent for farm households. However, the increase was only 4 percent for diversified households, slowing down their overall income growth. Despite some improvement in their overall income, diversified households suffer from increased indebtedness.

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Their total debt rose 55 percent between 2011 and 2019, causing them to have the highest debt-to-income ratio in 2019 at 1.52, compared 1.27 for farm households and 1.2 for non-farm households.

The majority of farm households are smallholders. In 2019, about 80 percent of households holding farmland were from the rural area. Over 70 percent of rural households holding farmland are smallholders[29], while 23 percent are medium and 6 percent are large holders (Figure 19A). The North has the highest share of smallholders, accounting for 83 percent of total rural households holding farmland. In contrast, the South has the largest share of medium size farms accounting for 30 percent of rural households holding farmland, while the Central has the largest share of large size farms accounting for 10 percent of rural households holding farmland.

Smallholder farm households tend to have much lower incomes than larger farmland holders. The average income of smallholders is about 30 percent lower than the average income of medium farmland holders and around two times lower than larger holders (Figure 19B). During 2011-15, all farmland holders faced a decline of their income due to the decline of agricultural products prices in the world market during 2011, and the great drought in 2015, which damaged large farmland areas in the country. Large farmland holders took the hardest hit, as their income declined about 36 percent compared to a decline of 13 percent for medium holders and 3 percent for smallholders. With the improvement of climate conditions in 2019, incomes rebounded for all farm holders. However, despite a faster rebound for large holders their income remained lower than in 2011 while the incomes of medium and smallholders reached slightly higher levels.

Figure 19. Farm Size and Income of Rural Households

A. Distribution of Rural Households by Farm Size and Region, 2019, Percent
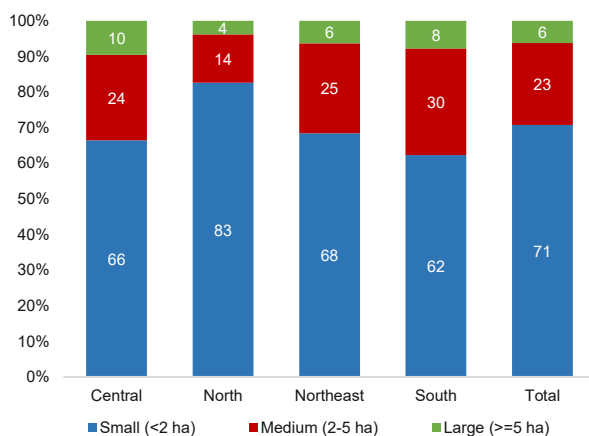
B. Average Annual Income of Rural Households by Farm Size, 2011-2019, USD
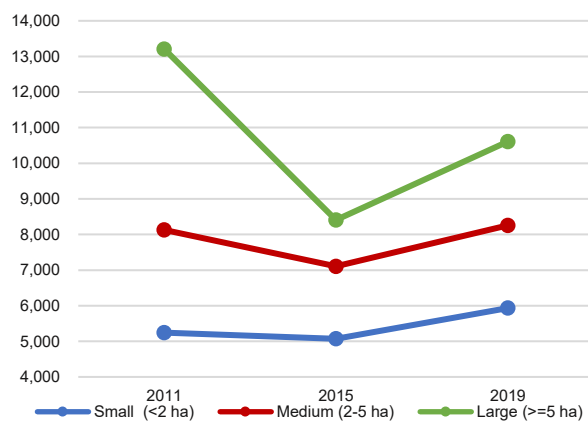
Source: SES 2019.

Source: SES 2011, 2015,2019.
Note: Income excludes transfers.

Rural households in the Central and Southern regions have the highest average income. The average income level (excluding transfers) of rural households in the central region is over 60 percent higher than that of rural households in the North and Northeast regions. In the South it is about 50 percent higher. While the average income of rural households in the South was the highest in 2011, it dropped significantly in 2015 and did not regain its initial level despite the rebound in 2019 (Figure 20). In contrast, the average income of rural households in the Central region increased steadily, though slowly, during

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[29] Smallholders are households with farmland less than 2 hectares (based on definition of Lowder, Skoet & Raney 2016). Medium size farms are 2 to less than 5 hectares and large size farms are 5 hectares and more.

2011-19. This is due to the low engagement of households in farming activities compared to the other regions. Rural households in the North and Northeast have the lowest incomes and while incomes in the North improved slightly in 2019, they kept deteriorating in the Northeast.

Figure 20. Average Annual Income of Rural Households Excluding Transfers by Region, 2011-2019, USD
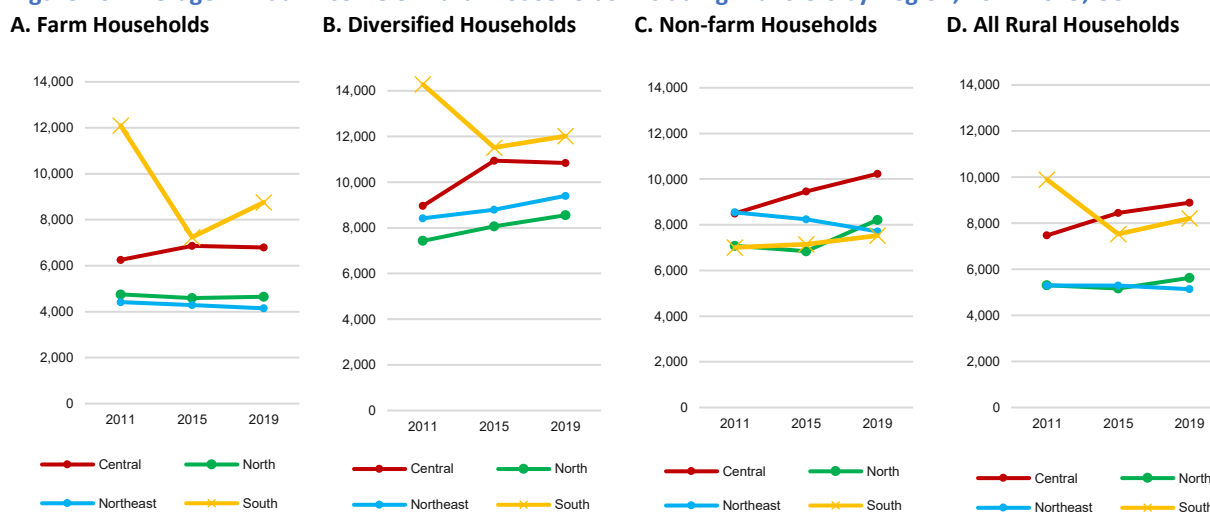
| A. Farm Households | B. Diversified Households | C. Non-farm Households | D. All Rural Households |

Farm households in the South fare better than in the other regions, though they were severely affected by the income decline in 2015. The sharp decline in rubber prices after 2011 had a severe impact on farm households in the South, almost halving their income. The South has most of the rubber plantations of Thailand and rubber output in the South accounts for 78 percent of the total national rubber output. While income of farm households in the South rebounded in 2019, it remained much lower than its level in 2011. Farm households in the North and Northeast were less affected by the farming crisis in 2015, but their average incomes kept deteriorating.

The average income of diversified households increased in the North and the Northeast, but remains much lower than in the South and Central regions. The rubber crisis seems to have severely affected diversified households in the South, indicating that their nonfarm income could not compensate for the income loss from the deterioration of rubber prices. The increase of average income of diversified households in the North and the Northeast is essentially driven by the rise of minimum wage and the increase of nonfarm income for the former.

Non-farm households in the Central region have the highest income. From 2011 to 2019, income of non-farm households increased 20 percent in the Central region and 16 percent in the North. The increase was driven by two main factors: 1) the transition from production in agriculture to production in industry and services sectors, and 2) the sustained increase in the minimum wage rate during 2012-17. The slight decline in income of non-farm households in the Northeast could be explained by the devastating effects of floods in the region in 2011.

Young workers fare better than older ones in the farming sector while older workers fare better in the non-farming sector. Workers aged 60 and above have the lowest average income of all groups, though their income in the nonfarm sectors rose sharply in 2019 (Figure 21). While young workers (less than 40) seem to have higher incomes in the farming sector, they earn much less than middle-aged workers (40 to 60) in the non-farming sector, probably due the larger experience of the latter and their capacity to build a career.

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Figure 21. Income of Rural Farm and Non-farm Workers by Age and Gender, 2011-2020, USD

A. Farm Workers by Age   B. Non-farm Workers by Age   C. Farm & Non-farm Workers by Gender

Young farm workers
Middle-aged farm workers
Old farm workers

Young non-farm workers
Middle-aged non-farm workers
Old non-farm workers

Female farm workers
Male farm workers
Female non-farm workers
Male non-farm workers
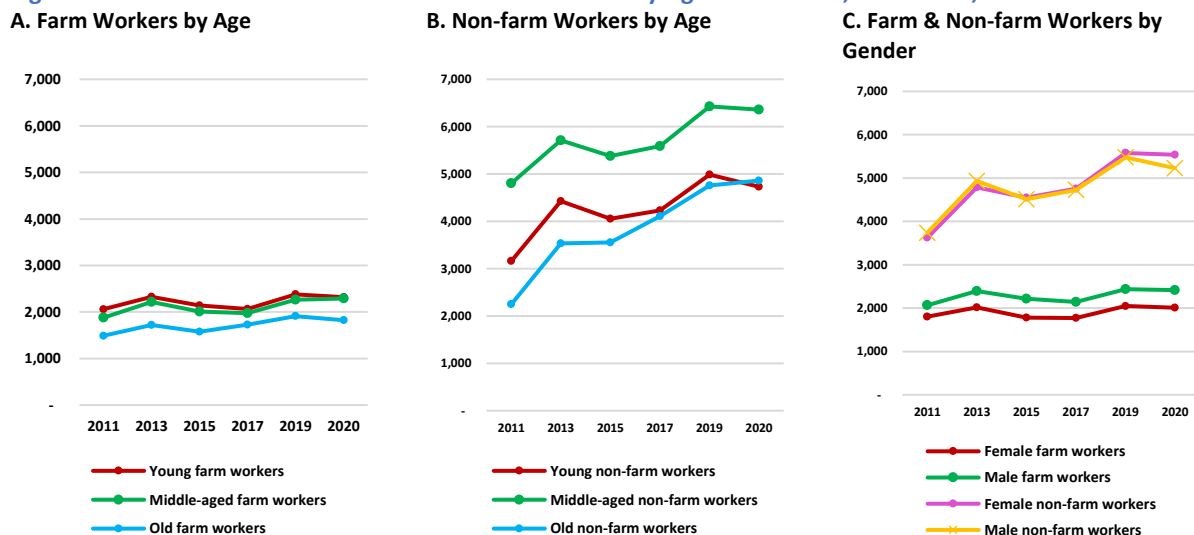
Source: Thailand Labor Force Survey 2011, 2013, 2015, 2019 and 2020
Note: Income is in USD using official exchange rates of BOT. Young workers are less than 40 years old, middle-aged workers are aged 40 to less than 60 years and old workers are 60 years and older.

Men and women earn, on average, similar incomes in the non-farm sector, but women earn less in the farm sector. The average annual income of women working in the non-agricultural sector is on par with that of men, and their incomes followed the same pattern though increasing slightly faster for women (Figure 21C). In contrast, average incomes in agriculture remained higher for men than women. However, men were more severely affected by the COVID-19 crisis than women: the 2020 LFS shows that the unemployment rate was 1.34 percent among men (198 thousand unemployed men) compared to 1.09 percent among women (171 thousand unemployed women).

The gender gap is closing in Thailand. With the structural transformation in Thailand, women shifted from agriculture to non-farming sectors at a faster pace than men. They also moved from unpaid household work to paid employment. In the 2020 Global Gender Gap Index, Thailand ranked 75th out of 153 countries, lower than the Philippines, but higher than other regional peers, such as Indonesia, Vietnam and Malaysia. In addition to this, the gender gap in formal employment in Thailand is also substantially lower than the global average (16 pp, compared to 26 pp) (ILO 2019). Female workers represent a large share in management of large companies (29 percent), ranking the fifth largest after Vietnam (34 percent) out of 35 economies in 2021 (Credit Suisse, 2021). The passage of the Gender Equality Act in 2015 has drastically reduced gender inequality. Moreover, the Constitution of the Kingdom of Thailand 2017 requires the equality of rights between men and women.

2.2 Challenges of rural households

Rural households have much lower levels of education than urban ones and farm households have the lowest level of education, which limits their opportunity for higher incomes. In 2020, over 70 percent of rural household heads did not go beyond primary schooling compared to less than 50 percent in urban areas. Among farm households, over 80 percent had primary education or less and among them about 60 percent did not even complete primary schooling (Figure 22). Among rural households, non-farm ones have the highest education levels— around 15 percent of their heads completed upper secondary school and another 19 percent had post-secondary or university degrees. The average income of rural households whose head has lower secondary education is about 50 percent higher than that of

households whose head has primary education or less and the average income of those whose head has a university degree is over three times higher.

Higher levels of education are also key for higher incomes for both farm and non-farm rural workers. Although rural non-farm workers have much higher income levels than farm ones, there is a clear gap between workers based on their education level in both groups. In particular, the average income of university graduates is significantly larger than that of those with lower education (Figure 23). Over the past decade, the annual income of non-farm workers with upper secondary education and above was almost twice the income of farm workers with similar education. The annual income of farm workers with a university degree sharply declined while the annual income of non-farm workers with a similar level of education increased significantly. Overall, annual income of non-farm workers no matter their level of education grew steadily. This increase was mainly driven by the increase of the minimum wage and the restructuring of civil servants' salaries.

Figure 22. Educational Attainment of Household Head by Type of Household, 2020, Percent
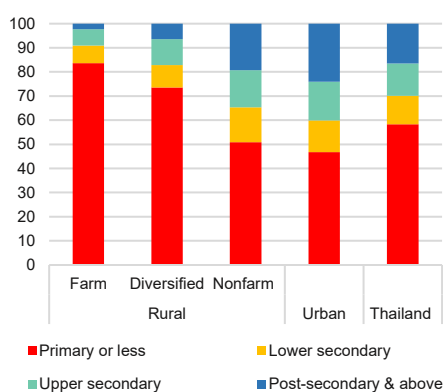
Source: SES 2020.

Figure 23. Rural Income of Farm and Non-farm Workers by Educational Level, 2020, USD

A. Farm workers

B. Non-farm workers
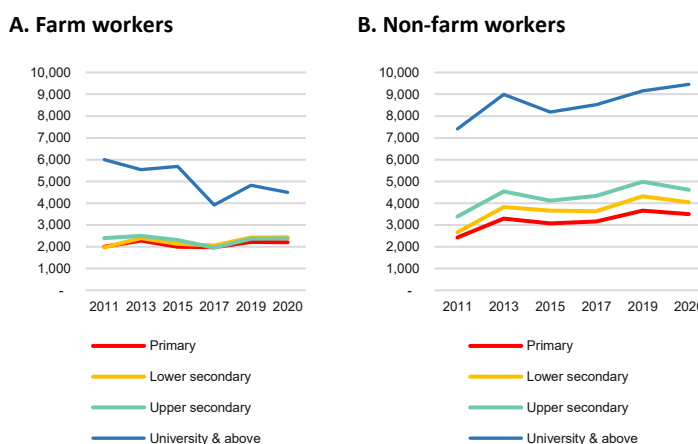
Source: LFS 2011, 2013, 2015, 2019 and 2020
Note: Income is in USD using official exchange rates of BOT.

Female workers face the additional challenge of a gender wage gap, particularly in low skilled informal work and the agricultural sector. Although the gender wage gap is fairly low in the formal sector, it is relatively high in the informal sector (4 percent compared to 10 percent, respectively) . While this is partially due to endowments, with female informal sector workers being less educated on average, among lower skilled workers in informal employment, women earn 23 percent less than men. In the agricultural sector, the gender wage gap is approximately 8 to 9 percent for both formal and informal employment (Paweenawat forthcoming).

The rural economy is facing an aging problem especially among agricultural workers. In 2020, elderly workers made up 20 percent of the rural farm population compared with 7 percent in 2001 and 10 percent in 2010 (Figure 24). Moreover, in 2020, young workers in the farming sector represented 30 percent of all rural farm workers, a decrease from 56 percent in 2001 and 45 percent in 2010.[30] While population aging is a serious challenge in all sectors of the economy, it is more problematic in the farming sector. On the one hand, young workers who are equipped with higher education prefer to live in the city and work in the nonfarm sector, which leaves mostly older workers in the sector, and on the other hand the rapid

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[30] The young farm worker is defined as an employed worker who has the age less than 40 years old, while the elderly farm worker is defined as an employed worker who has the age at least 60 years old.

aging of the population in farming involves a rapid decline in productivity. Overall, employed household heads are, on average, 5 years younger in urban areas than in rural areas (47 vs 52 years). Compounding this difficulty, older women are less likely to contribute to farming production, with only 27 percent of women 60 years old and older participating in the labor market, compared to 47 percent of men. This is due to the high level of unpaid care work that older women undertake, which constrains their participation in economic activities. When older women do work, it is often in informal employment which offer greater flexibility, but tend to offer lower wages and limited social protection (Paweenawat forthcoming).

Figure 24. Age Pyramid of Rural Workers in the Farm Sector by Gender, 2020, Percent
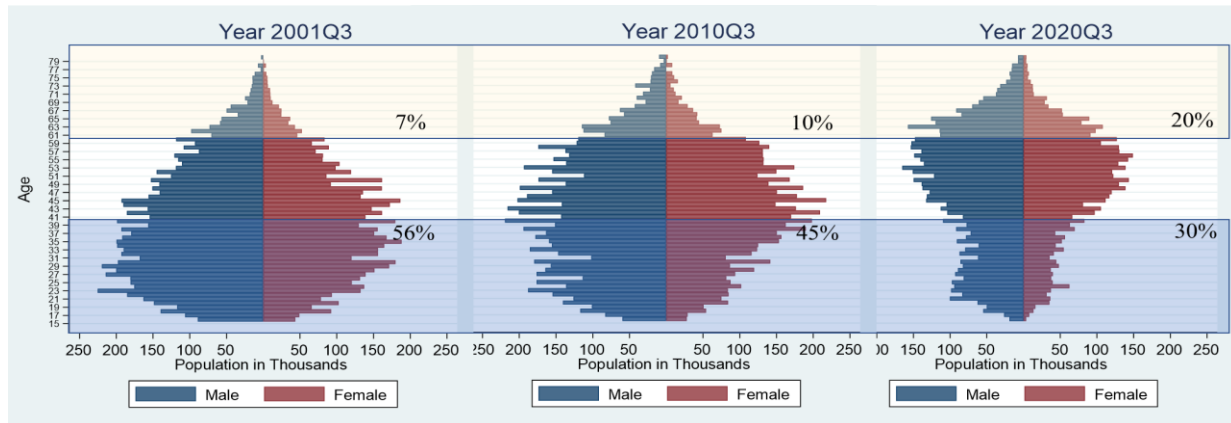
Source: LFS 2001,2010 and 2020.

Older rural farm households have the lowest income levels of all rural households. The heads of farm and diversified rural households are much older, on average, than heads of rural nonfarm households (57 vs 51 years). Only 7 percent of rural farm and diversified households have heads younger than 40 compared to 25 percent of nonfarm households (Figure 25). Over 40 percent of farm households have heads 60 years or older. Even though farm households have the lowest income level of all rural households, income is lowest among households whose head is 60 years or older, indicating that aging is a very serious concern for productivity and income in rural farming households (Figure 26). Among nonfarm and diversified households, middle age household heads (40-59) seem to fare better, probably reflecting the impact of experience on productivity and incomes.

Figure 25. Rural Households by Age Group and Activity, 2019, Percent
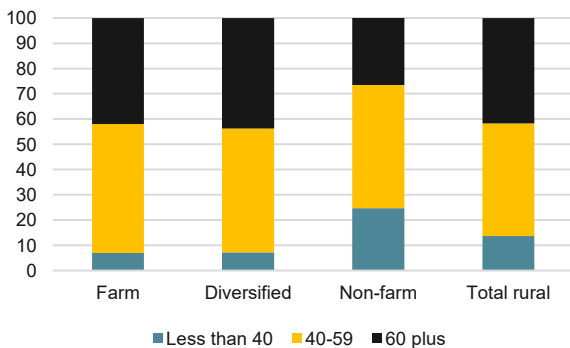
Source: SES 2019.

