

Review: Market, capital, and foreign labor access for all Thai farmers

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Abstract. Tanielian A. 2020. *Review: Market, capital, and foreign labor access for all Thai farmers*. *Asian J Agric* 4: 52-70. In this quantitative study of agricultural economic indicators for Thailand, its provinces, and seventeen other countries it is shown that Thailand's agriculture sector desperately needs assistance to lift farmers out of poverty and Thailand out of the middle-income trap. Data shows diminishing activity in the agricultural sector may be harming productivity and growth. Prices and yields plateau and fall as producer costs increase and farm incomes remain among the lowest. In 2006 and 2014, the military ousted two Shinawatra Prime Ministers amid corruption and misappropriation scandals relating to failed agricultural subsidy schemes that cost the government billions of dollars, while failing to substantially improve the situations of millions of smallholder farmers throughout the Kingdom. Analysis of primary data and literature suggests Thai farmers lack sufficient access to labor, capital, and markets that would give them the resources to improve farming methods, hire short-term labor, and ultimately rise in socioeconomic status along with the rest of the population. Recommendations include a series of government-sponsored and joint public-private initiatives that organize farmers into unions and connect them with human, financial, scientific, market, and educational resources via a range of mobile applications.

Keywords: Agricultural economics; commodities markets; migrant labor; quantitative methods; rural development; Southeast Asia

Abbreviations: ANOVA: Analysis of Variance, ASEAN: Association of Southeast Asian Nations, AEC: ASEAN Economic Community, BAAC: Bank for Agriculture and Agricultural Cooperatives, C: Central, FAO: Food and Agriculture Organization of the United Nations, GDP: Gross Domestic Product, GPP: Gross Provincial Product, N: North, NE: Northeast, S: South, SPSS: Statistical Package for Social Scientists

INTRODUCTION

Thailand's political history has been tumultuous since it became a constitutional monarchy in 1932. The Kingdom's military deposed the first Prime Minister in the first year after changeover from an absolute monarchy. Martial law followed and by 1935, King Rama VII abdicated, leaving his nephew Prince Ananda Mahidol the crown. Through 1937-38, the Parliament held elections, but no order lasted beyond the Japanese invasion in 1941. Crisis continued to ensue through the end of the war when the National Assembly forced the PM out of office. Five governments and PMs passed in two years leading up to the death of King Rama VIII. The military ushered in a civilian government which was ousted by coup again in 1947. Two PMs later, the military-led government repressed military rebellions from 1948 until 1951 when King Rama IX, Bhumibol Adulyadej, returned from his European collegiate education. The King appointed a military PM and restored the 1932 constitution. Subsequent governments resisted communist rebellion through 1957 when the military ousted another PM. Another coup ousted Lt. General Thanom Kittikachorn – the King's military appointment to PM – in 1958, and a new constitution was announced in 1959. In 1963 after the passing of an Assembly-elected military PM, the King appointed Kittikachorn again to the PM post. For the remainder of the 1960s, the Kingdom descended into bloody conflicts

between government forces and communist insurgencies. In 1971, Kittikachorn suspended the constitution and banned all political parties. By 1973, the King appointed a civilian PM whose government drafted a new constitution, but the government was unable to solve the communist crisis, so the King dissolved the Parliament in 1976. The military quickly rebelled and seized control of the government, which was overthrown by another military rebellion in 1977. The military government drafted another new constitution in 1979. Violence continued to plague the countryside through 1981, as the government repelled another military rebellion, and finally communist insurgents surrendered in 1982. Between 1983 and 1991, Thailand saw one military and two civilian-led governments before a 1991 coup reinstalled the military under martial law. Civilians took control again in 1992 and held the PM position until 2006 when the military deposed Thaksin Shinawatra. Five governments and five years later, the nation elected Thaksin's sister Yingluck Shinawatra, who was deposed by coup in 2014 (University of Central Arkansas 2019).

Between 1981 and 2014, the government supported farmers through "rice-pledging" systems whereby farmers would borrow money from the government in an amount equal to the value of x-kilograms of rice (FAO 2018). Farmers would surrender control of the rice to the government and after three months, farmers could pay back the loan with interest or forfeit the rice. Farmers often

viewed the arrangement as a purchase rather than a loan, especially because the loan value for the rice was set at future prices higher than spot prices. When prices failed to rise on the government's pseudo-futures contract, the lender could not offload its stockpiled collateral without taking a loss. By the time of the 2014 coup when the junta government stopped the pledging scheme, the nation had lost \$8-18 billion dollars depending on how much rice had already spoiled, how much would spoil before sale at auction, and how much below purchase prices the government sold the rice for at auction (Biswas et al. 2015; Niyomyat and Wongcha-um 2017).

This article presents a quantitative study of statistical data from the United Nations Food & Agricultural Organization (FAO 2019), Thailand National Statistical Office (2019), Thailand Bureau of Trade and Economic Indices (2019), Thailand Office of Agricultural Economics (2019), Thailand Ministry of Commerce (2019), Bank of Thailand (2019), and the World Bank (2019). Electronic databases provided spreadsheets of historical data for hundreds of agricultural economic indicators for Thailand, its provinces, and seventeen other countries: Australia, Brunei, Cambodia, Canada, China, India, Indonesia, Korea, Laos, Malaysia, Myanmar, New Zealand, Philippines, United Kingdom, United States, and Vietnam. Microsoft Excel generated charts, tables, and maps via Bing representing Thai domestic data. SPSS calculated ANOVA means comparisons, and correlation coefficient using Pearson, Kendall, and Spearman techniques. The next section offers a brief overview of the Thai agro-economy illustrated by color-coded maps of Thailand showing provincial values for GDP per capita, population, GPP in the agro-sector, the percent of all land used for agriculture, and work permits by province. The section following the overview presents more detailed examination of GDP per capita, GPP in agriculture, work permit grants, farm holdings, and land use in each of the four main regions: North, Northeast, Central, South. After the regional focus section, a section on agricultural inputs and outputs discusses statistics, trends, and Thai farmers face relating to land, labor, and capital. A section on agriculture and food markets follows with charts representing price, production, and inflation for several commodities.

The final section introduces potential longer-term solutions for the Thai agriculture sector, with particular focus on smallholders. Conclusions urge the government to sponsor and facilitate conception of new local agro-union-collectives that could provide support directly to farmers with machines, labor, credit, education, seeds, fertilizers, pesticides, and herbicides. Recommendations also encourage the government to fund development of a mobile phone platform that provides a forum for farmers to communicate, find information, post job openings, and put raw food commodities into the market – the app would link sellers on the farm to buyers across the country. The government is also advised to amend related labor and immigration laws to create a system of licensing for recruitment and staffing agencies that would handle the entire process from finding labor in neighboring countries to permit applications, transportation, housing, and

immigration compliance monitoring. Agencies would pay for access to the mobile app and community based agro-union-collectives for market and logistical support. Various revenues would be available to the government via membership payments for the app, union dues, visa and work permit fees, and agency licensing fees. All recommendations are plainly within the scope of justifiable measures provided to the government by the 2017 Constitution.