Figure 26. Average Annual Income of Rural Households by Age Group and Activity, 2019, USD
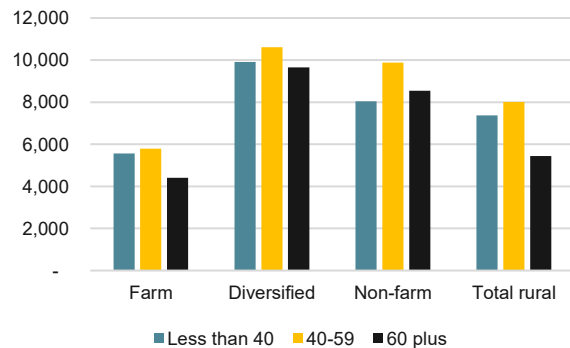
Source: SES 2019.
Note: Income excludes transfers.

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Besides aging and low education, rural households face a number of challenges that hold back their income growth. These challenges include lack of access to water, exposure to risks from climate change and COVID-19 pandemic, lack of on-farm diversification, low and declining productivity, fluctuation of farm profits, high debt, low assets, lack of well-defined property rights of farmland, small size of farmland, low adoption of farm digital technology. Details of these challenges will be discussed in the following sections.

2.2.1 Challenges of farm households

Water access

Low and unequal access to water has been one of the key challenges for Thai farming households. Using farmer registration data, Attavanich et al (2019) show that 58 percent of farm households cannot access any water source and only 26 percent have access to irrigation systems (Figure 27A). This situation has been persisting over time. Farmers in the Southern region suffer the most from limited access to water: only 23 percent of farm households in the region have access to water sources and 10 percent can access irrigation systems. In the Northeast, 26 percent of farm households can access water sources and 13 percent can access irrigation systems. Farmers in the Northeast are the most exposed to drought risks because the region has the largest proportion of farm households and much lower rainfall than in the South. Large, medium and smallholders all suffer from limited access to water, though medium and large farmland holders in the North seem to fare better than the rest (Figure 27B).

Figure 27. Access to Water Sources of Farm Households

A. Access to all water sources
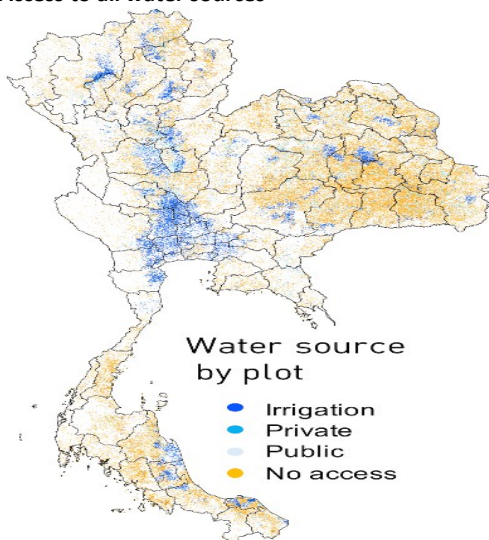
B. Access to water by farm size, Percent.
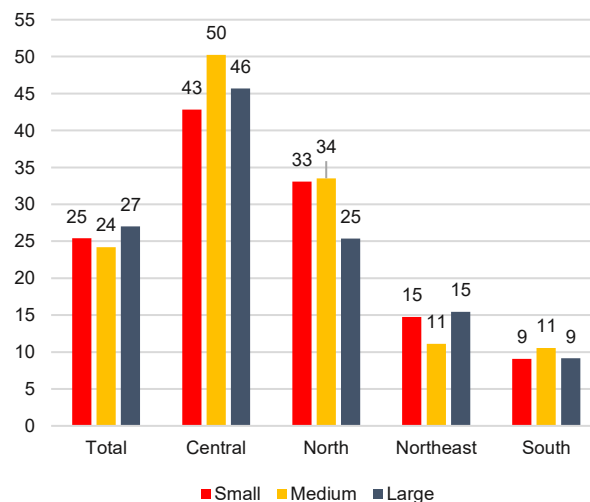
Source: Attavanich et al (2019) & 2019/2020 OAE Socio-Economic and Labor Survey.

Climate risks

Farmers face large losses due to drought and floods. Data from 2006-2020 DOAE database on disaster affected agricultural areas show large agricultural losses due to climate disasters, mainly droughts and floods. Losses from drought are more frequent due to limited access to water and irrigation systems.

Figure 28. Disaster Affected Agricultural areas, 2006-2020, Rai
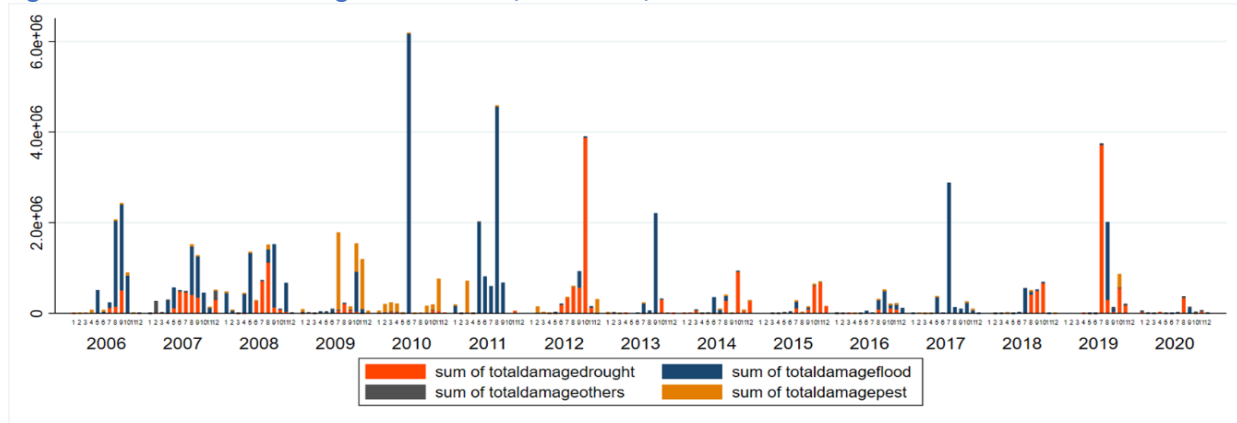
Source: Estimates from Department of Agricultural Extension (DOAE) database.
Note: A *rai* is a unit of area equal to 0.16 hectares and is used in measuring land area for a cadastral map.

Climate shocks appear to be increasingly concentrated in the Northern part of the country. The Northeast followed by the North have been the most affected regions by natural disasters, particularly drought (Figure 29). The figures are consistent with results from a study by German Watch, which ranked Thailand 9th in the world in terms of the largest damage from climate risk in 2021, with the country staying within the top 10 for six years since 2015 (Eckstein, Künzel & Schäfer, 2021). Small-sized farms, in particular, could be more affected than mid-sized and large farms by climate change due to lower access to modern machinery, lower income and higher debt-to-income ratios (Attavanich 2017).

Figure 29. Proportion of Agricultural Areas by Province that are Affected by Disasters, 2015-2020, Percent
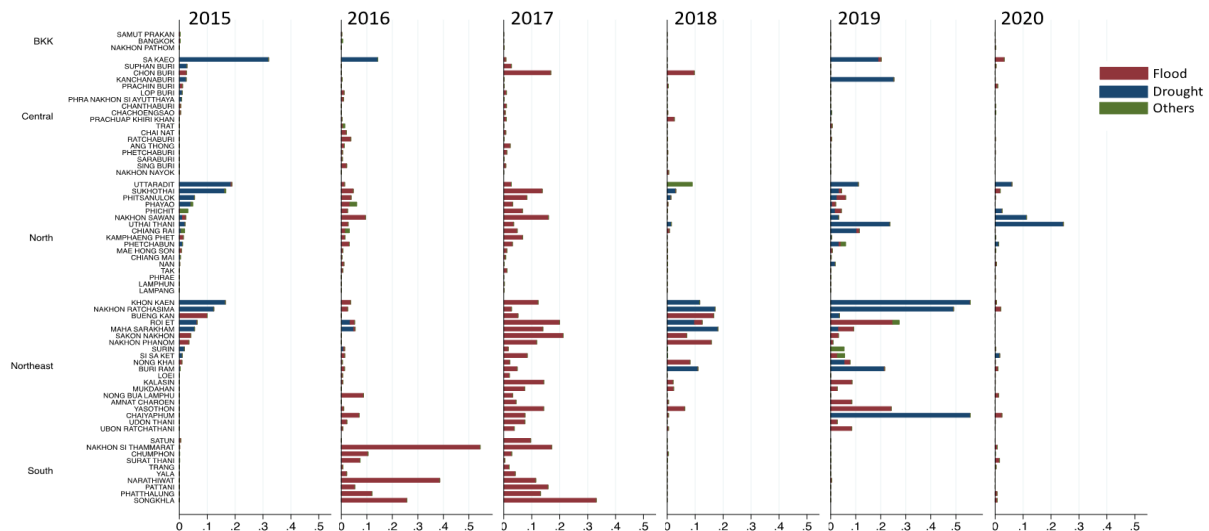
Source: Estimates from Department of Agricultural Extension (DOAE) database.

Impacts of COVID-19

The COVID-19 pandemic has affected rural households significantly and could result in long-term scarring effects on households. Various studies have shown that the pandemic has resulted in significant economic impacts on both urban and rural households especially on income, consumption, assets and investments. Impact and recovery have also been largely unequal, especially among those who were poor and were vulnerable before the pandemic. As such, the pandemic could result in long-term consequence,

particularly with respect to the disrupted education system, the debt overhang problem as well as asset and skill losses when businesses closed down.

Farm households have faced important income losses due to COVID-19 crisis which may leave longer-term damages. Over 50 percent of households experienced a decline in their incomes due to the COVID-19 crisis. However, the severity of the impact varied considerably between households and by income sources (Figure 30). While most households experienced a reduction in farm and non-farm wages, about 29 percent of households faced a reduction in their agricultural incomes due to obstacles in selling their products. Most of these obstacles were related to disruptions in the transportation system due to quarantine measures, and changes in the sale channels and in consumers behavior who switched to buying from supermarkets instead of community markets. This stresses the importance of supporting farmers' adaptation to these changes and of developing an efficient logistics system. The reduction in incomes has resulted in a decline in consumption, with 25 percent of households experiencing a decline in their food spending, though rural farm households have been able to smooth their consumption by consuming their own agricultural production. Due to income decline, about 60 percent households reported difficulties in paying their debt and more than 20 percent reported having to borrow from informal institutions, which suggests long-term scarring effects (Chantarat et al., forthcoming). These findings are consistent with results from a study by Attavanich (2020) which shows that income of farm households decreased significantly during the first wave of COVID-19. The study also found that farm households in the North experienced the largest drop in income compared to other regions.

Figure 30. Impacts of COVID-19 on Farm Households, 2020, Percent

A. Impact on household income

B. Impact on household expenditure

C. Impact on household's ability to service debt
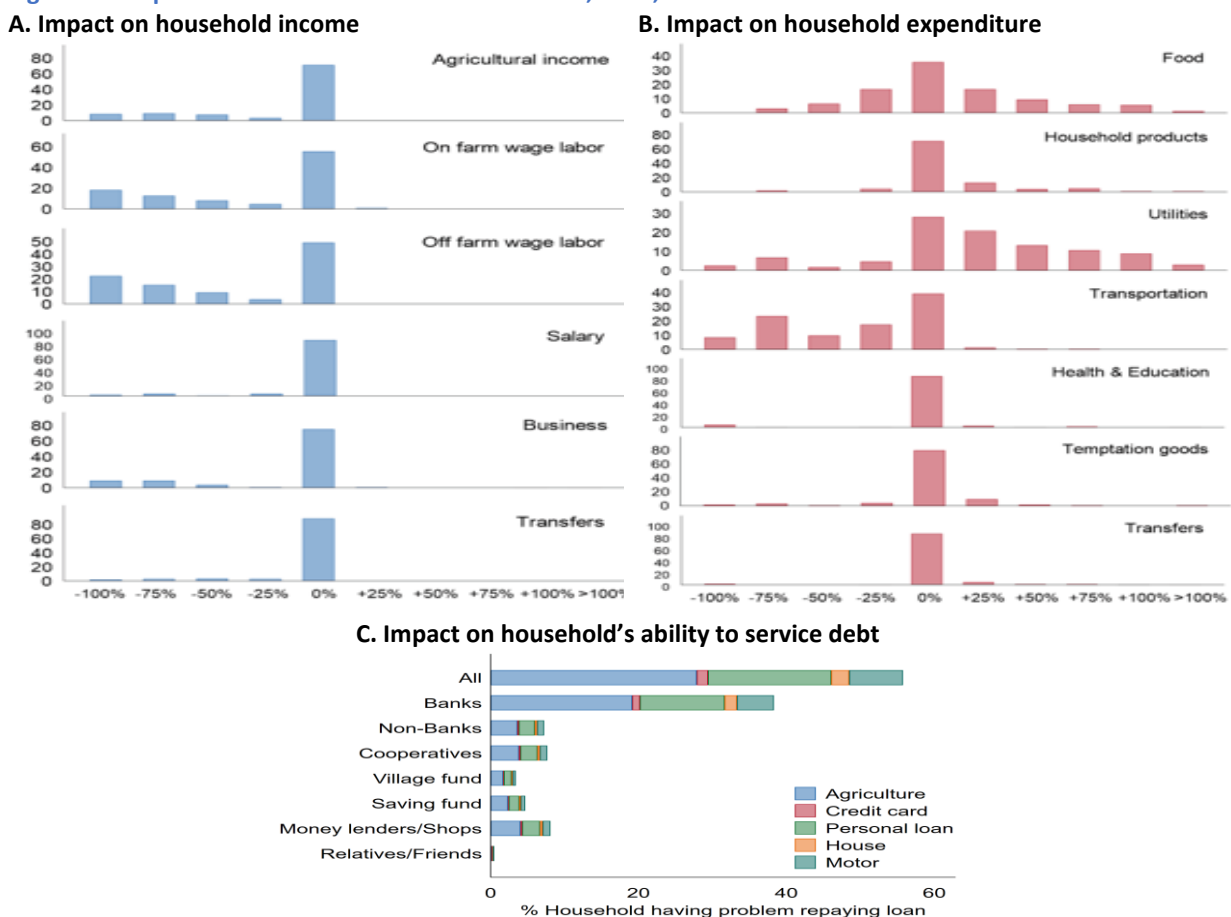
There are large variations in terms of market integration and gains from trade in agricultural markets. Attavanich et al. (2019) studied the distribution of farmgate prices at farm-level and their co-movement with world (export) prices for Thailand's key agricultural products. Figure 31 shows large variations across crops. Markets appear to be highly co-integrated for paddy rice and rubber, and less so for the rest. For paddy rice in particular, the data show a large gap between world and farmgate prices, reflecting that farmers are still not capturing large gains in the value chain.

Figure 31. Co-Movement and Gaps between Export and Farmgate Prices of Some main Agricultural Products, 2009-2018, Baht per Ton

A. Jasmine Rice

B. Paddy Rice

C. Maize

D. Rubber
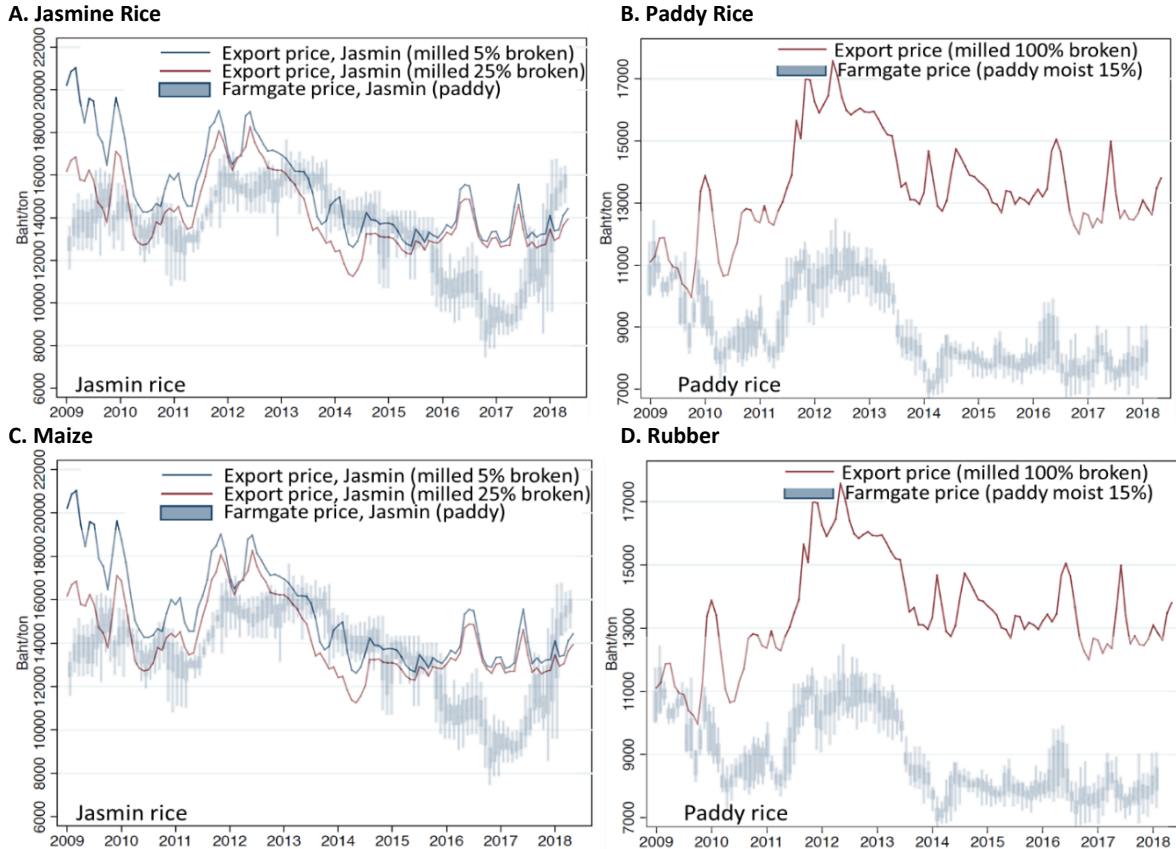
Source: Attavanich et al. (2019).

There are also large variations in market competition, which determines the extent to which households can capture value added shares throughout the value chain. Using the rice market as an example, Attavanich et al. (2019) reveals large variations in market competition with respect to the distribution of rice millers and access capacity by area (Figure 32). In addition, while competition has been high in the Central region, allowing farm households to gain more from trade and value chain, it has been relatively low in other parts of the country.

Figure 32. Degrees of Access to Rice Markets

A. Correlations of export and farmgate prices, 2009-2017
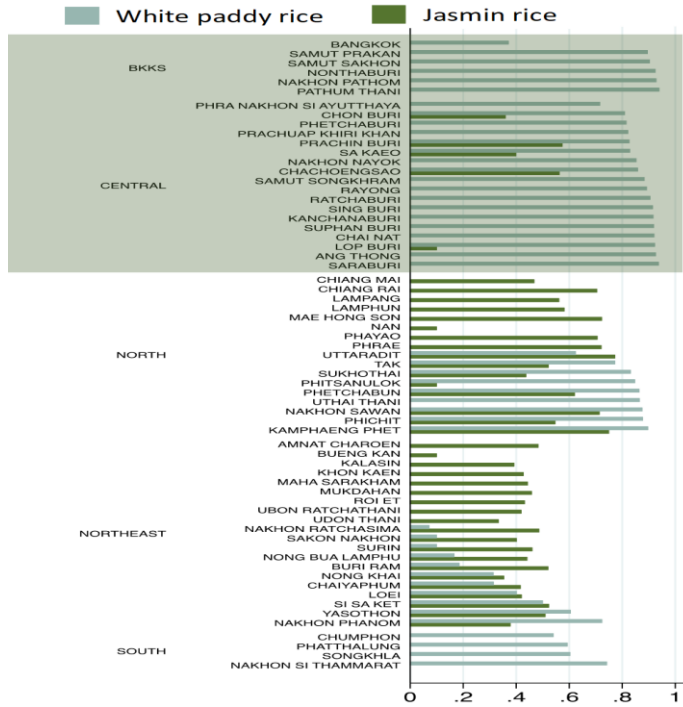
B. Miller location by capacity, 2018
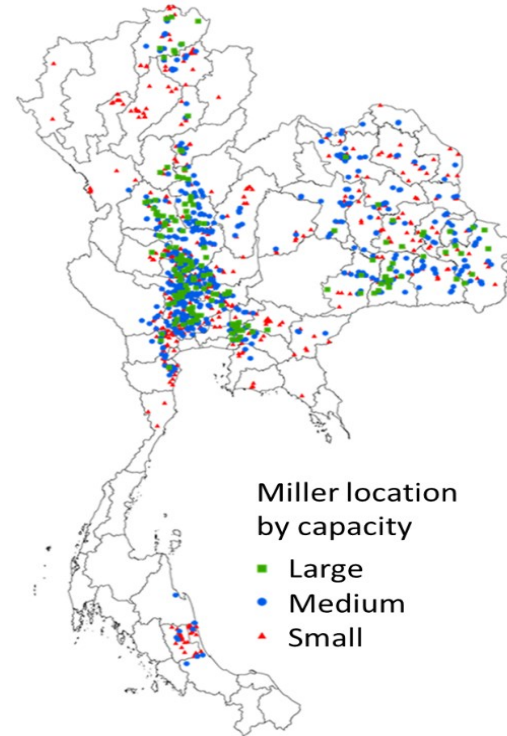
C. Ratio of miller capacity to rice production, 2018
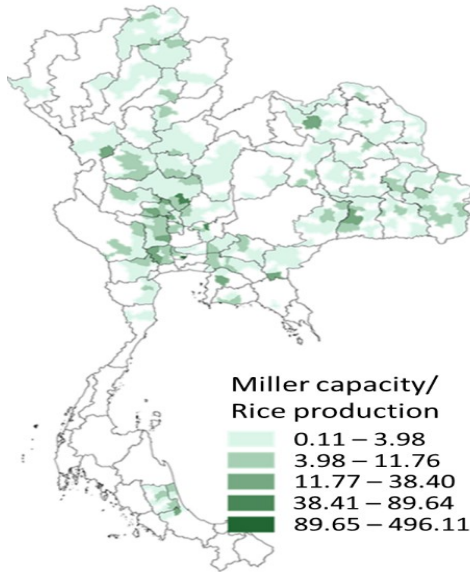
D. Shortest distance from plot to miller,2018, km
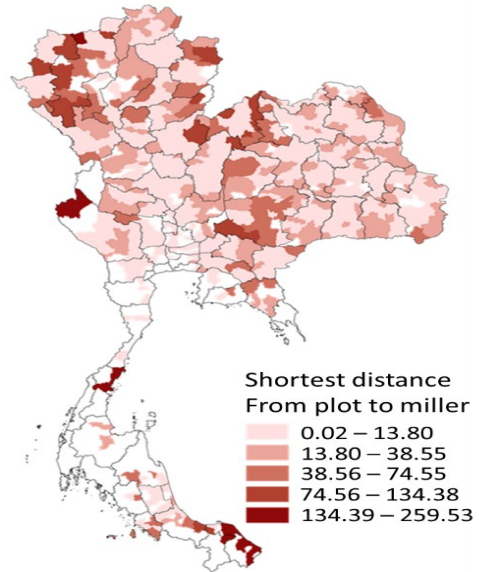
Source: Attavanich et al. (2019).

Farming Profits

Profits from farming have declined substantially and even turned negative for the country's main crops due to a combination of increasing inputs costs, declining productivity and increasing risks. Using the socioeconomic survey from the Office of Agricultural Economics (OAE), Attavanich et al. (2019) show a substantial decline during 2006-2018 in the net profits of Thailand's main economic crops (Figure 33). Moreover, for the majority of crops, net profits have become negative during the past 4-5 years. These

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declines are due to climate risks, low competition in the output markets, rising input costs and declining productivity. The latest research from USDA (2021) also reveals that Thailand's agricultural total factor productivity (TFP) has been very low over the past decade, and was surpassed by India, Indonesia, and Vietnam. Finally, data from the OAE Socio-Economic and Labor Survey show that the profit per rai (excluding the opportunity costs) of small, medium and large farms dropped 51-53 percent during crop years 2011/2012 and 2019/2020.

Figure 33. Farming Profits from Various Crops, 2006-2018, THB
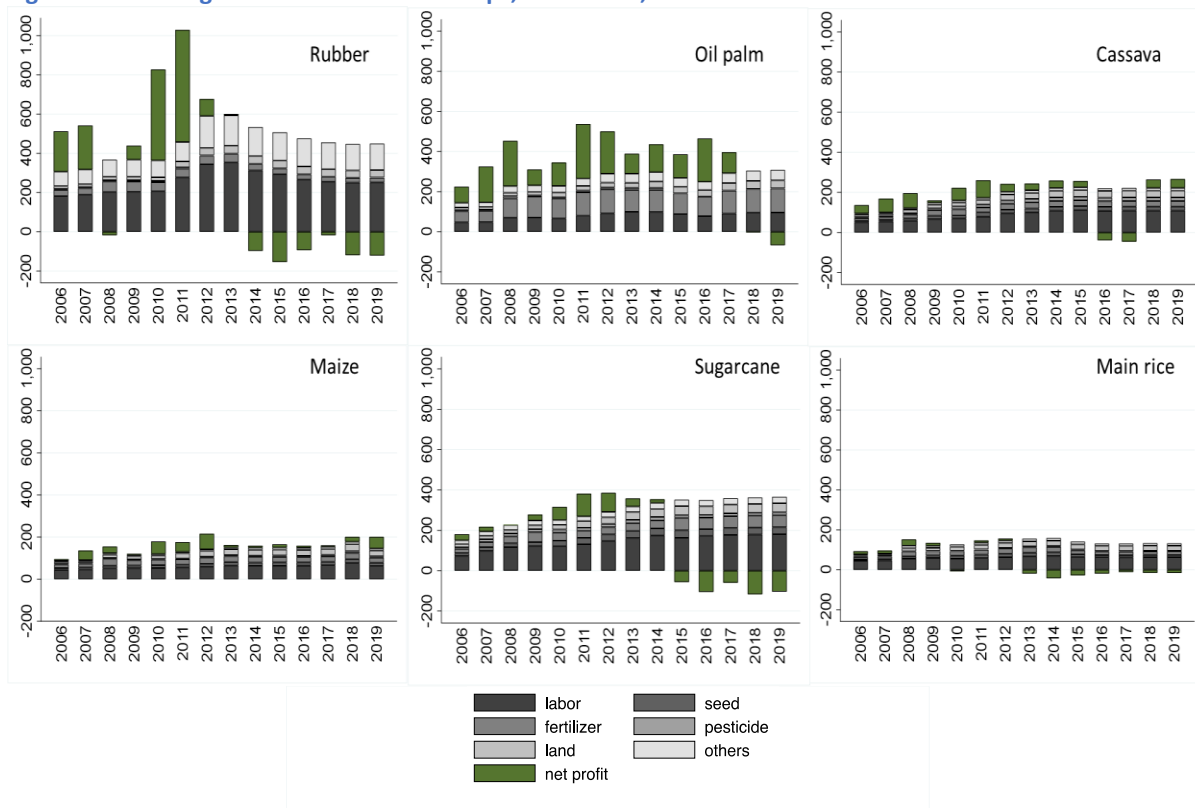
Source: Attavanich et al. (2019)

Farm portfolio

The majority of Thai farm households still rely on monocultures and on the country's major crops, reflecting less adaptability and less resiliency to shocks due to the lack of on-farm diversification. Figure 34 shows that the majority of Thai farm households still rely on monocropping, particularly on the six main agricultural products (rice, glutinous rice, rubber, cassava, maize and sugarcane), and this pattern has been fairly similar across four years of data. Moreover, the average number of farm activities declined from 2.4 to 1.4 activities between 2003 and 2018. Regionally, the South has the highest percentage of farm households that are dependent on monoculture at 74 percent, followed by the Northeast (72 percent), Central (68 percent), and North (59 percent). The high dependency on monocultures reflects the long-standing problem in Thai agriculture, where majority of farmers are less adaptive and less resilient to shocks (e.g., climate variability, diseases and price fluctuations) due to lack of on-farm diversification. Despite this, Attavanich (2019) shows that there is a small, but increasing, number of households engaging in organic or sustainable agriculture.

Figure 34. Farm Portfolio Diversification, 2016-2019
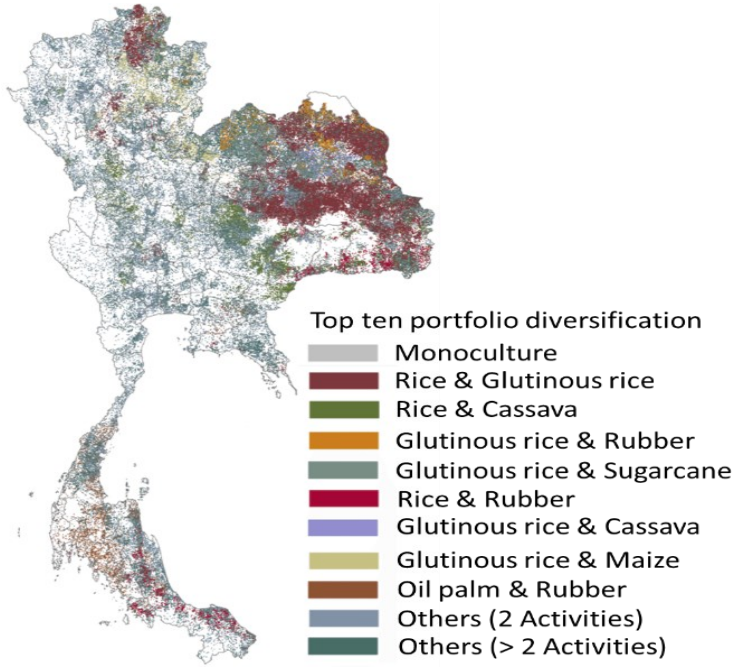
Source: Attavanich et al. (2019)

Human capital

Rural farm workers have lower education levels compared to rural non-farm workers. While workers with higher levels of education were able to take advantage of structural changes, moving to the non-farm sector, lower educated workers remained in agriculture. The share of farm workers who completed at least Grade 9 has remained low at 32 percent in 2020 (Figure 35A). At the regional level, farmers in the Northeast had the lowest level of education, with less than 30 percent of all farm workers having graduated at least Grade 9 in 12 out of the 26 provinces (Figure 35B).

Figure 35. Educational Attainment of Workers, 2001-2020, Percent

A. Educational attainment of non-farm workers
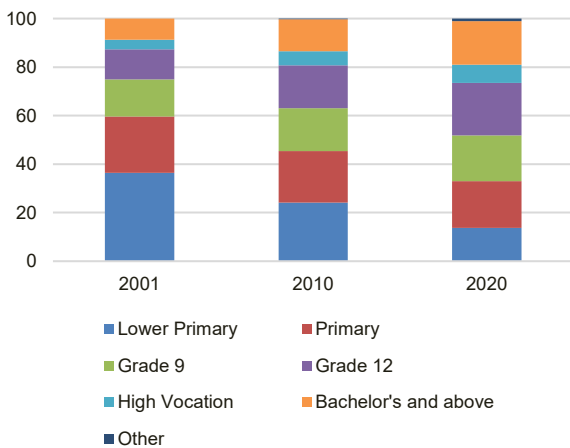
B. Educational attainment of farm workers
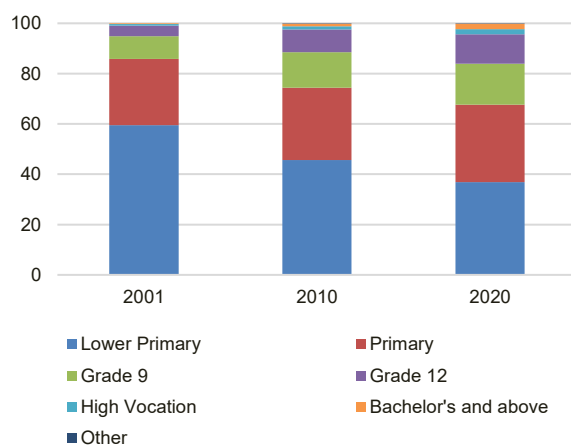
C. Proportion of non-farm workers with at least Grade 9 by province
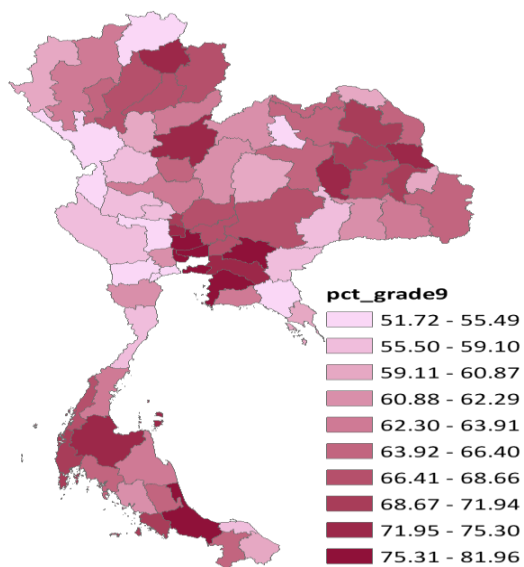
D. Proportion of farm workers with at least Grade 9 by province

pct_grade9
- 51.72 - 55.49
- 55.50 - 59.10
- 59.11 - 60.87
- 60.88 - 62.29
- 62.30 - 63.91
- 63.92 - 66.40
- 66.41 - 68.66
- 68.67 - 71.94
- 71.95 - 75.30
- 75.31 - 81.96

pct_grade9
- 20.20 - 23.69
- 23.70 - 26.44
- 26.45 - 28.93
- 28.94 - 30.61
- 30.62 - 32.09
- 32.10 - 34.19
- 34.20 - 36.52
- 36.53 - 39.65
- 39.66 - 44.74
- 44.75 - 49.71
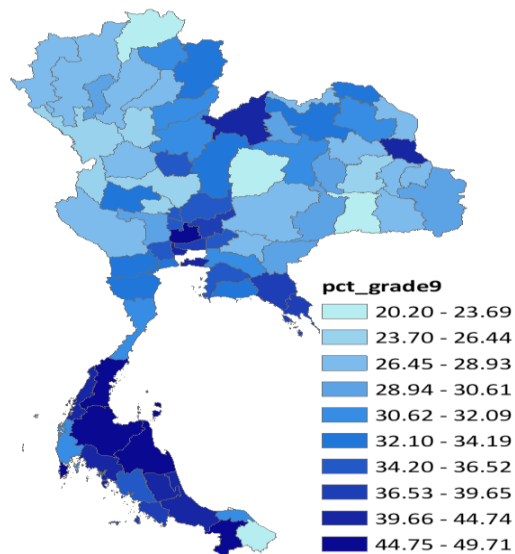
Source: LFS 2001-2020.

Households savings and debt

Assets are low relative to debt, especially among farm households. Figure 36 shows the distribution of liquid assets and total debt (formal, semi-formal and informal institutions) using a survey of 720 nationally representative farm households for 2019-20 (Chantarat et al., forthcoming). Overall, data show that, on average, farm households have 3.4 loans at an average debt outstanding of USD 13,200. Among the top two sources of loans are the Bank of Agricultural and Agricultural Cooperatives (BAAC) (60 percent) and the Village fund (16 percent), with 35 percent of farm households borrowing from informal institutions.

Figure 36. Total Debt and Liquid Assets per Household, 2019, in Million THB
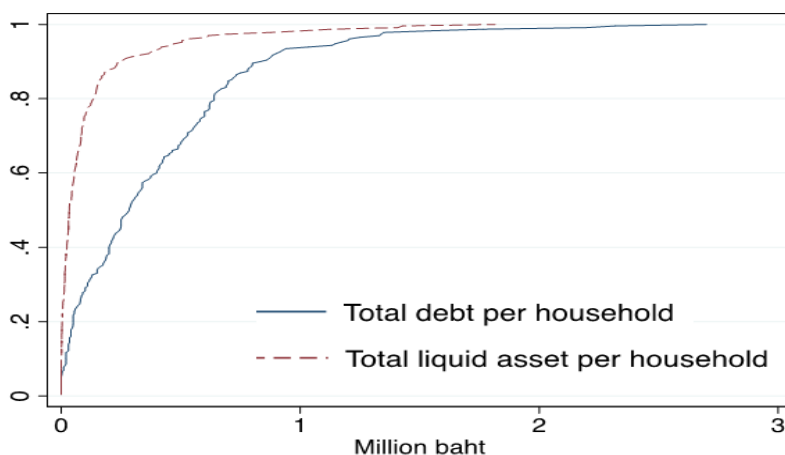
Source: Chantarat et. al. (forthcoming).

Farmland holdings

Most farm households are smallholders, which presents challenges in raising incomes and accessing credit as well as in benefiting from economies of scale. The average farm size per household is around 2.3 hectares, although more than 50 percent of farm households have farm sizes less than 1.6 hectares

(Figure 37) (Attavanich et. al. 2019). Farm households in the North have the largest average farm size, at 2.6 hectares followed by those in the Central (2.4 hectares), South (2.1 Hectares) and Northeast (1.9 hectares). In addition, the farm size per household have declined between 2003 and 2017.

Figure 37. Farmland Holdings of Farm Households, 2003-2017, Hectares

A. Cumulative distribution of farmland overtime
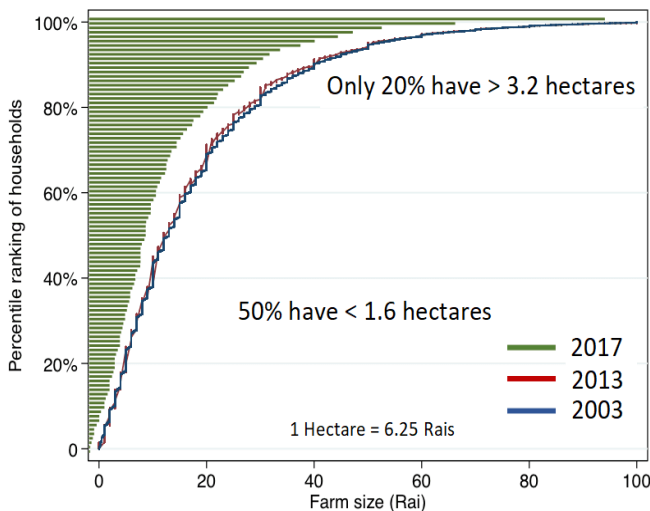
B. Size of farmland at the plot level
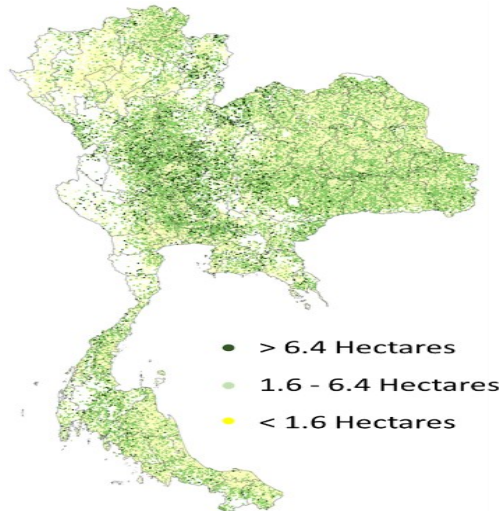
Source: Census 2003 and 2013, Farmers' registration 2017.

Tenure security of farmland

Weak tenure security has been one of the challenges among farm households in Thailand. Attavanich et al (2019) shows that only 60 percent of farm households have full ownership of land. In particular, farm households in the Central region have the lowest share of fully-owned land, accounting for 58 percent of total farmland. The Central region appears to have the largest amount of rented land for agriculture as shown in Figure 38A. Households without land ownership are distributed across all regions, particularly in the highlands and forests (Figure 38B).