AGRICULTURE & MIGRANT WORKERS IN THAI ECONOMY

Figures 1-3 show provinces that depend less on agriculture experience higher average incomes, and provinces low agricultural activity typically have low populations and low GDP per capita. Low incomes for agricultural workers help explain labor movement out of agriculture. Non-agriculture jobs are in higher supply in urban areas, so as people born into rural provinces sought upward income and class mobility, they moved to more urban provinces. The age-dependency ratio is growing in both N and NE regions (Keeratipongpaiboon 2012) due to increased out-migration and declining births. Births in all regions are falling, but nowhere as much as the NE where fewer children are born than in the Central region whose population is only two-thirds that of the NE.

As Thailand struggles to escape the "middle-income trap," its labor force moves from agriculture to manufacturing and services, out of rural and into urban areas. When would-be farmers move to cities, they often send money back home, which offsets some of the economic drains that resulted due to their migration. Recipients of domestic remittances can replace the agricultural labor lost by hiring farmhands with remittance money. For a farmer-parent in a NE province who receives monthly payments from an adult-child living and working in Bangkok, whether the child's migration results in a net gain or loss for the parent's household depends on the size of payments and the cost of farm labor to replace the child on the farm. Absent cheap and reliable labor, outward migration of Thais seeking job opportunities in urban areas can easily pose net-negative scenarios to farming communities.

Provinces with the highest populations generally have the most robust economies. Work permits are typically issued for manufacturing, tourism, and professional services, which are more abundant in populous provinces like Chiang Mai, Bangkok, and Nakhon Ratchasima. Work permits are also issued more in major tourist destinations like Chonburi and Surat Thani, and for technical jobs like those in the petrochemical sector in Rayong. Coincidentally, those provinces with large cities, tourist destinations, and expansive industrial estates rely less on agriculture than provinces that have fewer work permits granted.

Northern Region

The North is Thailand's largest geographical region. These seventeen provinces have more forest land than all

other provinces combined (Thailand Land Development Department 2012). The North ranks second to the Northeast in terms of agricultural land area. Paddies are mostly huddled to the lower elevations (20-50m) in Sukhothai, Kamphaeng Phet, Phichit, Nakhon Sawan, and Uthai Thani, with some of Phitsanulok and Phetchabun provinces under paddy. High plateaus (400m) in Chiang Rai and Phayao are also paddy lands. Mountainous regions (1000-2500m) in Maehongson, Chiang Mai, Tak, Lamphun, and Kamphaeng Phet prevent the types of expansive paddy systems that run through low plains. Various field crops and orchards dot the landscape among sprawling mountain forests that push from Tak's western border with Myanmar, all the way around the crown northward around Maehongson and Chiang Rai and down Nan's eastern border with Laos.

Maps in Figure 4 show provinces with lower dependence on agriculture and higher incomes issue more work permits. Chiang Mai and Lamphun provinces have the highest average incomes and among the lowest agricultural sector contribution to GPP. Chiang Mai is a major tourist destination, home to the largest city in the region, and a chief coordinator of the government's initiative to legalize undocumented workers from neighboring Myanmar. Map coloration may appear to suggest that Kamphaeng Phet defies the norm with lower GPP in agriculture and higher GDP per capita while suffering fewer working permits, however, the contrast is due to outlier Chiang Mai distorting the color scheme. Data showed discernible relationships between GDPs per capita, GPP in agriculture, and work permits.

Northeastern Region

The total land area of the NE region is slightly lower than in the North, but the NE has more than 40 percent of Thailand's agricultural land and 60 percent of the Kingdom's paddy land area. More than two-thirds of the NE is farmland, and two-thirds of that farmland is paddy land (Thailand National Statistical Office 2019). Rice farmers dominate the agriculture sector, especially along with the region's irrigation networks (Thailand Land Development Department 2010a). Nong Han Lake in eastern Sakon Nakhon is the region's other main supplier of irrigation waters with systems flowing along the border with Nakhon Phanom before joining the Mekong on the Laos border. The Mun Mun irrigation system flows from the Nakhon Ratchasima city to the provincial northern border with Buriram and continues along the northern borders of Surin and Si Sa Ket provinces to Ubon Ratchathani city, where it meets the Chi Chi network. The Chi Chi channels flow from the Ubonratana dam reservoir that straddles Khon Kaen and Nong Bua Lamphu. The Chi Chi forms part of Kalasin's southern border with Maha Sarakham and Roi Et, and it follows a portion of Yasothorn's western border with Roi Et before joining the Mun Mun in Ubon Ratchathani on the way to the Mekong and into Cambodia through Laos. Irrigated rice farms overwhelm lowland plateaus (100-200 m asl) throughout the region outside of mountainous Loei where altitudes reach 1,300 m asl, and aside from the hilly borderlands between Sakon Nakhon and Nakhon Phanom (300-500 m asl).

The NE has the lowest GDP per capita and highest dependency on agriculture. Two provinces stand out in terms of economic output: Khon Kaen and Nakhon Ratchasima. Khon Kaen initiated a series of programs intended to double GDP per capita, to \$12,000-15,000 by 2029 (Natanri and Kongrut 2018). Khon Kaen is home of the "Smart City" program, and unsurprisingly, it has the lowest dependence on agriculture in the region. Nakhon Ratchasima is Thailand's largest province in terms of area and second only to Bangkok in population. The province boasts several comparative advantages due to its location, size, and resources. Khon Kaen and Nakhon Ratchasima help illustrate the apparent connection between higher incomes, lower involvement in agriculture, and more work permits.

Central Region

Crisscrossed by the country's widest highways, connecting the country's busiest seaports and airports, the Central region is the logistical heart of the nation. The region is also the most economically diverse. The maps show Chantaburi has the highest dependence on agriculture of any province in the Kingdom, while neighboring Rayong and Chonburi rely on agriculture less than any provinces outside of Bangkok. Chonburi draws millions of tourists annually with Pattaya. Nearby Rayong hosts Map Ta Phut petrochemical industrial estate. Chonburi, outside of the Pattaya area, is mostly field crops and orchards. Farmers in Chachoengsao, Prachin Buri, and Sa Kaeo tend various vegetables. Assorted fruit, rubber, and eucalyptus trees make up agricultural lands throughout rural Rayong, Chantaburi, Trat (Thailand Land Development Department 2010b). Forests stretch across the western half of Kanchanaburi, following the mountain range (400-1300 m asl) along the border with Myanmar through Ratchaburi and Phetchaburi. Wetlands, orchards, and rubber farms abound in lowlands of Prachuap Kiri Khan and into Phetchaburi. Water is available from the Mae Khlong, Tha Chin, Chao Praya, and Bang Pakong rivers on their ways to the Gulf of Thailand at Samut Songkram, Samut Sakhon, Samut Prakan, and Chachoengsao, respectively. Rice farming flourishes in most of Suphan Buri and Ang Thong, and again in parts of Nakhon Nayok (Thailand Land Development Department 2010d). Work permits are plentiful throughout the region, except in Saraburi and Chai Nat. Chantaburi and Sa Kaeo defy the trend that agriculture's share of provincial economic output corresponds to fewer work permits. The region's central location, relative resource abundance, high-capacity logistical infrastructure, and proximity to Bangkok create some work permit anomalies, but generally, the trend holds up that GPP outside of agriculture, GDP per capita, and work permits rise and fall together.

Southern Region

The South has the smallest land area, fewest paddy fields, and only negligible field croplands when compared to other regions. Roughly half of the South is covered by rubber tree plantations. Tourist havens include Phuket, Krabi and its islands, and Surat Thani with Koh Samui, Koh Phangan, Koh Tao, and the Chumphon archipelago.

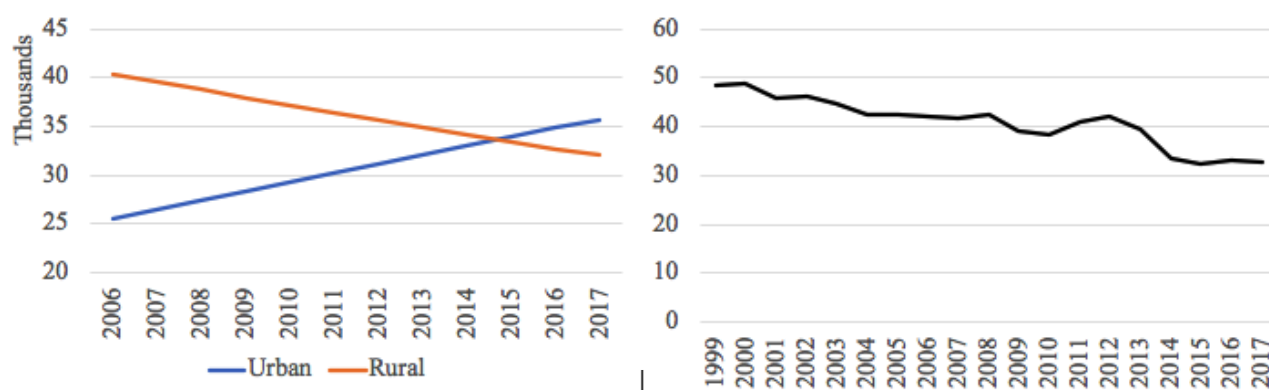


Figure 1. Thailand urban and rural populations (*left*). Thailand percent of labor force in agriculture (*right*). Data source: World Bank WDI (2019)

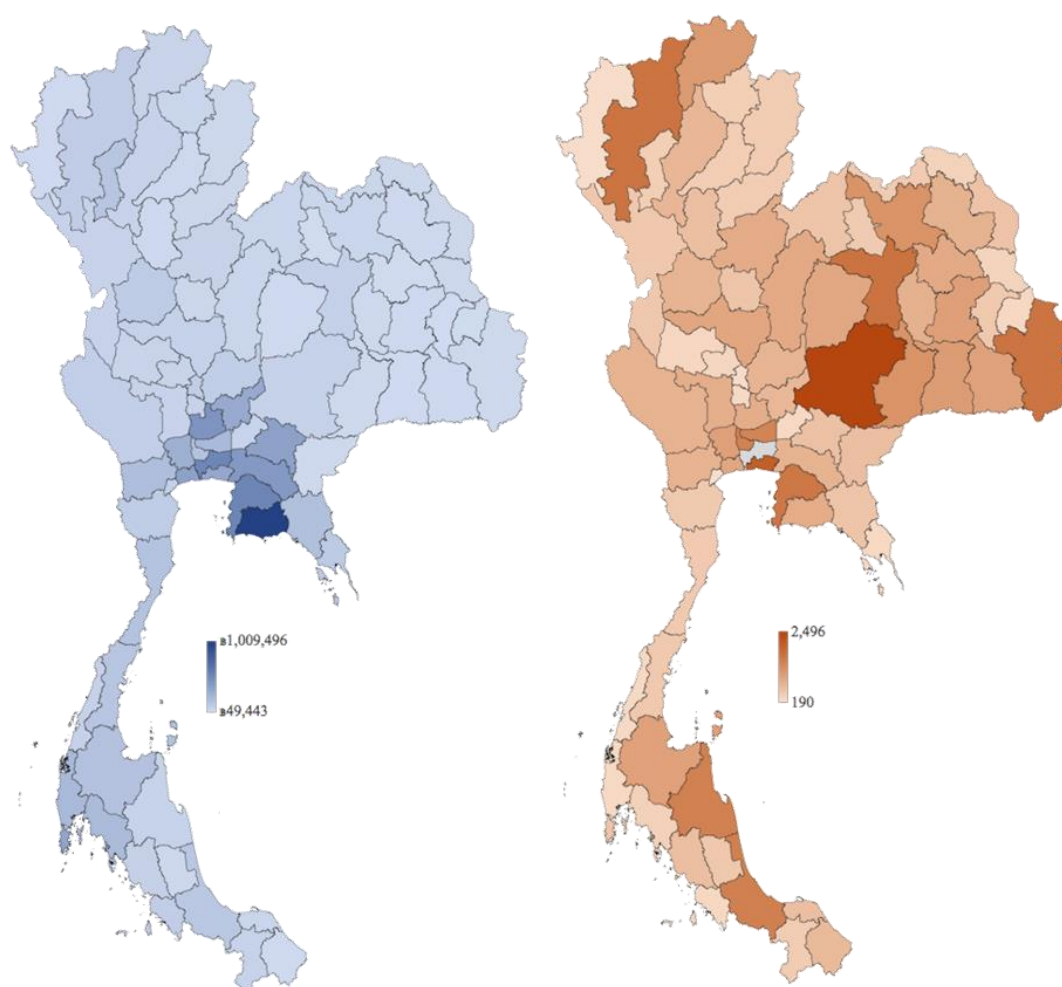


Figure 2. GDP per capita by province (*left*), population by province, in thousands of people, Bangkok excluded (*right*).