Figure 38. Ownership of Farmlands, 2003-2018

A. Types of Farmland Ownership, 2018
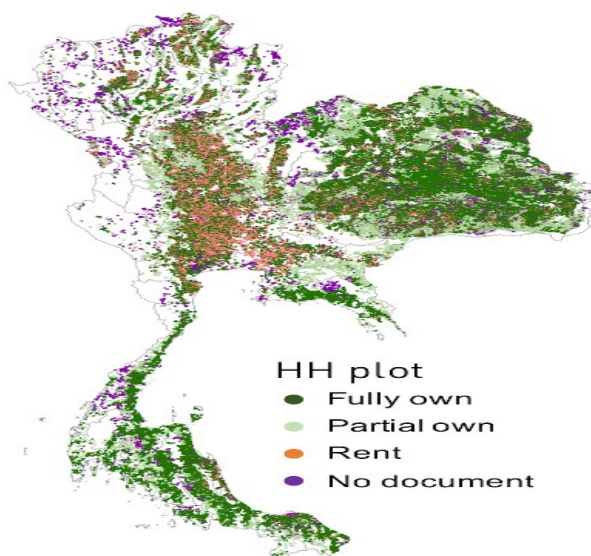
B. Proportion of fully owned farmland by region, 2003-2013, Percent

Source: Census 2003 and 2013, Farmers' registration 2017.

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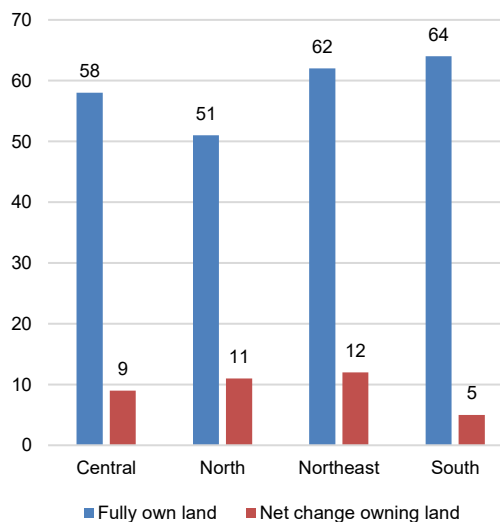
Adoption of modern machine and digital applications

Farm households have been moderately adopting modern machine. Attavanich et al. (2019) reveals that 60 percent of farm households used at least one type of modern machine in 2013. However, the ratio of small farm households using the modern machine to total small-farm households was less than that of medium-farm and large-farm households (Figure 39A). The ratio was the highest for households growing sugarcane (0.817) followed by maize (0.748), cassava (0.747), rice (0.721) and rubber (0.608) as shown in Figure 39B. In recent years, more farmers have been using modern machines due to the growth of machine renting markets, allowing smallholders to use modern machines without having to put up a large investment.

Figure 39. Farm Households' Adoption of Modern Machines, 2013, Percent

A. Ratio of modern machine use by farm size
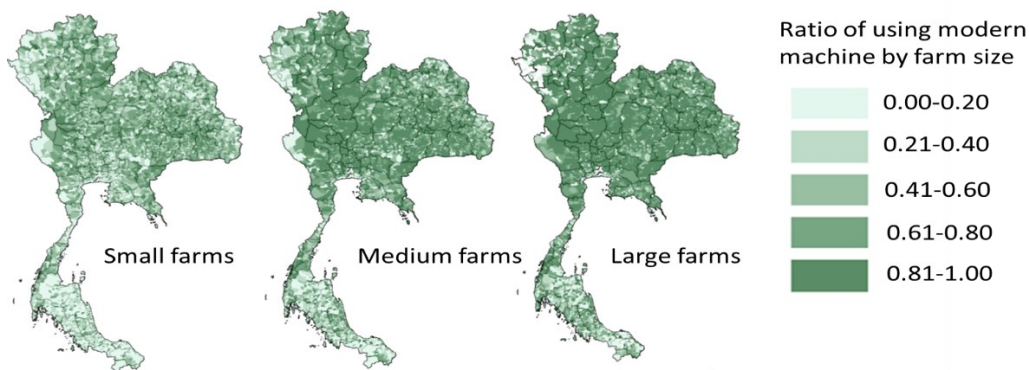
B. Ratio of modern machine use by activity
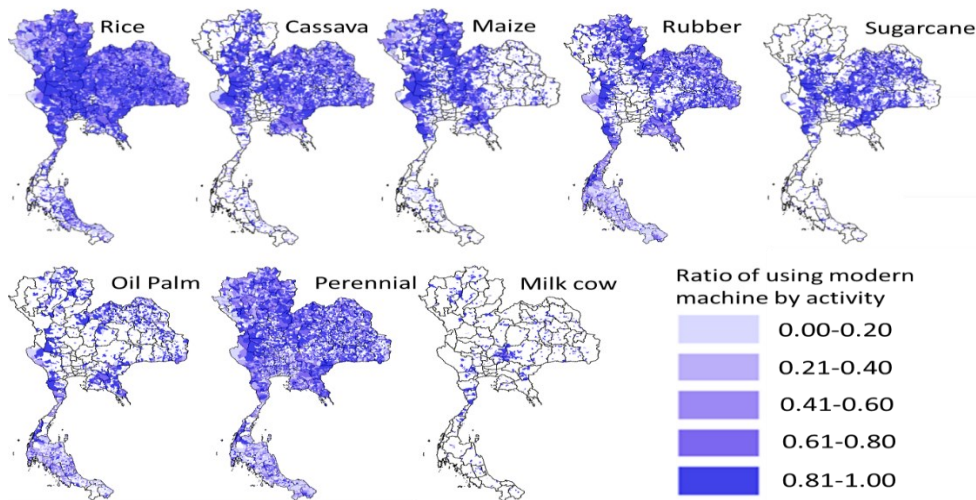
Source: Attavanich et al. (2019).

Although the pandemic accelerated the adoption of digital farm applications, a large share of farm households still does not use them for farming. Attavanich et al. (2022) conducted a countrywide farm survey in 2021 which revealed that 40 percent of farm households have adopted at least one farm-related digital application (Figure 40). Although this is an improvement from 2020, when the percentage of adoption was 26.7 percent (Attavanich 2020), a considerable share of farm households continues to resist using digital farm applications on their farms. Difficulty in understanding and in using digital applications

were the two main cited reasons for non-adoption. In addition to the relatively low uptake, quality of use could also be improved, as majority of farm households have only applied the digital farm application in 1-3 out of 9 potential uses, and with only 6 percent of total farm households using precision farming technologies.

Figure 40. Farming Households' Adoption of Digital Applications, 2021, Percent

A. Number of farming purposes

B. Reasons for not adopting applications
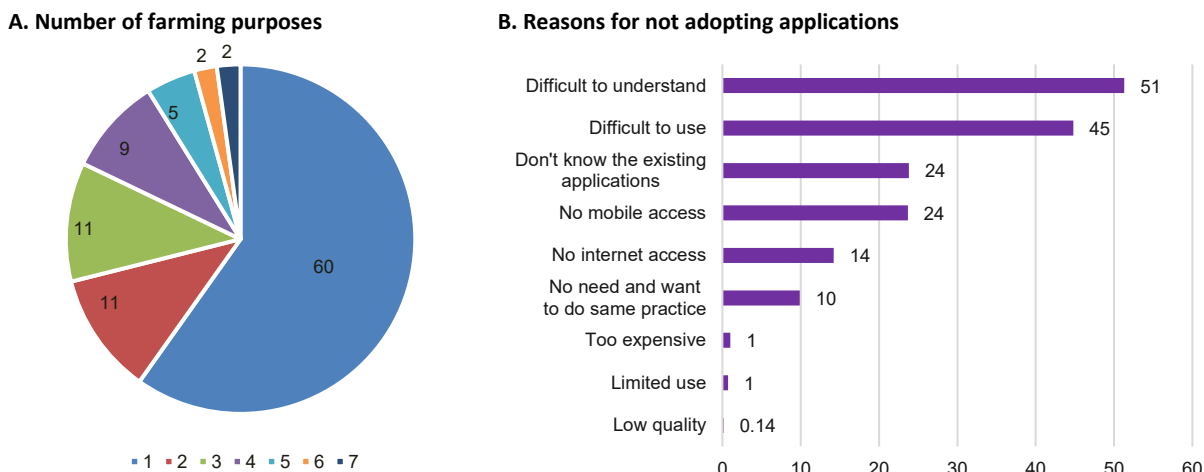
Source: Attavanich et al. (2022)

2.2.2 Challenges of non-farm households

Climate risk

Climate shocks have also negatively affected non-farm households. The Great Flood in 2011 was one of the worst floods on record, and non-farm households in 64 provinces were affected by it. For example, the flooding in 7 industrial estates in Ayutthaya and Pathum Thani provinces negatively affected non-farm households due to the shutdown of factories. Swiss Re Institute (2021) points out that heat stress from global warming is a key issue in Thailand since it can reduce the labor productivity of non-farm workers and hence, their income. They also predict that climate change will adversely affect the Thai tourism industry, which is an important source of employment for non-farm households.

Impacts of COVID-19

COVID-19 pandemic also adversely affected non-farm households, particularly those in the informal sector. Komin et al. (2021) shows that the COVID-19 pandemic adversely affected informal sector workers, with about 95 percent of survey respondents reporting that they faced economic insecurity because of diminished income. To compensate for reduced income, informal workers withdrew savings and increased their debt. Paweenawat and Liao (2021) also reveals that females in the informal sector were particularly affected by the crisis, as well as low income groups.

Women in the informal sector were particularly impacted by a lack of social insurance. Only 5 percent of the population had social insurance coverage which include unemployment benefits (Paweenawat forthcoming). The covered population was mostly composed of workers in the formal sector, as informal workers were eligible but had to apply and make contributions. As women in informal work are among the least educated and earn low wages, only a small share of women were covered by safety nets when the pandemic hit. In addition to this, women were often unable to earn alternative incomes due to an increased care burden as well as greater domestic obligations that accompanied lockdowns (Paweenawat forthcoming).

Household debt and saving

Rising household debt and low savings are prominent problems of Thai households. Using loan data from the National Credit Bureau (NCB), Chantarat et. al. (2020) reveals that the debt headcount (i.e., the share of the population that have at least one loan from a formal institution) rose from 18 percent to 29 percent between 2009 and 2020, while the delinquency headcount rose from 16 percent to almost 2020 in the same period. Overall, 49 percent of borrowers (from formal institutions) are from rural areas, accounting for about 40 percent of total debt outstanding (Figure 41). Figure 42 further shows that around 17 percent of rural households have debt, and about 24 percent of rural borrowers have delinquent debt Chantarat et. al. (2020). While the debt headcount in rural areas are lower than in urban areas, debt per borrower and delinquency headcounts are larger compared to urban areas.

Figure 41. Dynamics of Household Debt and Delinquency, 2010-2020
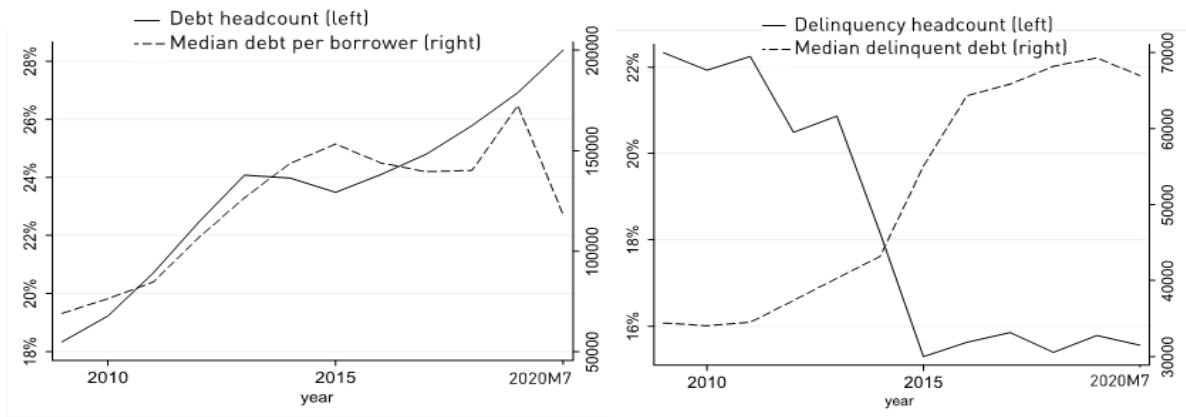
Source: Chantarat et al. (2020).
Note: Debt delinquency occurs when a borrower misses a payment on a loan.

Figure 42. Debt Headcount and Delinquency Headcount, 2020 – Quarter 4, Percent

A. Debt Headcount Q4 2020   **B. Delinquency Headcount Q4 2020**
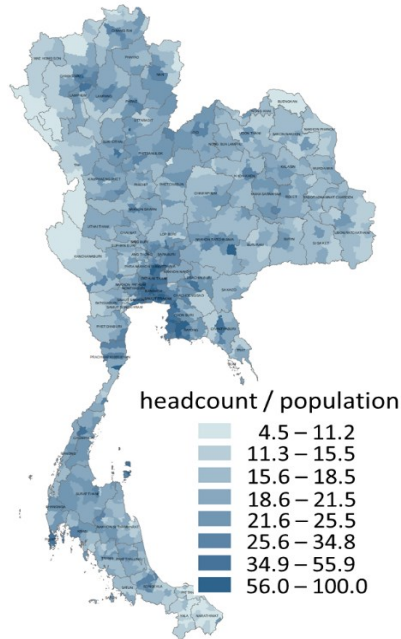
headcount / population
- 4.5 – 11.2
- 11.3 – 15.5
- 15.6 – 18.5
- 18.6 – 21.5
- 21.6 – 25.5
- 25.6 – 34.8
- 34.9 – 55.9
- 56.0 – 100.0

delinquency headcount / population
- 4.2 – 9.5
- 9.6 – 11.9
- 12.0 – 13.7
- 13.8 – 15.5
- 15.6 – 17.3
- 17.4 – 20.0
- 20.1 – 23.9
- 24.0 – 31.0
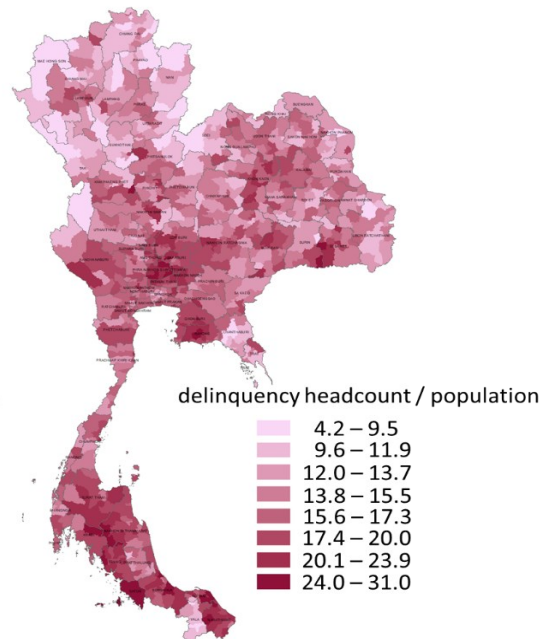
Source: Estimates from National Credit Bureau Data.

Savings and financial assets of households have been low relative to debt, especially in rural areas. The median of household's total liquid assets, which include savings in formal and semi-formal financial institutions, as well as other forms of liquid assets such as gold, is about USD 2,600 based on data from the Thailand SES 2020. This makes median debt per liquid asset of around 2.25.

The debt-to-income ratio of non-farm households in the rural areas has increased over time. Data from the SES show that the debt of non-farm households rose from 2015 to 2019. The increasing debt has surpassed the income of rural non-farm households. As a result, the debt-to-income ratio of non-farm households increased from 1.03 in 2011 to 1.20 in 2019. Regionally, non-farm households in the Central region faced the greatest debt problem, having the highest and fastest growing debt-to-income ratio compared to other regions from 2011-2019 (Figure 43). With the Central region having the highest percentage of non-farm households to total households, the debt problem of non-farm households appears to be very serious.

Figure 43. Debt-to-Income Ratio of Non-farm Households, 2011-2019
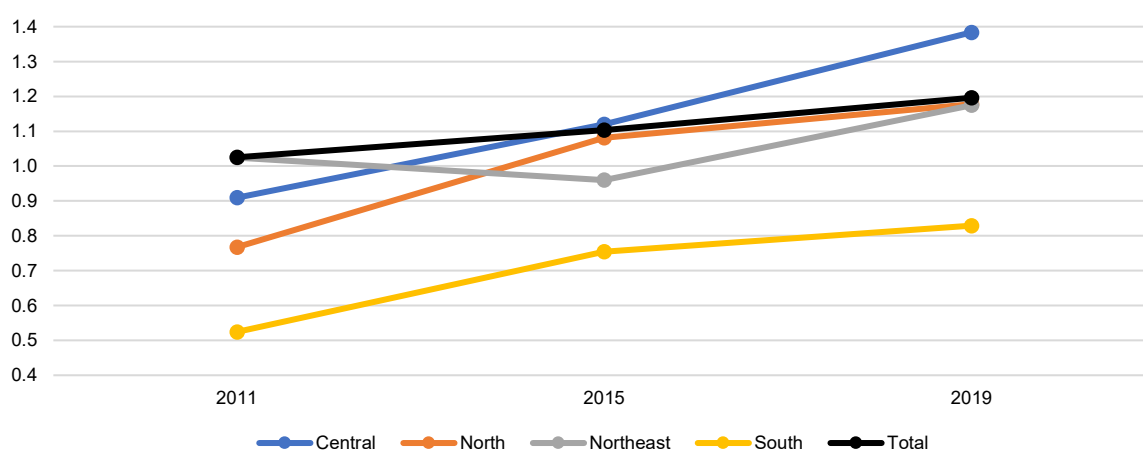
Source: SES 2011, 2015 and 2019.

Technology disruption

Advancements in technology necessitate the upskilling and reskilling of workers. Interviews with key stakeholders in the agro-food industry, which largely employ non-farming workers, reveal that operators in the industry are increasingly using automated machines and as a result non-farm workers who are not able to update their knowledge and skills are more likely to lose their jobs (Attavanich et. al. 2021). By studying the potential impact of computerization and reshoring of firm operations, Lekfuangfu and Nakavachara (2020) estimate that approximately one-third of existing jobs could be at risk. While new jobs may be created, workers would need to upskill or reskill to avail of opportunities.

Internet access

The COVID-19 pandemic has accelerated access to the internet and online trading via e-commerce in all rural regions. At the national level, the share of rural households with access the internet increased from 69 percent in 2019 to 86 percent in 2021, with the South and Central regions having the highest share of households that have access to and connect to the internet (Figure 44A). With increased internet access, the share of households buying online consumer goods (such as clothing, shoes, medicines, furniture, cooking and ready-to-eat meals) rose from 8 to 14 percent between 2019 and 2020 for rural households, and from 14 to 22 percent for urban households (Figure 44B). While increased access to the internet

provides market opportunities for both rural farm and non-farm households, it also creates a challenge for households who are not able to adjust to or utilize online trading platforms.

Figure 44. Access to the Internet and e-commerce, 2019-2021, Percent

A. Household access to the internet
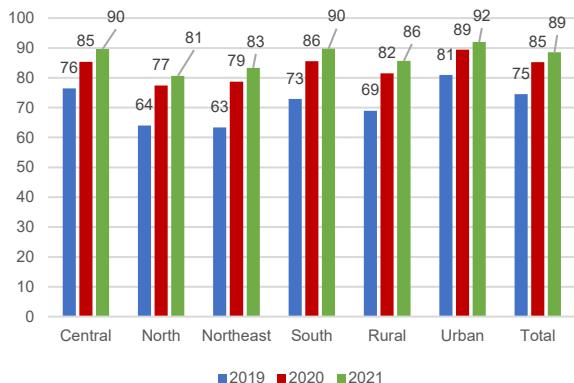
B. Household purchase of consumer goods from online shop
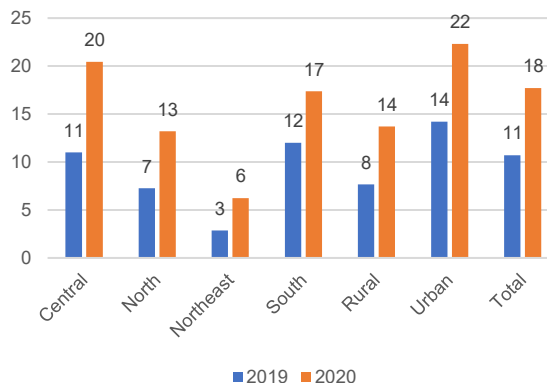
Source: Thailand NSO 2019-2021 and SES 2019-2020.