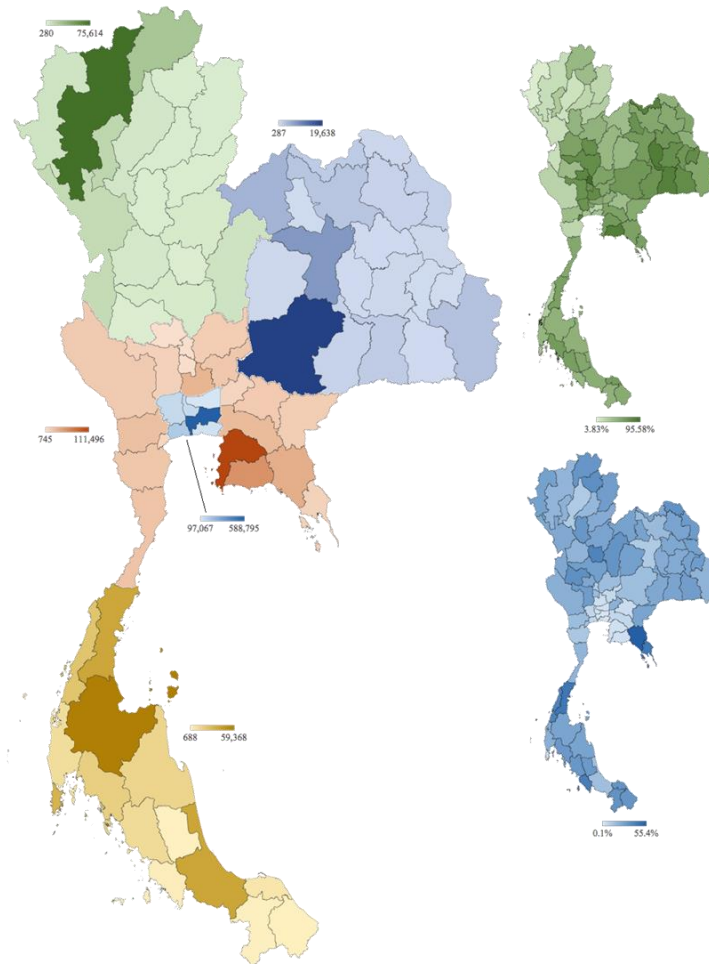


Figure 3. Work permits issued by province in each of five regions for year 2018 (*left*). Percent of land under agriculture by province (*lower right*) percent of GDP in agriculture sector (*upper right*). Darker colors indicate higher values (*lower right*). Data sources: Thailand Ministry of Labor (2018) and Thailand National Statistical Office (2019).

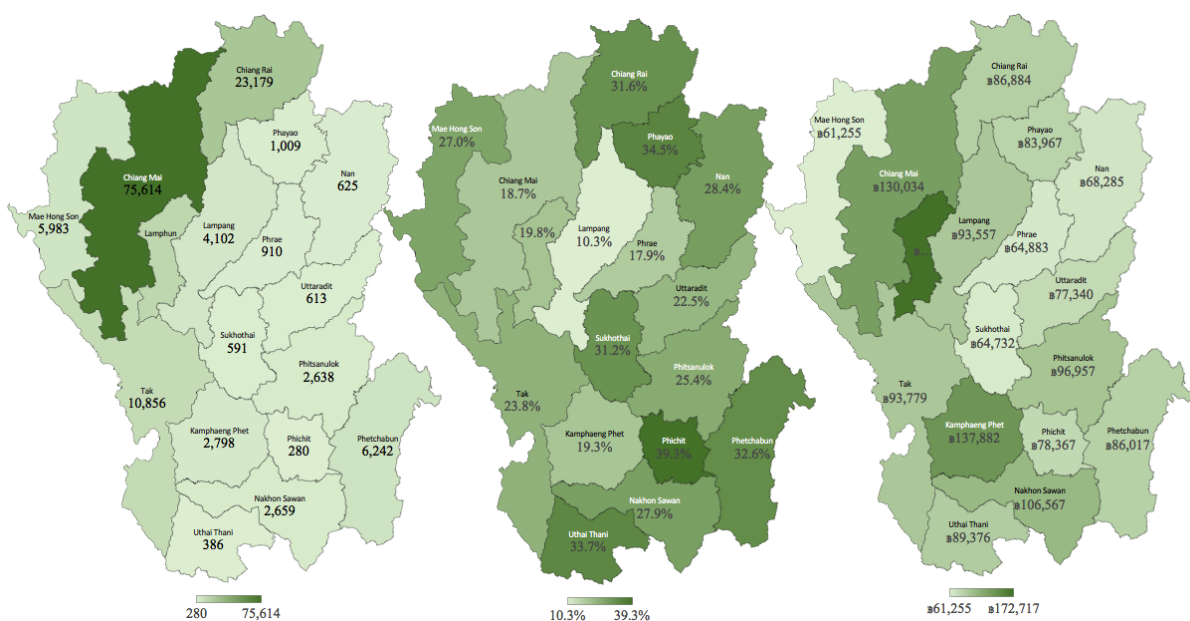


Figure 4. Northern region work permits by province (*left*), percent of GDP in agriculture sector (*center*), and GDP per capita (*right*). Data sources: Thailand Ministry of Labor (2018) and Thailand National Statistical Office (2019).

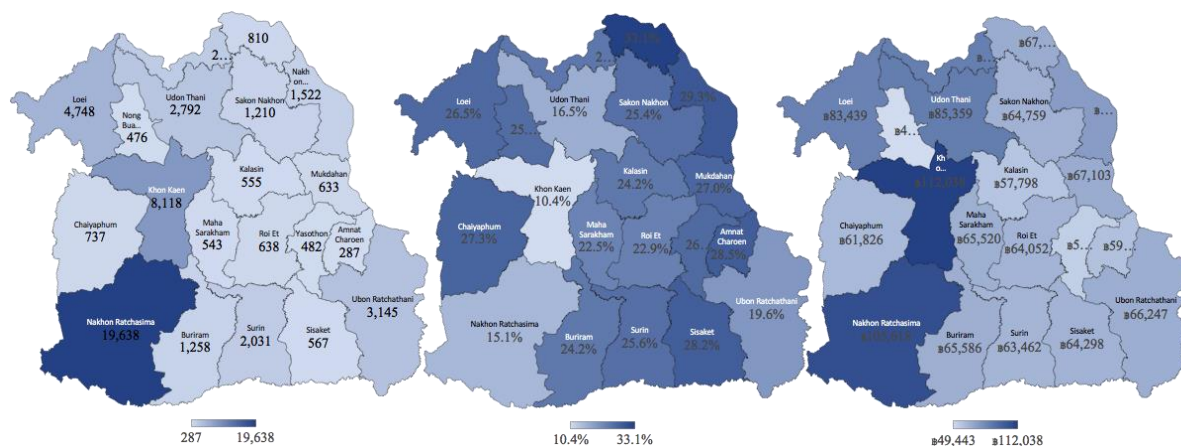


Figure 5. Northeastern region work permits by province (*left*), percent of GPP in agriculture sector (*center*), and GDP per capita (*right*). Data sources: Thailand Ministry of Labor (2018) and Thailand National Statistical Office (2019).

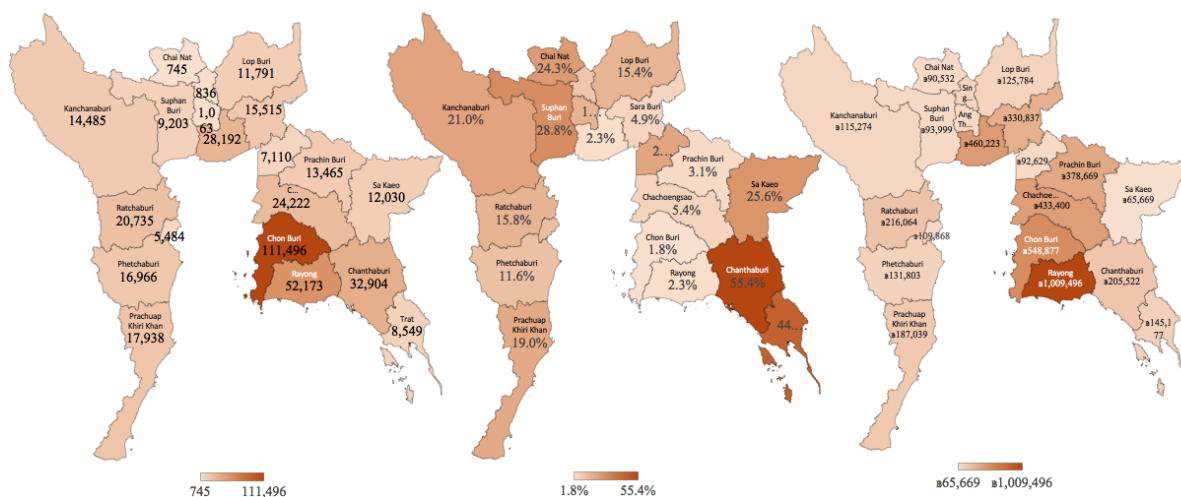


Figure 6. Central region work permits by province (*left*), percent of GPP in agriculture sector (*center*), and GDP per capita (*right*). Data sources: Thailand Ministry of Labor (2018) and Thailand National Statistical Office (2019).

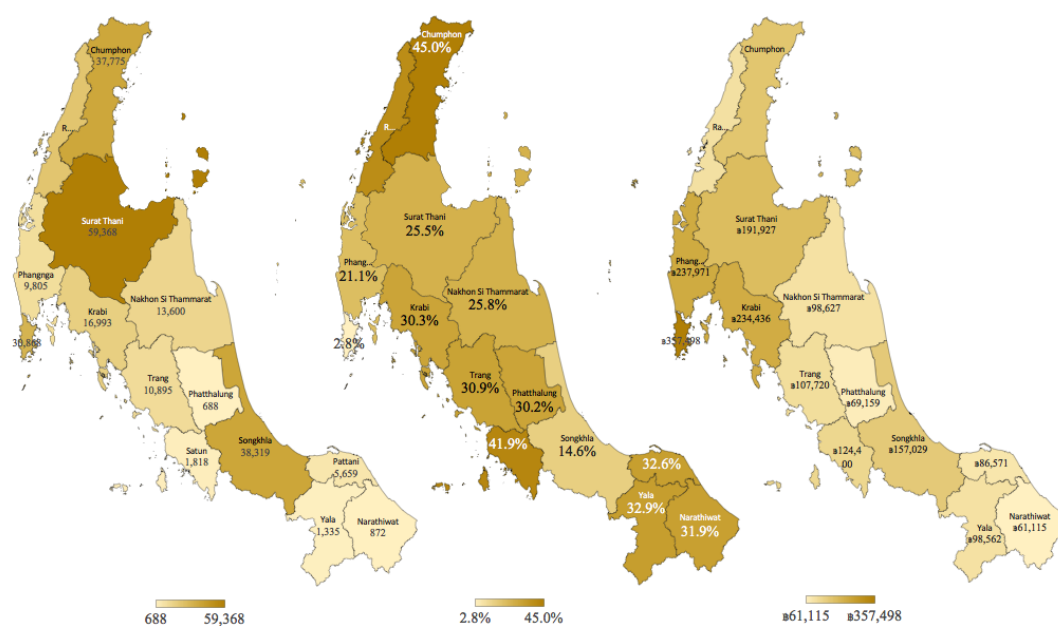


Figure 7. Southern region work permits by province (*left*), percent of GPP in agriculture sector (*center*), and GDP per capita (*right*). Data sources: Thailand Ministry of Labor (2018) and Thailand National Statistical Office (2019).

Peaks and valleys extend from Ranong's border with Myanmar south through Yala and into Malaysia on Narathiwat's west side. Rocky coastlines surround the mountainous spine of the isthmus. The Ratchaphrpha Dam in Surat Thani's northwest corner provides power and some irrigation through watershed rivers that support fruit tree farming. A narrow strip of paddies follows the Gulf coast from southern Nakhon Si Thammarat through Songkhla and into Pattani, which is the only province in the region whose agricultural output is not dominated by rubber tree farming (Thailand Land Development Department 2009; Thailand National Statistical Office 2019). Satun, Phattalung, Yala, and Narathiwat are prime examples of how provincial agricultural involvement, income, and work permit grants are related.

AGRICULTURAL INPUTS & OUTPUTS

Figure 8 shows Northeastern provinces produce the most rice as they have the most land under paddy, but their yields are among the lowest in the country. Rice yield in some southern provinces is higher than in northeastern provinces despite southerners' relative lack of knowledge and experience in farming rice when compared to northeasterners. Likewise, mountainous Chiang Mai province in the north has relatively little paddy land, but still, rice yields are higher than every province in the NE region.

Several factors affect yields in the NE. Most importantly, whereas the rest of the country rarely experiences drought, most of the NE region must deal with it every 2-3 years or more frequently (Thailand Land Development Department 2010c). Anomalous rainfall and increasing temperatures in the NE (Thailand Meteorological Department 2016) pose significant challenges to farmers, but exceptionally low yields in the region cannot be explained by weather or climate alone. Farmers, especially smallholders, across the country, face issues relating to land, labor, and capital.

Farming is a tradition in Thailand. Thai people have worked in the fields for their entire collective history. Farming is as fundamental to Thai identity, along the same lines as religion or the monarchy. Thai farmers are not always particularly economical, business-minded, nor entirely organized in their approach to the trade; that is, the farm is more than numbers, margins, yields, ratios, and calculations. The average Thai farmer is also not well-educated, so his or her knowledge may not extend beyond what she or he experiences while working on a farm, and from living among and talking to other farmers. Word of mouth can generate demand for chemical fertilizers or pesticides or some methods, but common knowledge cannot solve the types of problems that can bring millions of people into a higher income group. Farmers working with only their wits, traditional knowledge, and physical vitality lack the wherewithal to switch crops. The average farmer living on \$3-5 per day lacks the scientific awareness that rotating crops and leaving plots idle may reduce

overall production, but it increases quality and yield which may over time increase production with less land, and that the higher-quality rice should be worth more at market. Thai farmers have improved and continue to do so to the extent possible, given their meager earnings, but there is no efficiency-driven radical transformation of the countryside on the horizon.