Limited access of villages to main roads

Almost half of villages do not have year-round access to the main roads. At the national level, only 60 percent of total villages are able to access the main road all year. The lack of access to main roads has created a challenge for both farm and non-farm households in accessing input and output markets due to high logistic costs leading to low net profits from business and farming. Villages in the Northeast had the lowest year-round access to the main road (56 percent) followed by those in the North (59.3 percent) and South (67.7 percent). The top five provinces where villages have the lowest access to the main road are Uthai Thani, Prachinburi, Tak, Nakhon Sawan, and Nong Khai (Figure 45).

Figure 45. Village Year-Round Access to the Main Road, 2013-2019, Percent

A. Access to main roads, 2019, Percent
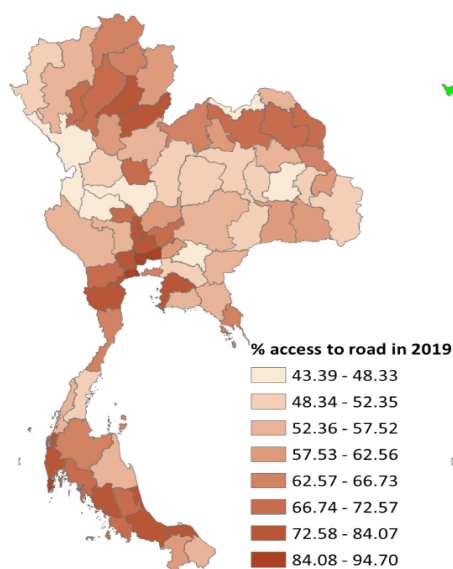
B. Change from 2013-2019

Source: NESDC (2021).

40
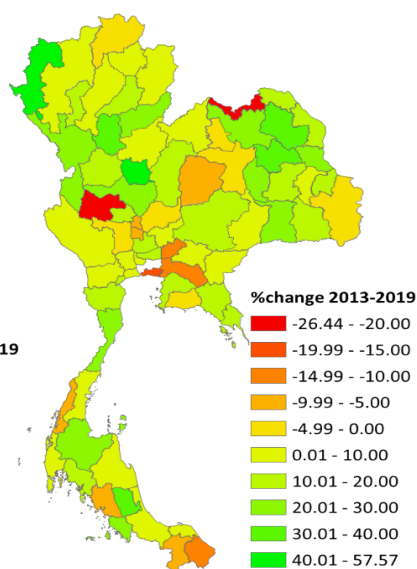
III. Opportunities and constraints

This section examines the key opportunities to increase rural incomes and the potential constraints that affect the realization of these opportunities. Specifically, this section considers where opportunities lie in increasing agricultural productivity, diversifying to higher value crops and the benefits of improving access to markets. The constraints that hinder the realization of these opportunities are then explored, which include the risks from climate change, the lack of access to markets as well as the inefficient use of water resources, among others.

3.1 Opportunities for income growth

Evidence in the report points to three sets of opportunities to enhance income growth. These include: increasing agricultural productivity, supporting diversification to higher value crops, and improving access to markets.

3.1.1 Increasing agricultural productivity

Improved access to irrigation water

Improved access to irrigation water would offer opportunities for farmers to raise crop yields. Irrigation water is an important factor in increasing agricultural productivity and crop diversification. In Thailand, high investment costs have prevented the development of large and medium-scale irrigation systems to provide greater access to irrigation water to a larger number of farmers who continue to be dependent on dryland agriculture. Only 42 percent of farm households are able to access water resources and only 26 percent have access to irrigation systems (Thai Ag Sector UN 2020). Farm households dependent on rain grow crops only in the rainy season and leave their farmland fallow during the dry season. Improved access to irrigation systems offers opportunities for farmers to cultivate year-round, increase their crop yields, diversify to horticulture and other high value crops, and thus increase their farm returns.

Use of improved inputs and modern technologies

There is significant room to improve the adoption of technology to raise agricultural productivity. This includes the use of improved climate resilient seeds and fertilizers and good agricultural practices, especially for rice as well as the use of digital applications and modern machinery in farming. With the migration of youth to non-farm sectors and cities, low birth rates and an aging rural population as well as the increased minimum wage, rural labor shortages and costs have increased. Increased access to agricultural machinery can help farmers overcome some of these problems and increase their productivity and efficiency. This would also enable farmers to achieve higher margins while allowing them to release labor for other activities to diversify their incomes.

The moderate use of modern machinery in farming further highlights the potential to increase agricultural productivity. While 60 percent of farm households used at least one type of modern machinery in 2013, the share of small farm households that utilized modern farm equipment was considerably less than medium and large farm households. Several studies have revealed that the adoption of modern farm machines can increase both yield as well as farm income (e.g., Benin, 2015; Yi, 2019; Pochanasomboon, 2020; Nguyen et al., 2020). A recent study by Pochanasomboon (2020) finds that the adoption of modern farm machines for rice farming had positive effects on small-sized farms—increasing their rice yield, improving annual farm income as well as reducing debt-to-income ratios (Table 1).

Table 1. Impact of Modern Farm Machines' Adoption on Rice Farming in Thailand

Types of rice farming	Change in yield per hectare (kg./hectare)	Change in Income (USD)	% Change in Debt-to-income ratio
Small	306***	1,289***	-20**
Medium	212***	1,767***	-36
Large	62	3,083***	-25*
Aging	165***	2,391***	-24**
Non-aging	231***	2,805***	-24*

Source: Pochanasomboon (2020)

Note: Outcomes are estimated by propensity score matching with kernel matching using the rice farm sample in the Agricultural Census of 2013. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level.

Analysis using data from the Agricultural Census reveals that there are several factors which raise the probability of adopting modern farm machines. Probit regression using 2003 & 2013 data from the Agricultural Census revealed that there are several key factors which influence the decision to adopt modern farm machinery (Appendix Table A.1). In particular, findings reveal that there is a need to enhance farmers knowledge in using modern machines. Encouraging consolidation among smallholders and promoting collaboration among farmers as members of agricultural institutions (such as cooperatives and farmer groups) as well as promoting diversification of farm production and improving irrigation systems could also increase the probability of adoption of modern farm machines.

In addition to these factors, digital technology could also enable greater adoption of modern machines by farmers. Digital technology can provide a platform for farmers to participate in the sharing economy, which allows the sharing of production factors such as tractors and other farm equipment among many actors. While rental markets and other means of sharing equipment are available, the ability of farmers to coordinate over a trusted digital platform has the potential to lowers costs. This could be particularly beneficial for smallholder farmers, who would be able to access productivity-enhancing equipment that would otherwise be too expensive.

The geographically concentrated nature of crop production in Thailand provides a conducive environment for the sharing economy. Using farmers' registration data, Attavanich et. al. (2019) shows that highly concentrated farming systems created economies of scale that stimulated gains from the sharing economy, especially as it allows smallholder farmers to access modern machines and technologies (Figure 46A). The increasing emergence of tractor sharing markets in the country is one example of the potential of the sharing economy in agriculture (Figure 46B).

Figure 46. Cropping patterns and use of modern machinery

A. Concentration of planting crops, 2018   B. Use of tractor classified by ownership, 2013
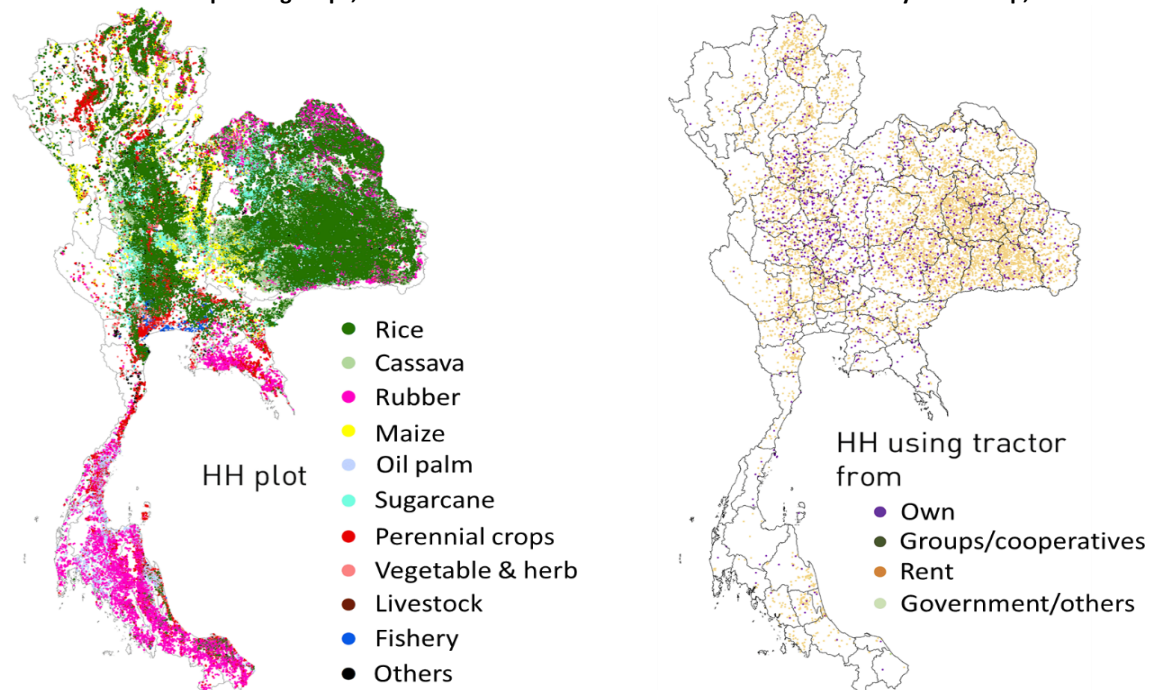
Source: Attavanich et al. (2019)

While digital technology provides opportunities to raise productivity, adoption rates in the country are still currently low. At the national level, only 40 percent of farm households have adopted digital applications for farming. However, adoption rates in the country vary widely by region—farm households in the Northeast had the lowest adoption followed by the South and the North (Figure 47).

Figure 47. Adoption of Digital Farm Application, Percent
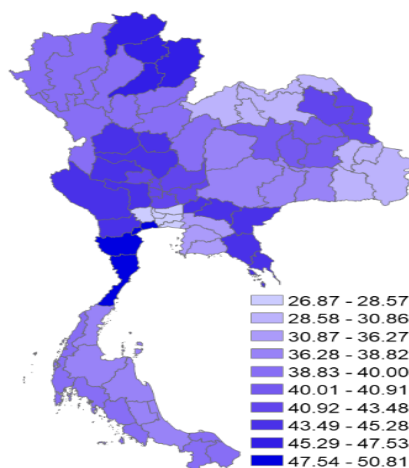
Source: Attavanich et al. (2022)

Recent studies provide evidence that the income of farm households could be improved by the adoption of farm digital technology. Using propensity score matching on the farm survey conducted in 2020, Attavanich, Pipitpukdee, and Sonthi (2021) investigated the impact of the adoption of agricultural digitalization on the farm income of smallholders. They found that the adoption of agricultural digitalization improved the annual income of farm households between USD 5,520-6,194 before the

emergence of COVID-19 pandemic, which was higher than it was for non-adopting farm households. Their study also reveals that after the emergence of the COVID-19 pandemic, an adopting farm household was projected to receive a higher total annual income between USD 2,133-3,083 than it was for non-adopting farm households. These findings show that the adoption of digital farm applications can help improve farm incomes significantly. Kassie et al. (2011) also confirms that the adoption of agricultural technology has been associated with higher earnings and lower poverty. Together, these findings suggest that the adoption of digital farm applications could accelerate income growth in the rural economy.

There are a multitude of factors that positively influence the decision to adopt digital farm applications by farm households. The results of the probit regression show that the use of digital farm applications could be expanded by the reskilling and upskilling of farm households. The probability of using digital applications could also be increased if: 1) household heads do not work full time and 2) farm households rent in the farmland (see Appendix Table A.2 for more details).

Improved agriculture extension and information services

Improving training and information services can be critical in promoting the adoption of modern technologies. Increased use of digital technologies can help promote the use of precision agriculture approaches and e-extension. Agricultural extension workers could use digital applications to efficiently serve a larger number of farmers. Extension services, such as soil testing geo-tagged to the farm location, combined with weather information, could provide customized information on optimal fertilizer applications. Agriculture extension systems can leverage digital applications, for example, a disease identification app that uses a smartphone camera and artificial intelligence (AI) technology to identify pests and diseases and provide advice on how to control them.

Improved tenure security

Improving tenure security could also enhance farm productivity. Empirical evidence shows that promoting farmland tenure security in Thailand could improve rice yields by 116–127 kg/hectare for small-scale farms and by 52–71 kg/hectare for midsize farms. The land rental market in Thailand is typically on an annual lease basis, which creates disincentives for renting farmers or those who only have use rights to the land to make long term investments This would include using modern machinery and equipment and on-farm irrigation systems (e.g. drip irrigation). For example, certificates of land tenure with SPK401, NS2, STK and PBT status give the right of a farm household to use the land, but ownership is not attached to the household and the land cannot be used as collateral. With an SPK401 certificate, farm households are not allowed to sell their land and it can only be transferred to an heir of the farm household. If farmers are not able to use these lands as collateral, they have limited access to much-needed credit. Although the certificate of land tenure with SPK401 can be used as collateral in a special case, farm households generally obtain a loan of 50 percent of the appraisal value from the Bank for Agriculture and Agricultural Cooperatives. Improving tenure security can therefore improve farmers' access to finance and medium to long-term farm improvement and investments.

3.1.2 Diversification to higher value crops

Rice production has played a dominant role in the Thai economy and the world's export market. Not only is it the staple food for Thai people, it also employed 3.5 out of 8 million farm households. Thailand is the second largest rice exporter in the world market, generating export revenues of USD 3.688 billion in 2020 (UN COMTRADE 2021).

However, Thailand's rice yield has been low relative to its peers. According to USDA (2021), Thailand's rice yields have been low compared to global rice producers over the past decade (Figure 48A). Across regions, the Northeast and South have the lowest average yield of 2.21 and 2.99 metric tons/hectare (MT/ha), respectively. Provinces with the lowest yield of rice includes Sa Kaeo, Bueng Kan, Khon Kaen, Sakon Nakhon, Nong Bua Lamphu, Buriram, Sisaket, Roi Et, Nakhon Ratchasima, and Ubon Ratchathani as demonstrated in Figure 48B. In addition, the Global Yield Gap Atlas (2021) reveals that the actual and potential yields of rice were stagnant from 2009-2017, with potential yields more than two times higher than the actual rice yield. The actual rice yields in irrigated areas (*YA_Irrigate*), as shown in Figure 48C, was approximately 4 MT/ha, while potential rice yields in irrigated areas (*YP_Irrigate*) ranged from 8.7-10.5 MT/ha. For rainfed areas, the actual yield (*YA_Rainfed*) and potential yield (*YW*) were around 2.5 MT/ha and 5.6 MT/ha, respectively.

Figure 48. Comparison of Thailand's Rice Yield with Peers and Potential, 2010-2022

A. Comparison of Thai Rice with Peers Over Time, MT/Hectare
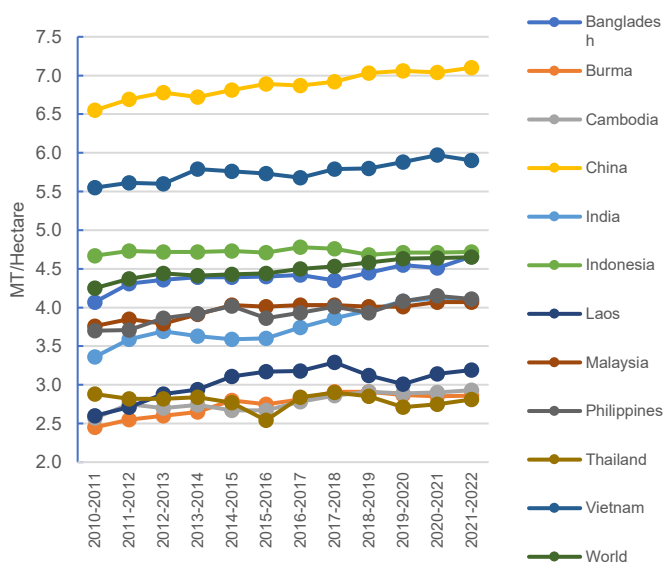
B. Harvested Average Rice Yield
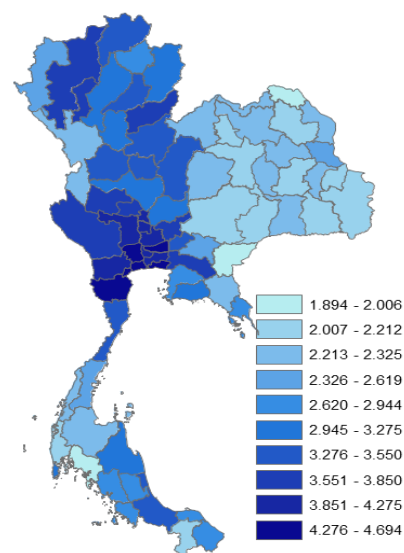
C. Comparison of Actual Rice Yield and its potential, MT/Hectare
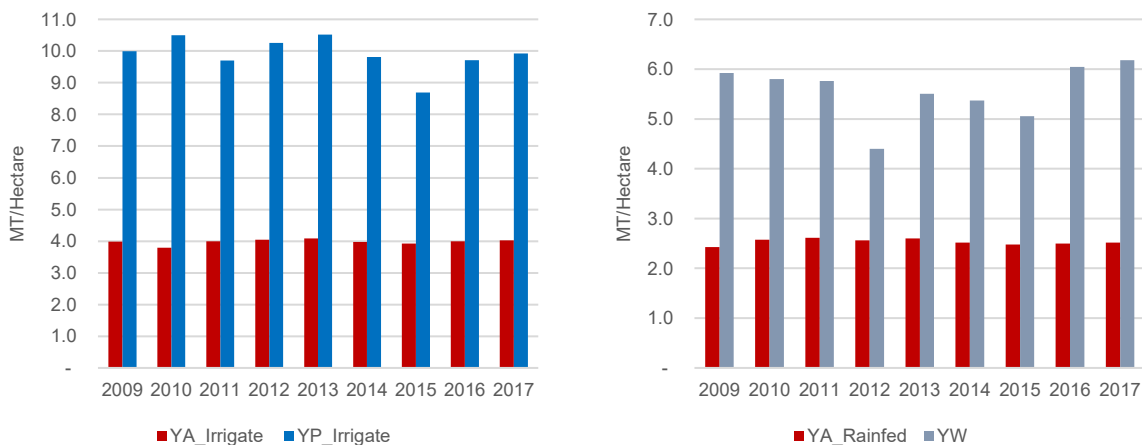
Source: USDA (2021), OAE (2021) and Global Yield Gap (2020).

The efficient use of limited irrigated areas could widen the opportunity for income growth. Despite only 26 percent of farm households having access to the irrigation system, observational data reveals that the

majority of irrigated areas rely on monocultures, with planting paddy rice accounting for 66.4 percent of total irrigated areas and other field crops accounting for 9.9 percent of total irrigated areas (Figure 49A). At the national level, growing rice in irrigated areas provide low returns, and has resulted in negative net revenue from 2013-2019 (Figure 49B). In comparison, diversified cropping and crop rotation could yield a higher return on assets at the same risk level as monocropping (Attavanich et. al. 2019). Recent findings from Prommawin et al. (2022) also reveal that higher temperature negatively affects the value of agricultural output, and that households engaged in multiple production activities are better insulated against the consequences of higher temperatures.

Figure 49. Share of Activities and Net Revenue in the Irrigated Area plus Return and Risk of Portfolios

A. Share of Activities in the Irrigated Area
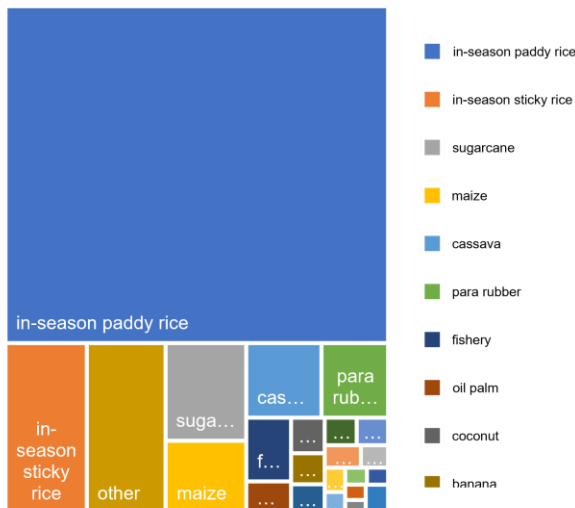
B. Net Revenue of In-Season Rice, 2008-2019, USD/ton
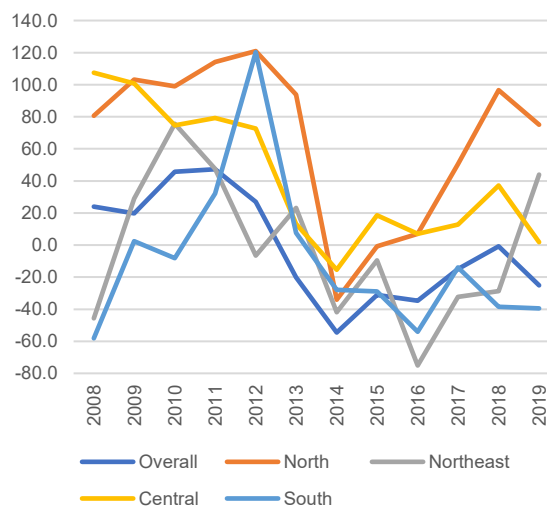
C. Top Diversified Portfolios and Monocropping
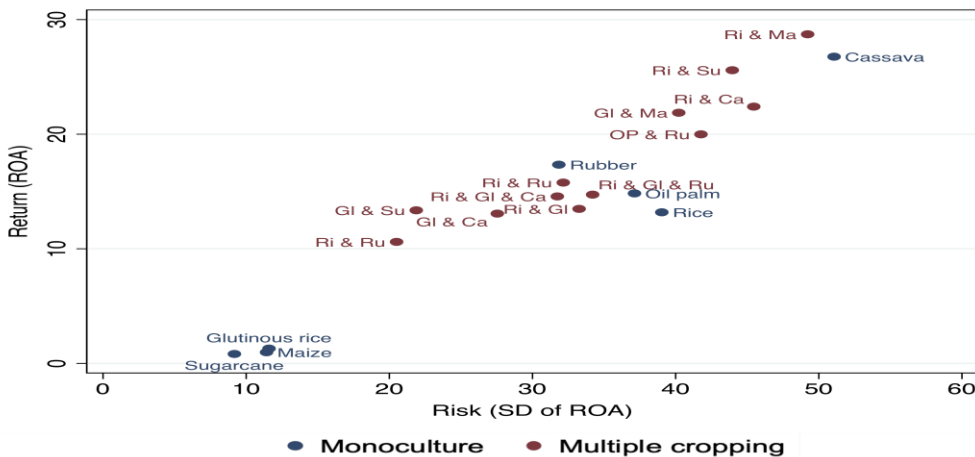
Note: RI = Rice, GI = Glutinous rice, Ru = Rubber, Ca = Cassava, Ma = Maize, Su = Sugarcane, OP = Oil palm. Calculated from agricultural household survey (2549/50-2559/60) collected by the Office of Agricultural Economics

Source: Attavanich et al. (2019)
Note: Planted area of activities are averaged during crop year 2009/2010 - 2019/2020.

Growing crops that are agro-ecologically suited for the land also opens up opportunities to improve productivity and farm income. At the national level, there are 41.5 out of 134.6 million rais, accounting for 31 percent of planted areas for 13 major economic crops including rice, that had low levels of land

suitability capturing both soil suitability and water availability. Attavanich (2018) developed the Thai Agricultural Sector Model (ASM) and projected that reducing this mismatch between crops and land suitability could improve both crop yields and total economic welfare. The economic welfare of producing in-season rice, cassava, and maize is expected to increase as shown in Figure 50.

Figure 50. Total Economic Surplus with and Without Policy Addressing Mismatching of Land Use, USD

Legend: ■ Base 2025 ■ Zoning 2025
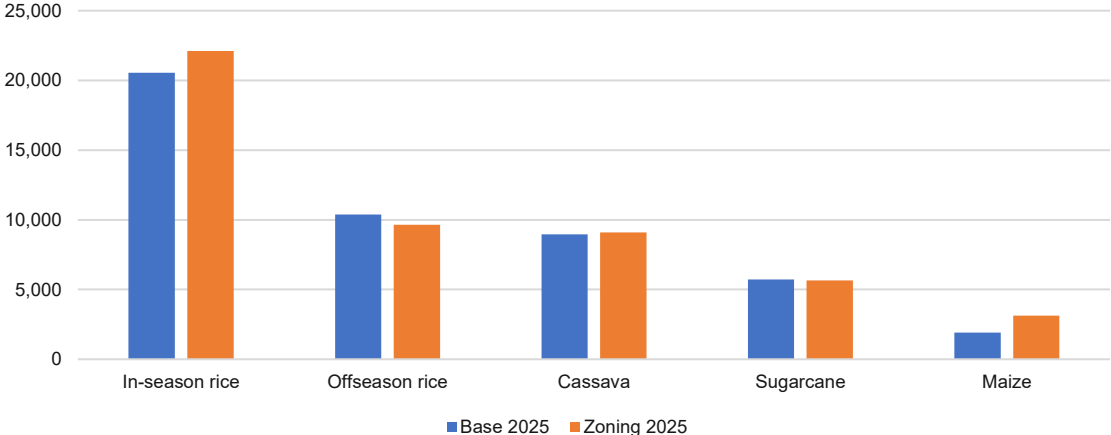
Source: Attavanich (2019).

There are several factors which influence crop diversification. Analysis from SES data for 2009-2020 show that the probability of crop diversification increases with the education of the household head (graduated at least grade 9). It is also higher if the head worked full time on farm, if the household has at least one young farmer, has larger or multiple plots, has access to water from various sources and is member of a cooperative organization. These findings indicate opportunities to promote greater diversification (see Appendix Table A.3 for more details).

Analysis also reveals several factors which influence the decision to grow high value crops. Analysis using OAE dataset show that having a small farmland, not participating in market distortionary policies (such as rice mortgage), having access to water sources (aside from water providers), having a large number of plots as well as participating as a member of a farmer group all increase the probability of growing high value crops (see Appendix Table A.4 for more details).

3.1.3 Improving access to markets

E-commerce and online trading could help widen access to markets by providing a platform that facilitates the efficient matching of buyers and sellers. The expansion of market access could benefit both farm and non-farm rural enterprises. It has the potential to raise employment and incomes, thereby contributing to the development of the rural economy. Sathirathai and Nakavachara (2019) surveyed representative enterprises that sell through e-commerce platforms and showed that trade connection significantly increased, especially from rural areas. It is important to note that the potential benefits of e-commerce could be further bolstered if coupled with efforts to strengthen logistics systems to allow rural enterprises to expand their input and output markets, realize the gains that could accrue from shortening the value chain, and provide opportunities for farmers to move up the agricultural value chain to agro-processing and distribution.

3.2 Key constraints hindering income growth

Evidence points to three sets of constraints which need to be addressed to fully realize the potential to increase rural farm incomes. These constraints are broadly grouped to align with opportunities to raise rural incomes, and are categorized as: constraints to improving agriculture, constraints to diversification and lack of access to markets. It is important to note that many of these constraints have broad and cross-cutting impacts. Notably, climate change will be highly impactful on agricultural productivity, but will also influence planting decisions and farmers' decisions to diversify crops. Similarly, water access and water use are closely linked to both increased productivity as well as farmers' ability to diversify to more water-intensive and high-value crops.

3.2.1 Constraints to improving agricultural productivity

The constraints to improving agricultural productivity include: 1) limited access to irrigation systems and water sources, 2) farm size and tenure security, 3) risks from climate change, 4) ineffective crop insurance, and 5) low levels of agricultural R&D

Limited access to irrigation systems and water resources

The majority of farm households in Thailand cannot access irrigation systems and water resources. Only 42 percent of farm households are able to access water resources and only 26 percent of farm households are able to access irrigation systems (Figure 27). These households are only able to obtain farm income from growing crops in the rainy season and have to leave their farmland unused during the dry season, depriving them the opportunity to earn additional income for the remainder of the year. Farm households in the Northeast have the lowest income compared to other regions. Farmers in the South and Northeast of Thailand suffer the most from limited access to irrigation water. Farmers in the South have the lowest access, but the problem is partially mitigated by higher rainfall, whereas farmers in the Northeast face high exposure to droughts. Even in regions with better access to irrigation water, less than half of farm households have access. As a result, many farm households are not able to maximize the use of their farmland and face limited options for growing suitable higher value crops.

Thailand's water security is lower than peers, and water stress is projected to increase due to future changes in climate and socio-economic conditions. The Asian Development Bank (ADB) constructed a water security index for 49 countries across Asia in 2020, and found that Thailand's water security index was lower than its peers with similar gross national income per capita, ranking 31 out of 49 countries in Asia (ADB 2020). Three aspects of concern were: water-related disaster security, urban water security and environmental water security. ADB also projects that Thailand may need an annual investment of at least 1-2 percent of GDP to improve its water security.

Farm size and tenure security

Most farm households are smallholders and the size of their farms has continued to decrease over time. Small farm sizes could prevent gain from economies of scale for farm and technological investments thus leading to low productivity. These small farms also experience more difficulty in accessing credit and due to low bargaining power with middlemen, the received farmgate prices from products sold will be low. The small size of farmland may not suffice in generating income needed to cover the farm households' living costs thus amplifying the household debt problem. Data from Figure 19 reveals that small farm households have the lowest income levels, on average, compared to medium and large farms. The 2019 SES data shows that small farm households had the highest debt-to-income ratio (1.35) compared to medium (1.14) and large farms (1.00), indicating the challenge of alleviating poverty in rural areas. Mellor and Malik (2017) argue that to address poverty in rural areas for both farm and non-farm sectors it is necessary to increase the productivity growth of small commercial farmers.

Weak tenure security amplifies the inefficient use of farmland. Around 40 percent of farm households do not have full land ownership. Several studies confirm that the lack of tenure security is a key constraint for growth of farm income as it impedes incentives for productive investment (e.g., Feder and Onchan, 1987; Koirala et al., 2016; Pochanasomboon et al. 2020). In Thailand, there are several types of land ownership rights. These are: 1) full ownership rights such as land types with a tile deed and a certificate of utilization (NS5 or NS.3K); 2) other types of ownership which have restrictions on sale or transfer such as a certificate of agricultural land reform (SPK401, NS2, STK and PBT); 3) rented land; and 4) land without a document of identified rights. Except for the first type, households have weak property rights. For example, rented lands are usually for an annual lease, with very few long-term lease contracts. Small farm size and weak tenure security constrain the liquidity of farm households since they can only obtain lower levels of credit when using their farmland as collateral.

Risks from climate change

Impacts of climate change and natural disasters are projected to increase in their intensity in the future and will likely increase water stress, reduce income and increase income variability of rural households. The damage caused by climate change and natural disaster observed is increasing overtime. The sixth assessment report from Intergovernmental Panel on Climate Change (IPCC) (2021) also revealed that future changes in climate will likely post a larger threat to rural households. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in greenhouse gas emissions occur in the coming decades. Global warming could result in increases in the frequency and intensity of hot extremes, marine heatwaves, heavy precipitation and flooding, agricultural and ecological droughts in some regions and intense tropical cyclones. Swiss Re Institute (2021) estimated the future loss of GDP from climate change in 48 countries and ranked Thailand as one of the top five countries that are expected to have the largest decline in GDP in 2048.

Production of major crops in Thailand could be adversely affected by climate change. In addition to existing challenges, which include low access to water, less diversification of the farm portfolio as well as limited ability of farmers to cope with shocks, studies have estimated that climate change will further reduce the future national production of rice by 10 to 13 percent, of sugarcane by 25 to 35 percent and of cassava by 15 to 21 percent without adaption and the adoption of new technologies (Pipitpukdee, 2020; Pipitpukdee and Attavanich, 2020a; 2020b). Production of in-season rice in irrigated areas are expected to increase, while production of in-season rice in the non-irrigated and off-season rice are expected to be adversely affected by climate change. Figure 51 shows that rice production in the Northeast is expected to be most affected by climate change. Sugarcane production and cassava production in all regions are projected to decline under the scenario with high impact of climate change (RCP8.5). Climate change is expected to negatively affect the farm income of 4.42 million households, and increasing risks of income loss for an additional 3.61 million households. Attavanich (2017) also estimates that climate change could create damage to Thailand's agriculture ranging from USD 17.5 billion to 83.8 billion from 2011 to 2045, depending on climate change scenarios.

Figure 51. Projected Impact of Climate Change on the Production of Rice, Sugarcane and Cassava

A. Rice

20.01 – 40.00
0.01 – 20.00
-19.99 – 0.00
-39.99 – -20.00
-59.99 – -40.00
-79.99 – -60.00
-100.00 – -80.00

-10.18%   RCP4.5
-13.33%   RCP8.5

B. Sugarcane

No sugarcane planting
-19.99 – 0.00
-39.99 – -20.00
-59.99 – -40.00
-79.99 – -60.00
-100.00 – -80.00

-24.94%   RCP4.5
-34.93%   RCP8.5

C. Cassava

0.01 – 20.00
No cassava planting
-19.99 – 0.00
-39.99 – -20.00
-59.99 – -40.00
-79.99 – -60.00
-100.00 – -80.00

-14.74%   RCP4.5
-21.26%   RCP8.5
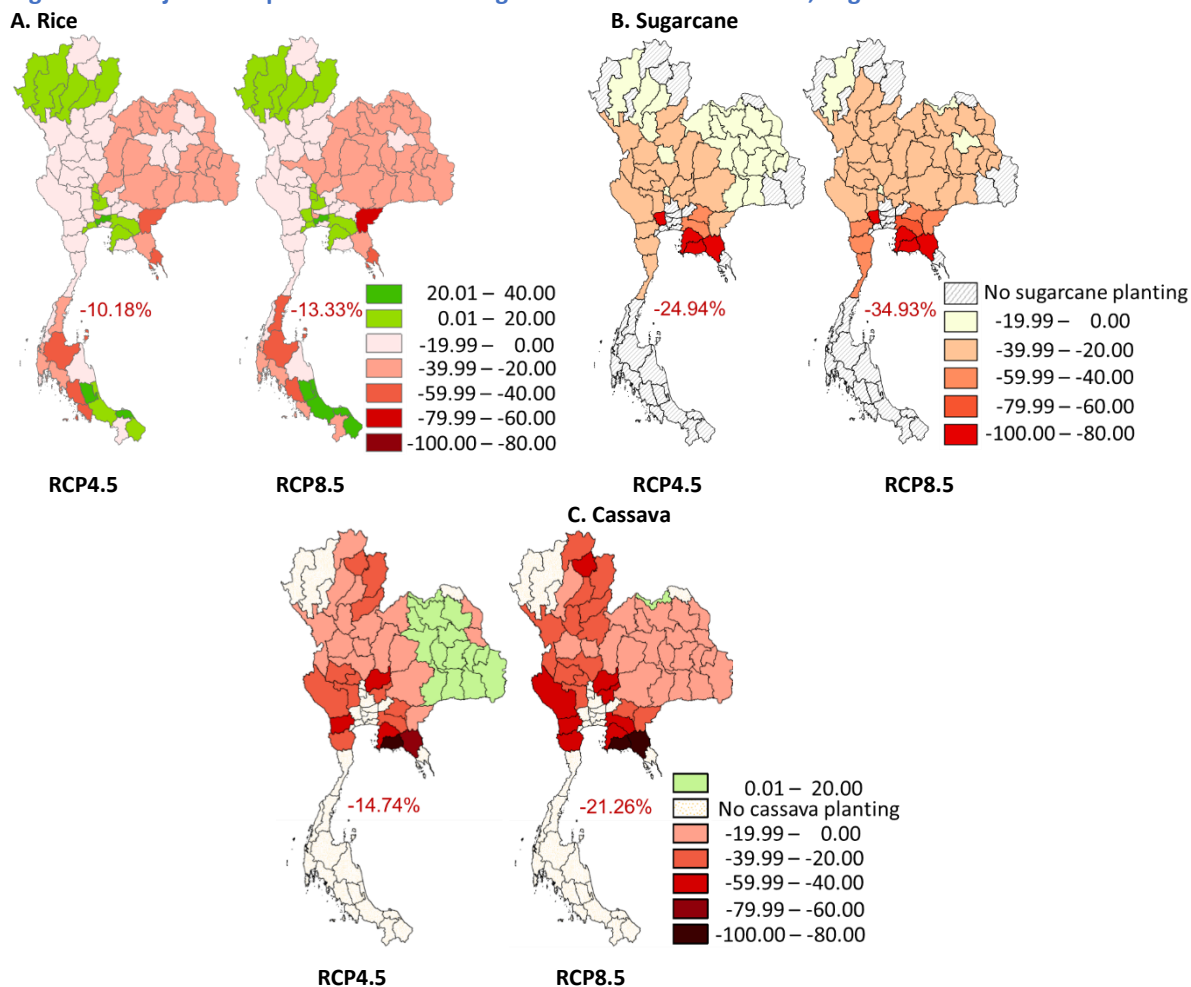
Source: Pipitpukdee (2020); Pipitpukdee and Attavanich (2020a; 2020b).
Note: Percentage changes in 2046-2055 under scenarios from the baseline 1992-2016.

Climate shocks also affect non-farm enterprises. Using Thailand as a case study, Grabrucker and Grimm (2021) showed that rainfall shocks lead to increased input costs for non-farm enterprises in the food processing industry and higher input costs for farmers. Nguyen et al. (2020) also revealed that weather shocks have significant adverse effects on rural household income, consumption and poverty in Thailand, with floods having higher impacts on rural households in terms of income and poverty compared to storms.

Ineffective crop insurance

Although the impacts of climate change are increasing overtime, the current crop insurance program in Thailand has been less effective and far from sustainable. The nationwide rice insurance program has been Thailand's only large-scale and prominent crop insurance since 2011. The program insures about 30 percent of input costs, covers farm losses from 7 calamities including floods, droughts, dry spells, windstorms, forest fire, frost and pest and relies on the government's farm loss assessment for making indemnity payouts. Insured farmers, whose farms are located within the disaster zones and verified by local authorities, would receive both government disaster assistance (30 percent of input cost) and insurance payout (another 30 percent of input cost). The program was subsidized at the rate of 60 percent pre-2015, and 100 percent among BAAC borrowers from 2015 onwards.

There are several potential threats to program sustainability and effectiveness. From the supply side, even with sharp rise in penetration rate to above 50 percent (due to the 100 percent subsidy to BAAC borrowers) and relatively high premium (6.7 to 7.1 percent with a larger scale from 2015 onward), insurers still bear high loss ratios as shown in Figure 52. From the demand side, farmers' willingness to pay for premiums has been extremely low, and the government subsidy that has been the main contributor to premium costs results in high budget exposures (both for disaster assistance and subsidies for the insurance program). In addition, despite the high budget exposures, majority of farmers still did not benefit much from the two safety net programs—disaster shocks still resulted in a large fluctuation of income and consumption as well as contributing to debt accumulation.