Unstable politicization of agriculture

World Bank (2019) provided a metric gauging political stability in various countries. An ANOVA found Thailand's mean political stability rating for years 2006-2016 was statistically significantly lower ($p < 0.0005$) than Australia, Brunei, Cambodia, Canada, China, Indonesia, Korea, Laos, Malaysia, New Zealand, Singapore, UK, USA, and Vietnam. Among the seventeen countries compared to Thailand, only Philippines was rated as less politically stable, but those results were not statistically significant ($p = 0.630$). Two Shinawatra Prime Ministers have been removed from office by military coup: one in 2006. Both Shinawatras were embroiled in corruption scandals and now live in exile. The Thai Supreme Court seized more than \$1.7 billion from Thaksin Shinawatra and nearly \$1 billion from Yingluck Shinawatra (Hookway and Watcharasakwet 2010; Perawongmetha 2016). Shinawatras invented the agricultural subsidy schemes to embolden the farmers, especially in the NE, to vote for them and their parties. In exchange for votes, the Shinawatra parties would buy rice, rubber, and other key agricultural commodities at prices far above market averages, which created a glut of low-quality commodities and a farming population dependent on state price-fixing. Farmers borrowed money from state-sponsored financial programs based on expected earnings from sub-standard products sold back to the government at artificially inflated prices. When the futility and corrupt nature of the schemes were discovered and the military had seized power, prices fell toward what would have been their normal level and farmers were left without sufficient cash to pay debts they owed to their customer: the government. The government had a brief monopsony on extremely overpriced rice that it funded with loans that turned into bad debt, and then much of the rice was spoiled in warehouses because of the artificial boom (The Nation 2015). The government intervention failed to (i) significantly increase Thai farm incomes, (ii) improve yields or quality of crops, and most importantly, (iii) lead to a longer-term solution for ailing agricultural sectors. Thailand's public debt doubled between 2007 and 2017 due in large part to subsidies and payments to financial institutions (Thailand National Statistical Office 2019). Neither the government nor economy can withstand much more fiscal pressure.

Minimalist mechanization

From 2009 to 2016, land area under (i) paddy, (ii) fruit and other trees, and (iii) field crops remained stable in all four Thai regions. While labor is moving into cities and out of agricultural jobs, land utilization remains relatively stable. Rice is the dominant crop in the Northeast and even

trial substitution in search of a higher yield crop is unlikely. Thai farmers use machines to the extent possible considering issues related to terrain and cost, the latter of which subdues more machine purchases than the former. The growth curve for new technology adoption has slowed since the 1980s for the average farmer who might make \$2,000 in a year. These farmers sell their crops, but it is still subsistence living, some with support of Royal Sufficiency Economy projects (Win 2017). Most of the Thai rice, vegetable, fruit, meat, and seafood suppliers incorporate machinery into their operations, and up or down the supply chain different machines are being used in the processes. Two-wheeled tractor plows, roto-tillers, assorted water pumps, sprayers, cleaning equipment, and processing equipment make the Thai agriculture sector many times more efficient than it was forty years ago. When the tractor plow replaced the buffalo, marginal utility for machines was at an all-time high whereas now farmers might not find any benefit of purchasing a weed whacker because a machete and a hoe can do the same job. In other words, the poor farmer is not considering the implicit costs of time and physical energy spent using a simple tool like a knife to do a job a machine could do, like clean the grass and shrubs from between paddies in a terraced field; that farmer knows the machine is faster and easier, but the farmer cannot get ahead enough to afford so much as \$500 for an equipment purchase. At best, the hypothetical weed-whacker would be de-prioritized to the bottom of an already long list of machines the farmer could use but cannot afford. If farmers could afford state-of-the-art machinery, another reality could exist with regards to production, yield, and profitability, but presently farmers cannot afford to adopt radically new technologies despite their better efforts to increase revenues on their croplands and borrow money from the government. Raising farm income is a problem that plagues the entire world.

Fertilizer and production

World Bank (2019) provided data on fertilizer consumption, which was significantly lower in Thailand for years 2006-2016 when compared to China ($p < 0.0005$), Korea ($p < 0.0005$), Malaysia ($p < 0.0005$), New Zealand ($p < 0.0005$), and Vietnam ($p = 0.001$) as assessed by a one-way ANOVA and Tukey post-hoc test. The same tests revealed overall crop yields in Thailand were significantly lower than in China ($p < 0.0005$), Indonesia ($p < 0.0005$), Korea ($p < 0.0005$), Laos ($p < 0.0005$), Malaysia ($p = 0.015$), Myanmar ($p = 0.034$), UK ($p < 0.0005$), USA ($p < 0.0005$), Vietnam ($p < 0.0005$) during the period of fertilizer application. The larger group of countries experiencing higher yields when compared to the group using more fertilizer shows there is not necessarily a direct relationship between fertilizer use and yield. FAO (2006) reported rice farming uses less fertilizer than higher-value vegetable and fruit farming. Malaysia and New Zealand use ten times as

much fertilizer as Thailand, but they have different crops. Over the long term, productivity growth cannot be sustained by increasing fertilizer consumption with any crop (Tirado et al. 2008).

Thailand's yield surged in the rice-subsidy years, then it peaked and fell along with fertilizer consumption in the post-Shinawatra economy. By 2011, the government was paying 50 percent more than the market price for sub-standard rice (Kyozyuka 2017). Farmers were selling more, lower-quality rice for higher prices. Figure 9 shows yield rises did not continue as production peaked and fell in 2011-2013, even amid increasing fertilizer consumption. Data represented in the graphs were for the whole Kingdom of Thailand and not by province or region.

The 2003 agricultural census showed NE farmers were earlier adopters of fertilizer with only three percent not using compared to 10.5-17.7 percent in N, C, and S regions. At that time, more farmers in the NE region had shifted to a blend of organic and non-organic fertilizers; farmers in C, S, and N regions were more likely than their NE counterparts to use exclusively organic fertilizers (Thailand National Statistical Office 2019). Waraporn (2017) compared inputs and outputs in N, C, and NE regions and found that while yields were lowest in the NE, fertilizer use was the highest, but studies suggest increasing fertilizer use is unlikely to increase yields or profits, and it comes with social risks. Nahm and Sutummakid (2015) found low marginal productivity of fertilizer in the Central region. Aditto (2010) found farmers' lack of knowledge in the Central region resulted in excessive use of chemical fertilizers in irrigated rice paddies which increased costs and polluted soils while failing to achieve optimal yields. Yields peaked and declined while fertilizer consumption was growing, suggesting the optimal level fertilizer use may have been exceeded. Furthermore, studies have shown agricultural chemical usage carries serious environmental and health risks. Doi and Pitiwut (2014) found the optimal level of fertilizer and pesticide, or herbicide use for health and safety does not produce the maximum yield. Panuwet, et al. (2012) discussed high morbidity rates in the N and NE due to agrochemical exposure.

Capital disconnect

Waraporn (2017) found Northeastern farmers faced higher prices for n-p-k fertilizers, pesticides, and human labor. The only significantly lower cost in the NE was organic fertilizer, likely due to an abundance of animal waste in the NE – the runaway leader in livestock rearing (Bank of Thailand 2019). Titapiwatanakun (2012) cited world oil price fluctuations as influencing the rise in chemical fertilizer prices and concluded that, given cost constraints, rice yields are unlikely to rise barring introduction of cultivars of higher-yielding plant strains, but such research and development also requires investment capital that is in short supply.

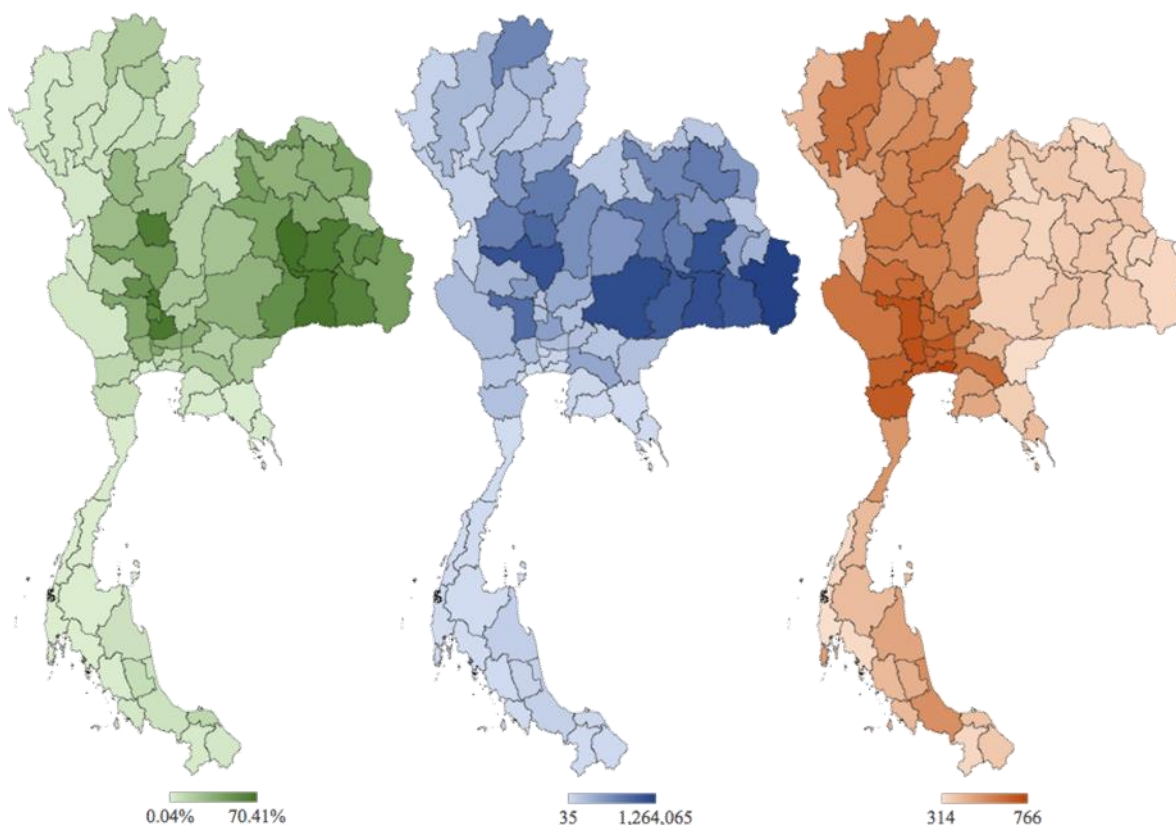


Figure 8. Percent of province under rice paddy (*left*), annual rice production by province, in tons (*center*), and rice yield by province, in kg/rai (*right*). Data sources: Thailand Ministry of Labor (2018) and Thailand National Statistical Office (2019).

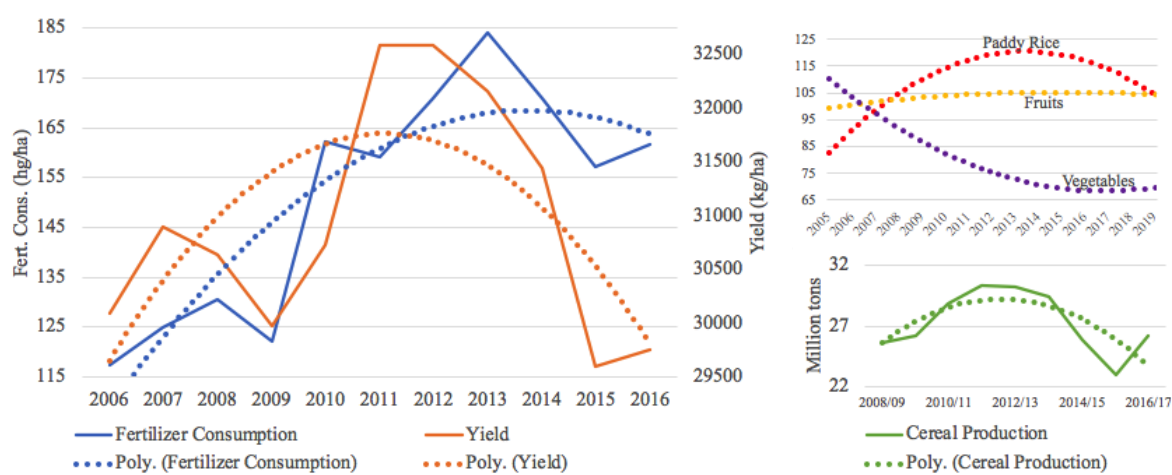


Figure 9. Thailand fertilizer consumption and yield with second-order polynomial trendlines (Left), trendlines for production indexes of Thailand paddy rice, fruits, and vegetables (*upper right*), and Thailand cereal production with second order polynomial trendline (*lower right*). Data sources: World Bank (2019), FAO (2019), and Thailand Bureau of Trade and Economic Indices (2019).

Residents in most provinces without major industrial estates or tourist attractions lack access to formal financial systems, but none as much as in the NE region where there is fewer than one bank branch per 10,000 adults (Bank of Thailand 2017). Family farms are typically excluded from commercial credit markets due to low and unpredictable

income, and the NE is mainly family farms. Each successive government has offered support by way of interest payment reductions through the Bank for Agriculture and Agricultural Cooperatives (BAAC), from which more than one million rice farmers borrow between a few hundred and tens of thousands of dollars (Chiang Rai

Times 2018). Debtors use their crops or land as collateral, but debt payments frequently become unmanageable between price fluctuations, flooding, drought, and declining yields (Kyozuka 2017). Table 1 shows key balance sheet statistics at BAAC which between 2012 and 2017, saw rises in the numbers of loans, doubtful accounts, and bad debts amid simultaneous falls in return on assets, return on investment, and capital adequacy ratio (BAAC 2019). The agriculture sector faces flat and falling production indices across all crop categories, increasing costs that affect the poorest rural districts most, and neither is capital available to rapidly improve mechanization nor is increasing fertilizer use a likely solution.