Figure 52. Challenges with Thailand's Nationwide Rice Insurance Program
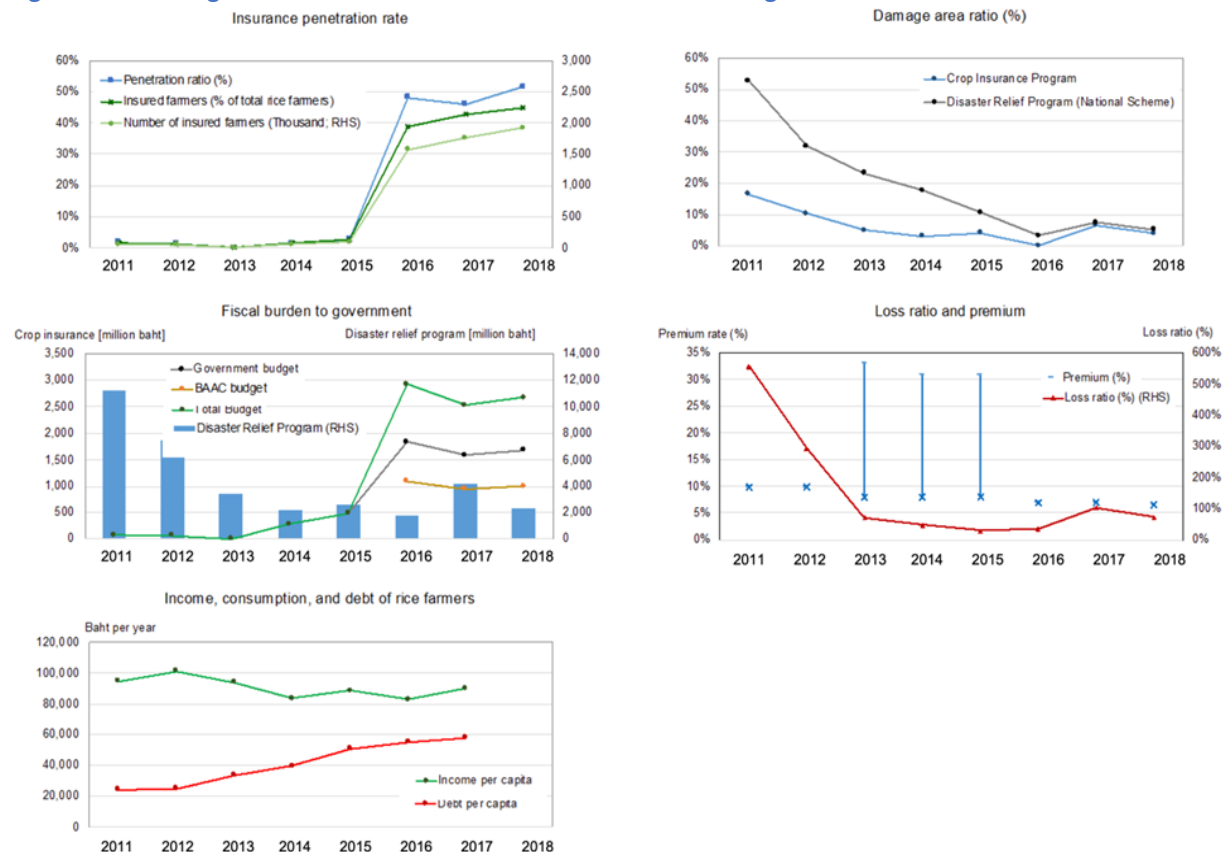
Source: Chantarat et al. (2017).

The first key challenge of the current crop insurance program is the lack of effective farm loss assessment. From the demand side, it could take 3-6 months to receive the insurance payout and disaster assistance and high basis risk (when farmers experience losses but their farms lie outside disaster zone, making them ineligible for both payouts), making the insurance program less useful to farm households. From the supply side, the current loss assessment is less objective and especially prone to information asymmetry. When coupled with the lack of appropriate risk information at the farm level, insurers have to charge high premiums to cover very high costs, making the program less marketable.

There are other key challenges that impede farm households' demand for insurance. These include: 1) disincentive effects from the co-existence with government disaster assistance program; 2) the currently large subsidy schemes for some crops; 3) the current insurance design with ineffective loss assessment and low insurance coverage, which reduces its value to farmers; and 4) other behavioral biases that could obstruct farmers' willingness to pay. Chantarat et al. (2017) provide more details on the recently

established collaborations aiming to resolve challenges for designing sustainable agricultural insurance for Thai farmers using a combination of technology (e.g., big data, satellite imagery, drone and mobile technology) and behavioral insights.

Low levels of agricultural R&D

Low public research and development (R&D) spending in agriculture during the past two decades will limit future opportunity for income growth as major Thai agricultural products are losing their competitiveness in the world's export market. Thailand's share of agricultural public R&D spending in agricultural GDP has stayed below 1 percent in the last two decades, much lower than other agricultural exporting countries such as Brazil, South Africa, Chile and Malaysia (Figure 53A). As a result, the competitiveness of Thailand's major agricultural products (i.e., rice, sugars & sugar confectionery, natural rubber and cassava) in the world's export market has diminished over the past decade (Figure 53B). With the increasing threats from climate change, investment in R&D is becoming more important to develop more climate resilient crops and other climate smart agriculture technologies and practices to sustain yields in the face of climate events.

Figure 53. Percentage of Public R&D Spending in Agriculture to Agricultural GDP and Thailand's Export Revenues of Major Agricultural Products

A. Public R&D spending in agriculture to agricultural GDP, 2000-2017, Percent
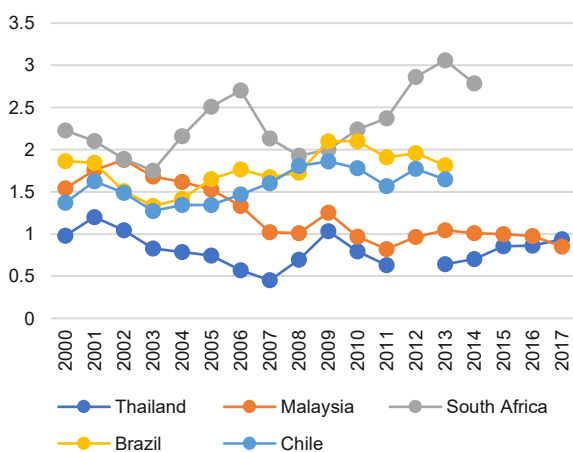
B. Export values of major agricultural products of Thailand, 2010-2020, Thousands USD

Source: ASTI IFPRI (2020)
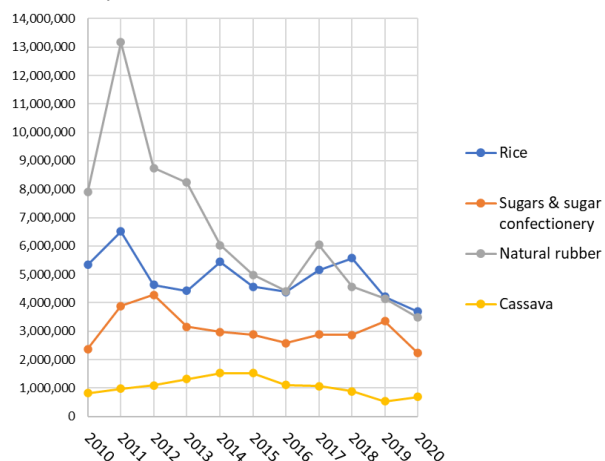
Source: UN Comtrade (2021)

3.2.2 Constraints to diversification

Unconditional farm assistance programs

A considerable share of the total farmland used for growing 13 main economic crops in Thailand had low and/or no soil or water suitability. According to the Land Development Department (2019), Thailand encountered a mismatch between planted crops and the suitability of the soil. Out of the 20.3 million hectares used to grow the 13 major economic crops, 35 percent (7.1 million hectares) of the land had low and/or no soil and water suitability, increasing from 30.8 percent in 2014 (Figure 54).   Several studies (e.g., Ramankutty *et al.,* 2008; Mesgaran et al. 2017; Akpoti et al., 2019) found that inefficient agricultural practices in unsuitable lands cause low crop yields at the cost of exacerbating land degradation and lower farm income.

Figure 54. Land Suitability for 13 Economic Crops Classified by Types of Land Suitability, Percent

■ No suitability ■ Low suitability ■ Moderate suitability ■ High suitability
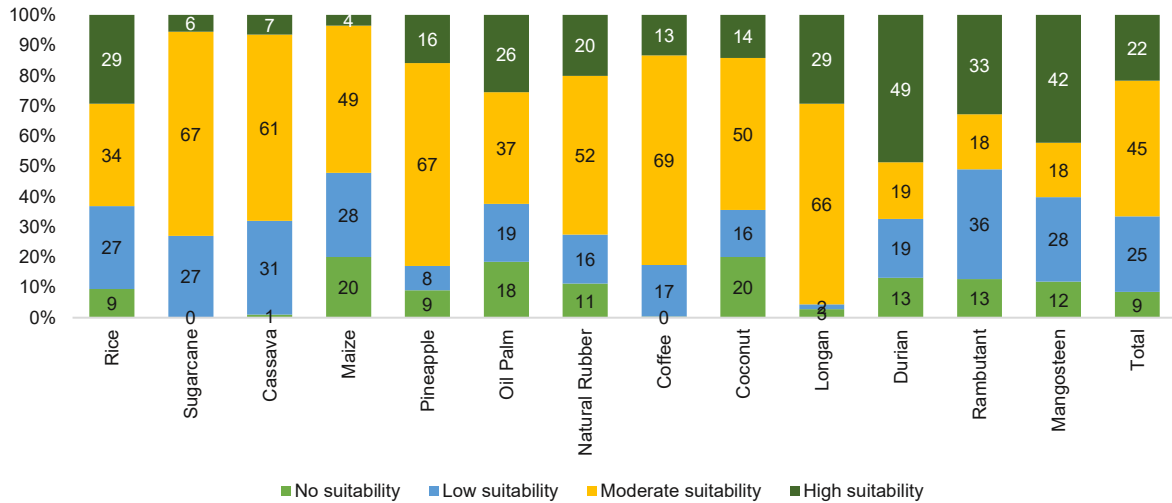
Source: Estimated from Land Development Department (2019).

Unconditional farm assistance (e.g., price and income guarantee for farmers, subsidy for farm inputs and harvesting cost to increase farm income) reduces farmers' incentives to switch to more suitable crops to their farmland. Attavanich et al. (2019) found that each farm household growing rice received an average support of about 550 USD per year through three main programs. As shown in Figure 55, most of the implemented policies were unconditional assistance compared to a small number of growth-driven implemented policies (blue). Attavanich (2021) found that most farm households benefitted from 2 to 3 policies at the same time and some of them received assistance through eight policies simultaneously.

Figure 55. Assistance Policies for Rice Farmers

Source: Attavanich et al. (2019).

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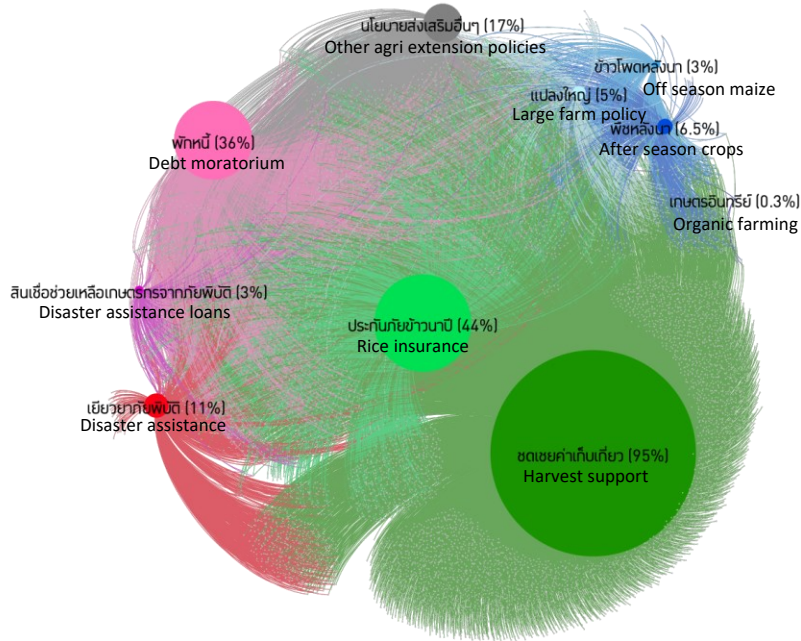
Past studies revealed that unconditional farm assistance policies are ineffective in increasing farm income because they reduce incentives for farmers to improve productivity and efficient use of their land. Attavanich (2021) simultaneously evaluated eight farm policies on farm performance and variability of farming and found that all unconditional farm assistance policies could not increase net farm income, while three policies were found to reduce the net farm income since farmers had no incentives to improve farm productivity. Chantarat and Ratanavararak (forthcoming) used loan-level data from the BAAC and showed that debt moratorium policies were given to all farmers, and that the program for all rice farmers resulted in creating larger delinquency and outstanding debt. While risk contingent policies (e.g., debt moratorium for drought affected households) could improve households' ability to repay loan in the short term, they could also result in larger delinquency and outstanding debt in the long run. Faysse et al. (2020) support this, as they concluded that some Thai rice farms in the irrigated area have been trapped in a poverty cycle and that Thai agricultural policies provided limited means to break this cycle.

Inefficient use of water resources

Many rural areas in Thailand have faced water shortages due to the inefficient use of water. Results from TDRI (2018) and Attavanich et al. (2022) show that one major reason for the inefficiency is due to the provision of water free of charge to farm households by the Thai government (according to Section 42 of Water Resources Act of 2018). Agriculture is the largest water user, accounting for 63 to 78 percent of water use from the irrigation system, with rice production consuming the highest amount of water among all crops. In addition to this, the water fee applied by Thai government is lower than the economic cost of water supply to non-farm sectors. Free of charge water for the farm sector and low water price for the non-farm sector led to excessive use of water, above the social optimal level (Phenrat et al., 2021). This, combined with government support programs to farmers which encourage cultivation of water-intensive crops with low profitability, such as rice, exacerbates the inefficient use of water.

3.2.3 Lack of access to markets

Lack of access to markets further constrain rural income growth. Around 40 percent of villages in the country, including 44 percent in the Northeast, lack year-round access to main roads. This challenge limits the capacity of farmers, as well as non-farmer producers, to access inputs which increases the cost of production and reduces their ability to sell their outputs and improve their potential incomes. Where processing facilities are distant from rice fields and without good connections to multiple facilities and buyers, farmers have lower bargaining power and receive less for their rice due to the high transportation costs. In addition, limited internet access, particularly in remote areas, affects connections to buyers as it makes coordinating more difficult, which raises transaction costs while also limiting opportunities to connect with a wider range of buyers.

IV. Priority actions to overcome major constraints in the next 5-10 years

This section proposes policy actions that can help overcome the constraints faced by rural farmers in the next 5-10 years. We have structured the policy options into four broad groups: (i) measures to increase agricultural productivity, ii) measures to support access to markets, iii) policy and institutional reforms to enhance efficiency of resource use and productivity, and iv) cross-cutting policy measures related to skills development.

4.1 Measures to increase agricultural productivity

Expanding access to irrigation systems and promoting the adoption of water efficient irrigation methods. Low and unequal access to water has been one of the key challenges for Thai farming households, with estimates showing that only 26 percent of farming households have access to irrigation systems (Attavanich et al 2019). Precision irrigation, in contrast to large-scale irrigation, is one of an emerging set of irrigation techniques which can help reduce water use while delivering the required amounts of water to crops. This technology can measure the moisture present in soil, allowing farmers to use the exact amount of water specific to a crop and soil type. This can increase yields and reduce overuse of water. These methods are well-suited to adjust to drier climates which will become a greater concern in the future due to climate change.

Promoting risk mitigation strategies to cope with increasing weather volatility among farming households. With the production of major crops projected to be adversely affected by climate change, developing more effective and sustainable risk mitigation strategies could help reduce volatility and income loss among farming households. This would be particularly useful for small farms as they are more vulnerable to climate change given their lower incomes, higher debt-to-income ratios and lower access to modern machinery. These strategies could include strengthening risk management systems, particularly early warning systems, as well as promoting the development and adoption of more effective and sustainable crop insurance.

Facilitating access to finance. Improving farmers' access to finance could widen opportunities for farmers to invest in the use of higher quality inputs, modern machinery and other productivity-enhancing tools. As such, facilitating access to finance could play a key role in increasing farm productivity, profitability and farmers' incomes. This could be further complemented by the provision of services or training which help raise the financial literacy of farmers.

Strengthening agricultural R&D. Investments in agricultural R&D need to be strengthened to increase productivity, raise competitiveness in export markets and to adapt to climate change. This could be coupled with expanded private-sector participation which can help develop varieties and agricultural technologies tailored to conditions in Thailand.

4.2 Measures to support access to markets

Expanding rural infrastructure to strengthen the connection between farmers and markets. Without year-round road connections, access to markets is constrained in many parts of rural Thailand. Investing in farm-to-market roads would improve the connectivity of rural areas, benefiting both farm and non-farm enterprises by reducing transport and logistic costs, reducing marketing margins, and expanding their reach to new customers.

Promoting the development of e-commerce to create new opportunities to raise incomes. The participation of farmers in e-commerce would allow for easier matching with buyers. It can also shorten the value chain, by allowing producers to sell directly to consumers. The value of e-commerce transactions could be also enhanced by the development of applications which bring together the processing and

distribution stages of the supply chain, reducing transaction costs even further. In addition to this, e-commerce also provides women with an opportunity to earn additional income with the flexibility to better balance work and duties in the home.

4.3 Policy and institutional reforms to enhance efficiency of resource use and productivity

Reviewing policies that weaken tenure security and constrain longer land rental tenure. Having land tenure with limitations (i.e., lacking the ability to use, control or transfer ownership of the land) could have broad and cross-cutting effects which affect agricultural productivity, crop diversification and farmers' decisions to use new technologies or modern machinery that would enhance productivity. On rented farmland, short rental contracts, which are more common than long-term leases, act as a constraint for farmers to invest in the land, given the uncertainty of being able to benefit from long-term investments. In addition to incentivizing longer-term investments in farmland, tenure security also widens access to credit and mitigates liquidity constraints, as it enables farmers to use their farmland as collateral. As such, crafting policies to strengthen tenure security and reviewing policies that constrain long-term leases of farmland could provide cross-cutting benefits to farmers.

Adopting optimal water pricing schemes, particularly in water stressed areas to reduce the inefficient use of water. With farm households' limited access to water partially stemming from the inefficient use of water due to its free or very low pricing, institutional reforms are needed particularly in water stressed areas. In the short-term, one approach would be to establish regulations that allow water user groups to collect water fees into local funds that could then be used to maintain irrigation canals (TDRI 2018).

Reviewing the use of policies which provide unconditional farm assistance. Past studies have revealed that unconditional farm assistance are not always effective in increasing farm incomes, particularly when they reduce farmers' incentives to improve their productivity. Reviewing the effectiveness of these unconditional policies, and shifting away from ineffective assistance, where appropriate, could motivate farmers to adjust their farming practices.

4.4 Cross-cutting policy measures related to skills development

Strengthening the knowledge and capacity of farmers. Building the skills of farmers and reducing the knowledge gap of farmers is critical in seizing available opportunities and mitigating constraints on increasing agricultural yield, diversifying to higher value crops and ultimately, raising income for rural farm households. This can be done through a range of approaches which include extension services, vocational training and skills development programs, which would allow them to be better equipped in a world of changing climate and new technologies. Through these programs, farmers could gain knowledge on more efficient input management and climate adaptation. They also could learn about i) the benefits of planting crops that have high soil and water suitability to their farmland, ii) the gains to be had from the use of improved seeds and fertilizers, and iii) the tools and equipment that are available to help them raise agricultural yields and increase their professional capacity to operate a farm as a sustainable business. They could receive training on operating modern machinery to help raise rates of adoption, as well as develop other pertinent skills which include financial literacy and business management.

Promoting digital literacy and strengthening the adoption of digital technology. The application of digital technology for farming opens up several possibilities to raise agricultural productivity and increase farm incomes: i) it provides a platform for the sharing economy, which allows even smallholder farmers to use modern equipment that would otherwise include large upfront costs; ii) it provides a platform for e-commerce, which provides broader access to both input and output markets; iii) it can act as a mechanism for the transfer of information and knowledge that could be critical factors in planting decisions such as the market price of crops, weather information and the costs of processing and transportation; iv) it can

be used as a platform for farmer extension services; and v) it could also be used as a mechanism for early warning systems. Despite the enormous potential that digital applications could have in raising productivity, farmers' adoption of mobile technology for agriculture has been low relative to supply, with digital literacy among farmers estimated at over 50 percent (Rattanavararak et al. 2019). To raise the adoption of digital technology in farming, promoting digital literacy is a critical first step. In addition, in raising farmers' digital literacy, it is important that older farmers are not left behind, particularly as one-fifth of the rural farm population are workers aged 60 and above. Additional support can be given to ensure that older farmers are able to benefit from the use of digital technology.

Leverage existing farmer institutions to enhance social learning. The results of the analysis in this report reveal that the likelihood of adoption of productivity enhancing practices rise when farmers are members of agricultural institutions or membership organizations, which include cooperatives and farmer groups. With this, promoting the use of digital technology and modern farm machineries through these networks is recommended. In addition to this, farmer groups and cooperatives could also collaborate with educational institutions in upskilling and reskilling farmers through trainings, which would also complement the work of MOAC extension officers.

Summary of policy recommendations

The policy recommendations are summarized below:

Table 2. Policy Priorities

Policy group	Specific policy measure		Strength of evidence of impact	Ease of implementation	Breadth of impact
Measures to increase agricultural productivity	1.1	Expand access to irrigation systems and promote the adoption of water efficient irrigation methods	High	Moderate	Broad
	1.2	Promote risk mitigation strategies to cope with increasing weather volatility	High	High	Broad
	1.3	Facilitate access to finance	High	Moderate	Targeted
	1.4	Strengthen agricultural R&D	High	High	Broad
Measures to support access to markets	2.1	Expand rural infrastructure to strengthen the connection between farmers and markets	High	Moderate	Broad
	2.2	Promote the development of e-commerce to create new opportunities to raise incomes	High	High	Targeted
Policy and institutional reforms to enhance efficiency of resource use and productivity	3.1	Review policies that weaken tenure security and constrain longer land rental tenure	High	Moderate	Broad
	3.2	Adopt optimal water pricing schemes, particularly in water stressed areas to reduce the inefficient use of water	High	Moderate	Broad
	3.3	Review the use of policies which provide unconditional farm assistance	Moderate	Moderate	Targeted
Cross-cutting policy measures related to skills development	4.1	Strengthen the knowledge and capacity of farmers	High	High	Broad
	4.2	Promote digital literacy and strengthen the adoption of digital technology	High	High	Broad
	4.3	Leverage existing farmer institutions to enhance social learning	High	High	Broad

V. Conclusion

This report shows potential for increasing income of farm and non-farm rural households. The report analyzes data from several sources to assess the major constraints and opportunities for faster and sustained income growth of both farm and non-farm households in rural areas. Feasible policy solutions are then proposed to overcome key constraints. After analyzing the income of rural households and the challenges they face, the study revealed three most important opportunities: 1) increasing agricultural productivity; 2) diversification to higher value crops; and 3) improving access to markets.

Several constraints hinder rural income growth. The constraints which need to be addressed to fully realize the potential to raise rural farm incomes include: 1) constraints to improving agricultural productivity; 2) constraints to diversification; and 3) lack of access to markets. While the constraints are broadly grouped to align with opportunities to raise rural incomes, many of these constraints have broad and cross-cutting impacts. For instance climate change will be highly impactful on agricultural productivity, but will also influence farmers' decisions to diversify crops.

The study provides four sets of feasible policy solutions that need to be prioritized for faster and sustained income growth of rural households. These include: 1) measures to increase agricultural productivity, 2) measures to support access to markets, 3) policy and institutional reforms, and 4) cross-cutting policy measures related to skills development.

- **The first set of policy solutions are measures to increase agricultural productivity.** These policy solutions aim to address constraints that farmers face in increasing farm productivity and income. This set of policy solutions include: 1) expanding access to irrigation and promoting the adoption of water efficient irrigation methods, 2) promoting risk mitigation strategies to cope with increasing weather volatility among farming households, 3) facilitating access to finance and 4) strengthening agricultural R&D.

- **The second set of policy solutions are measures to support market access.** With almost half of villages in Thailand lacking year-round access to main roads combined with limited internet access in remote areas, a significant share of households have limited ability to connect with markets and utilize e-commerce. As such, this set of policy solutions include: 1) expanding rural infrastructure to strengthen the connection between farmers and markets and 2) promoting the development of e-commerce to create new opportunities to raise incomes. These policy solutions could allow farmers to raise profits by facilitating easier matching of producers with purchasers, shortening the value chain and reducing transaction costs.

- **The third set of recommended policy solutions are policy and institutional reforms to enhance efficiency of resource use and productivity.** This set of policy solutions include: 1) reviewing policies that weaken tenure security and constrain longer land rental tenure, 2) adopting optimal water pricing schemes, particularly in water stressed areas to reduce the inefficient use of water, and 3) reviewing the use of policies which provide unconditional farm assistance. The first policy solution aims to further strengthen farmers' incentives to invest in higher quality inputs, modern machinery and productivity-enhancing tools. The second policy solution, on the other hand, aims to mitigate farm households' limited access to water which partially stems from the inefficient use of water due to its free or very low pricing. Finally, the third policy solution proposes reviewing the effectiveness of unconditional policies, particularly those that could reduce incentives for farmers to improve their productivity.

- **The fourth set of feasible policy solutions are cross-cutting policy measures related to skills development.** This set of policy solutions focus on equipping farmers with the skills they need to

raise farm productivity and incomes. This set of policy solutions include: 1) strengthening the knowledge and capacity of farmers, 2) promoting digital literacy and strengthening the adoption of digital technology, and 3) leveraging existing farmer institutions to enhance social learning.

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Appendix

Main data sources

The descriptive analysis presented in this report depends mainly on five household surveys: the Thailand Socio-Economic Survey (SES), the Thailand Labor Force Surveys (LFS), the Farmers' Registration, the Agricultural Household Socio-Economic and Labor Survey (AHSESLS), and the Agricultural Census. These data combined make it possible to compare patterns across areas, time and households.

The SES is a representative household survey conducted by Thailand National Statistical Office (NSO), which collects detailed data annually on households-level detailed information on economics and social matters of the household. The survey provides data on, for example, income, expenditures, liabilities, assets, structure of household members, housing characteristics, migration and remittance transfer as well as the information on access to social welfare/ government program and public services. The survey covered all private, non-institution households residing in all provinces, and also in both municipal and non-municipal areas. The survey collects the data of household income every two years, while the household's expenditures will be collected every year. The main analyses presented here rely on the 2011, 2013, 2015, 2017 and 2019 rounds.

We also perform the analysis with LFS, which is a comprehensive, nationally representative survey used to measure employment situation on the quarterly basis conducted by Thailand National Statistical Office (NSO). The age of persons in labor force were over 15 years of age and over in order to agree with the child labor law. The international standard of classification in occupation, industry and status of employment were adopted, and area of local administration; sanitary districts, which used to be included in non-municipal area were presently included in municipal area. The main analyses presented here use the data from the first quarter of 2011 to the fourth quarter of 2020. For the analysis related to the agriculture, the report mainly uses the data from the third quarter of every year for the analysis because it is the quarter that has the highest employment since the growing season usually start from May to October.

The Farmers' Registration provides the most up-to-date and comprehensive data of farm households. It is a comprehensive, nationally representative survey allowing for a deeper analysis of farm households in several aspects such as household demographic, farm characteristics (e.g., planted and harvested area, types of crops, livestock and fishery), growing period, access to water, farm production, adoption of farm mechanization, income, debt, and farm practices. The survey covers almost 90% of farmers in Thailand and the data were collected every year at the plot level by the Department of Agricultural Extension, Ministry of Agriculture and Cooperatives. The main analyses presented here use the surveys in 2017 and 2018.

We complement the analysis of farm households with the Agricultural Household Socio-Economic and Labor Survey (AHSESLS), which is a comprehensive, nationally representative survey allowing us to observe the dynamics of farm households overtime. This survey is conducted by the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives every year tracked back since at least 1995 and collect the data from all provinces. Although the sample size of HALSES is a lot smaller than that of the Farmers' Registration, HALSES collects the rich data related to the agricultural policies implemented by the government and the cost of on-farm production. It can be used to measure the effectiveness of the agricultural policies/programs aiming to enhance farm productivity, farm income and net farm income. This study mainly uses this HALSES data during crop year 2009/2010 – 2019/2020. We use this dataset for

several aspects such as the investigation of factors influencing the number of farm activities and factors influencing the decision to grow high value crops.

Agricultural Census is used to investigate the long-term change of farm households, on-farm production and productivity, access to water, adoption of farm mechanization, and practices. It is the most comprehensive dataset to explore the long-term structural transformation of Thai agriculture since the Census collects the data from all farm households in the country. However, it is conducted every 10 years by Thailand National Statistical Office (NSO). This study mainly uses two recent rounds conducted in 2003 and 2013. It covers 5.9 million households, 19.6 million labors in 2013. We also use this dataset to analyze factors influencing the decision to adopt of modern farm machines.

Each of these five surveys brings its own advantages and limitations to the analysis. Whenever possible, the analysis was repeated for all five surveys, and results are presented when findings seem to be consistent. The descriptive analysis in sections 2 and 3 will present figures using the best data for the particular purpose at hand. Specifically, we use the SES data to describe households' income sources, as this is a survey specifically designed to capture incomes from both urban and rural households. SES data also is used to investigate the dynamic of poverty, debt, farm and non-farm distribution, education attainment of households in the rural area across regions and industries. We use the LFS survey to analyze the recent trends of working status and participation in the labor markets of farm and non-farm workers classified by age, gender and education attainment in the rural areas. It also is used to observe changes in income of farm and non-farm workers classified by education attainment. For the analysis of farm household, the report used the Farmers' Registration to investigate the access to water sources, farm portfolio, farmland holding and farmland ownership of farm households. The AHSESLS is used to complement the Farmers' Registration to observe trends of farm activities and net revenue in the irrigated area plus return and risk of portfolios that farm households faced. Last but not least, we used the Agricultural Census to analysis the long-term change in farmland holding, farmland ownership, and the adoption of modern machine of farm households.

The report supplements findings from the five main surveys with information from other sources. The report uses the provincial-level agricultural productivity for key crops conducted by OAE; disaster data from Department of Agricultural Extension; the data of COVID-19 impact and agriculture digitalization survey conducted by Attavanich et al. (2022); and Debt Headcount and Delinquency Headcount from the National Credit Bureau. We also use statistics from the World Development Indicators (WDI), USDA, and other sources for benchmarking.

Figure A. 1. Types of income growth for rural households

Labor income growth for rural households

Agricultural growth

Smallholders obtain Increased profitability from existing goods through favorable changes in relative prices, more stable prices, yield growth, reduced yield volatilty, area expansion, more cost-effective production

Smallholders achieve greater market participation of existing goods through commercializing a larger share of production, selling further up the value chain, engaging in contract farming or outgrower schemes

Smallholders transition into higher-value crops and non-crop agriculture including livestock

Growth in large-scale commercial farming that increases demand for agricultural wage labor

Non-farm growth

Growth in **non-tradable goods and services** (wage or self-employment)

Growth in tradable goods through **mining, tourism or rural manufacturing** (wage or self-employment)

Migration

Temporary migration of family members to urban areas or internationally

Permanent migration of individuals or families

Commuting

Table A. 1. Factors influencing the decision to adopt modern farm machines from the probit regression

Use modern machines	Coef.	Std. Err.	
edu_head_gt_second	0.0449	0.0023	***
age_agwork	0.0072	0.0002	***
age_agwork^2	-0.0001	0.0000	***
% workmainag_hh	0.0003	0.0000	***
d_fully_own	0.0569	0.0016	***
d_partial_own	0.0598	0.0022	***
d_rent	0.1089	0.0035	***
rice	0.0926	0.0352	***
rubber	-0.0846	0.0350	**
maize	0.0870	0.0350	**
cassava	0.0815	0.0350	**
sugarc	0.1182	0.0348	**
oilpalm	-0.0472	0.0348	
parennial	-0.0226	0.0353	
livestock	-0.1519	0.0355	***
Fishery	-0.0223	0.0017	***
Vegetable	0.0076	0.0357	
area_hold	0.0008	0.0003	***
ag_group	0.1193	0.0012	***
total_activites	0.0754	0.0355	**
Irrigation	0.0396	0.0008	***
year2556	0.0358	0.0006	***
_cons	0.0477	0.0365	
Pseudo R2	0.1463		
F(26, 3117615)	25087.12		
Number of obs	3,117,642		

Note: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level. Regional fixed effects are included.

Definition of modern machines: It is defined as machinery that is either highly capital intensive or simultaneously providing multiple functions such as of 4-wheel tractor, pump or turbine using electric motor or modern renewable energy, pesticide sprayer using motor, weeding machine using motor, planters with self-propelled engines, planters with 4-wheel tractors and rice combine harvester.

Table A. 2. Factors influencing the decision to use digital application from the probit regression

Use application	Coef.	Std. Err.	Use application	Coef.	Std. Err.
female	-0.0165	0.1046	Oil palm	0.2151	0.1808
age	0.0361	0.0327	pineapple	-0.6364	0.4348
age_2	-0.0006	0.0003*	coconut	0.2514	0.2030
head educationgtG12	0.7674	0.1177***	durian	0.1310	0.2418
work_ag_only	-0.3039	0.1581*	longan	0.3206	0.2403
work_main_ag	-0.2082	0.1590	mango	0.1432	0.1917
family_member	-0.0805	0.0320**	vegetable	-0.0079	0.1303
rai_all	0.0043	0.0022**	Beef cattle	0.0192	0.1593
mem_baac	0.1947	0.1094*	Milk cattle	0.6030	0.2919**
mem_ag_coop	0.0438	0.1781	poultry	-0.0761	0.1358
rent	0.2523	0.1265**	swine	-0.2274	0.2298
paddy	0.0127	0.1172	fish	0.4112	0.1381***
glutinous rice	0.0898	0.1550	shrimp	1.4382	0.3279***
maize	0.1398	0.2506	irrigation	0.0368	0.1182
cassava	-0.3819	0.2332	Pseudo R2	0.2065	
sugarcane	-0.5077	0.3254	Number of obs	930	

Note: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level. Regional fixed effects are included.

Table A. 3. Factors influencing the number of farm activities from the Poisson regression

Number of activities	Coef.	Std. Err.	
female_head	-0.0657	0.0067	***
edugrade9_head	0.0147	0.0075	*
age_head	0.0040	0.0018	**
age_head_2	0.0000	0.0000	***
head_full time_ag	0.0288	0.0075	***
young_farm	0.0315	0.0038	***
area_plant	0.0025	0.0001	***
price_fruit	0.0016	0.0003	***
price_vegetable	0.0064	0.0013	***
rice_mortgage	0.0272	0.0170	
water_irrigation	-0.0287	0.0028	***
water_ownpond	0.0228	0.0042	***
water_pubprivate	0.0198	0.0083	**
water_farmgroup	-0.0045	0.0193	
water_providers	0.0369	0.0084	***
fully_own	0.0002	0.0002	
rent	-0.0028	0.0002	***
plot_no	0.0704	0.0015	***
group_baac	0.0565	0.0041	***
group_coop	0.0390	0.0067	***
group_farmgroup	0.0310	0.0060	***
constant	-1.5999	0.2547	***
Pseudo R2	0.0257		
LR chi2(34)	5,476.15		
Number of obs	76,793		

Note: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level. Regional and year fixed effects are included. Models are estimated using the OAE survey data from 2009/2010 - 2019/2020

Table A. 4. Factors influencing the decision to grow high value crops from the probit regression

High_value_crop	Coef.	Std. Err.	
female_head	-0.0174	0.0330	
edugrade9_head	0.2703	0.0371	***
age_head	0.0166	0.0093	*
age_head_2	-0.0001	0.0001	
head_ftime_age	0.0068	0.0380	
young_farm	0.0089	0.0209	
area_plant	-0.0024	0.0009	***
price_fruit	-0.0014	0.0013	
price_vegetable	-0.0018	0.0061	
rice_mortgage	-0.3379	0.0813	***
water_irrigation	0.0894	0.0128	***
water_ownpond	0.3084	0.0174	***
water_pubprivate	0.0857	0.0370	**
water_farmgroup	0.1424	0.0760	*
water_providers	0.0653	0.0430	
fully_own	-0.0055	0.0014	***
rent	-0.0177	0.0035	***
plot_no	0.3764	0.0146	***
group_baac	-0.0608	0.0230	***
group_coop	0.0185	0.0337	
group_farmgroup	0.1000	0.0272	***
constant	-2.1953	1.1602	
Pseudo R2	0.1508		
Wald chi2(34)	4,358.7500		
Number of obs	76,793		

Note: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level. Regional and year fixed effects are included. Models are estimated using the OAE survey data from 2009/2010 - 2019/2020

Policy Priorities, Thai National Strategy and SDG

Table B. 1. Policy Priorities and Corresponding Strategies in the Thai National Strategy 20 year (2018-2037) and Sustainable Development Goals (SDGs)

Policy Priorities	Thai National Strategy 20 year (2018-2037)	SDGs
Improving access and management of water resource	**Social Cohesion and Equity** 4.2.1 Developing economic, social and technological hubs in all regions **Eco-Friendly Development and Growth** 4.3.3 Focusing on investment in public and private sectors' climate-friendly infrastructure development 4.5.1 Developing the entire river basin management system to ensure national water security 4.5.2 Enhancing productivity of an entire water system to promote water-use efficiency and generate value added for water consumption adequate with international standard	No poverty (1.1, 1.2, 1.4, 1.5); Zero hunger (2.3); Clean water and sanitation (6.4, 6.5, 6.6, 6.a, 6.b); Decent work and economic growth (8.1, 8.4); and Reduced inequalities (10.1); Responsible consumption and production (12.2)
Promoting mitigation and adaptation to climate risk and climate change	**Developing and Strengthening Human Capital** 4.2.3 Working-age population stage **Eco-Friendly Development and Growth** 4.1.5 Promoting sustainable consumption and production 4.3.1 Mitigating greenhouse gas emissions 4.3.2 Adapting to prevent and reduce losses and damages caused by natural disasters and impacts of climate change 4.3.3 Focusing on investment in public and private sectors' climate-friendly infrastructure development	No poverty (1.1, 1.2, 1.4, 1.5); Zero hunger (2.4); Good health and well-being (3.9); Decent work and economic growth (8.1, 8.4, 8.10); Reduced inequalities (10.1); Sustainable cities and communities (11.5, 11.6); Responsible consumption and production (12.3); Climate action (13.1); and Life on land (15.3)
Improving access and use of technology among smallholders	**Competitiveness Enhancement** 4.1.5 Smart farming 4.4.4 Developing modern technological infrastructures 4.5.4 Facilitating information access **Developing and Strengthening Human Capital** 4.2.3 Working-age population stage 4.3.1 Adjusting learning systems to promote necessary skill development 4.3.4 Developing lifelong learning systems 4.3.6 Using digital platforms to enhance learning systems **Social Cohesion and Equity** 4.1.1 Adjusting local economic structures 4.2.1 Developing economic, social and technological hubs in all regions 4.3.6 Promoting development of information technology and creative media to accommodate a digital society	No poverty (1.1, 1.2, 1.5); Zero hunger (2.3, 2.a); Decent work and economic growth (8.1, 8.2); Industry, innovation and infrastructure (9.b, 9.c); Reduced inequalities (10.1); and Responsible consumption and production (12.3)
Promoting land consolidation and efficient use of farmland	**Competitiveness Enhancement** 4.1.5 Smart farming **Social Cohesion and Equity** 4.1.1 Adjusting local economic structures 4.1.3 Distributing land ownership and resource access on an equitable basis 4.4.1 Promoting household behavioural changes to have increased capacity in life, health, family, finance and work planning **Public Sector Rebalancing and Development** 4.2.2 Having national monetary and financial systems designed to effectively support the implementation of the National Strategy 4.2.3 Designing a national monitoring and evaluation systems designed to effectively evaluate the National Strategy's achievements at all levels	No poverty (1.1, 1.2,1.4,1.5); Zero hunger (2.3); Decent work and economic growth (8.2, 8.3); Reduced inequalities (10.1,10.2); Responsible consumption and production (12.2, 12.3); Climate action (13.1); Life on land (15.3)

Policy Priorities	Thai National Strategy 20 year (2018-2037)	SDGs
	4.4.2 Developing and adjusting procedures and practices of all government agencies	

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