Labor shortage

Migrant flows into all economic sectors increased following the 2015-2016 launch of the AEC and related bilateral and multilateral mutual-recognition agreements on labor migration. Agricultural work permits still lag those for industrial jobs, despite agriculture's greater demand for labor (World Bank 2019). Figure 10 shows flat migrant flows into agricultural sectors in the ten years prior to launch of AEC with still insufficient labor to meet job demands. Kampan (2019) surveyed 203 migrant workers from Myanmar who worked for 40 businesses. Employers complained of lengthy, complicated, and expensive work permit processes, which contributed to agricultural labor shortages for employers and resulted in wage expenses that exceeded those costs in construction, manufacturing, and services by 30 percent or more. Kampan (2019) also surveyed 147 migrants from Cambodia whose 60 employers likewise paid the highest daily wages to agricultural workers. Two-thirds of Burmese and three-fourths of Cambodians had prior work experience in Thailand – their chief complaint was high costs and complicated legal processes. Ninety-five percent of employees surveyed were referred from a friend or family member rather than recruited by an agency; such suboptimal recruiting alongside premium wages suggests serious inefficiencies in the process.

Table 1. Change in key financial data at Thailand's Bank for Agriculture and Agricultural Cooperatives. Data source: BAAC (2019).

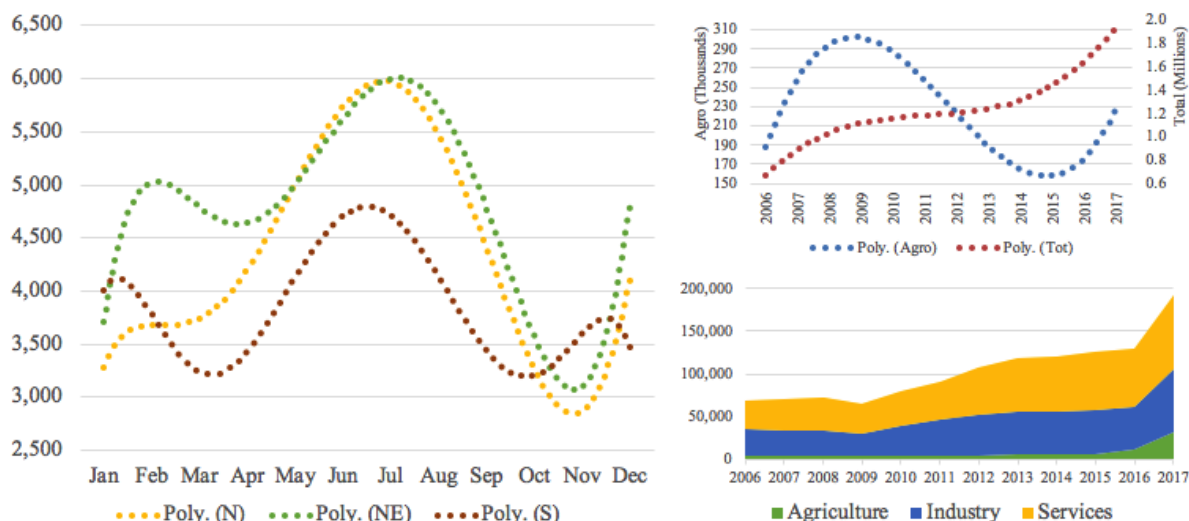
Outstanding Loans:	57%
Doubtful Accounts:	60%
Bad Debts:	38%
Percent of Loans Non-Performing:	10%
Loans/Deposits:	2%
Return on Assets:	-29%
Return on Equity:	-25%
Capital Adequacy Ratio:	-12%

A Pearson Correlation analysis showed a province's number of work permits issued shared a high positive association with GPP ($r(32)=0.850$, $p<0.0005$), and provincial work permits shared a strong negative correlation with the proportion of land under paddy ($r(32)=-0.633$, $p<0.0005$), whereas no statistically significant relationships were found between work permits and land under field crop or fruit/food trees. One possible reason is the legal restrictions of some agricultural employment categories for foreigners under the (Thailand Ministry of Labor 2009; Thailand Board of Investment 2015). Also worthy of mention, is that data do not include employment of foreign laborers in violation of legal work permit requirements. The Thai government recognized some 3.8 million such migrant workers from Myanmar, Laos, and Cambodia whom immigration authorities seek to legalize as quickly as possible (Xin 2018). While migrant-inflow statistics show increasing legal entry and employment, there already exist millions of undocumented migrants, and the sum of all these foreign workers plus the Thai labor force still does not satisfy all labor demand. Table 2 shows sizeable increases in available jobs in primarily-agricultural northeast and multi-sectoral central regions between 2008 and 2017 whereas urban Bangkok's job vacancies decreased significantly in the same period.

Figure 10 shows that job vacancies throughout 2017 rose and fell with the crop cycle in the north, northeast, and south regions. Job vacancies in all regions peaked in the main planting season at the start of the rainy season; another relative maximum for N and NE regions is found in the winter harvest months; a third relative maximum around the dry-season planting phase is clearest in the NE where most of the country's rice is planted. The rise and fall of job openings coinciding with the plant and harvest seasons suggest these variable labor demands are in the agricultural sector, and that Thai people cannot or do not want to fill these positions. Assuming the difference between peak and valley on the 2017 jobs graph is attributable to agricultural demand, there were over 2,000 unfilled seasonal agricultural jobs in the S, more than 3,500 in the NE, and over 3,800 in the N. Thus, at least 10,000 more seasonal agricultural work permits were needed in three regions in 2017. The same method of calculating foreign agricultural labor demand (maximum minus minimum if following the crop cycle) yields an estimate of nearly 15,000 additional agricultural work permits required in the Central region, but industrial and service capacity in the region presents potential interfering variables that cannot be isolated. Figure 10 also shows that while total migrant stocks consistently increased between 2006 and 2017, migrant stocks in agriculture experienced approximately no growth overall. In the same period, ten percent of the Thai labor force exited the agricultural sector and total farmlands in the country remained flat alongside use of farm machines (FAO 2019), again indicating agriculture has been experiencing labor shortages.

Table 2. Job vacancies in Thailand by region, years 2008-2017. Data source: Thailand National Statistical Office (2019).

Location	Minimum (year)	Maximum (year)	Mean	% Change 2008-2017
Bangkok	80,236 (2017)	142,007 (2008)	104,188	-43%
Central	108,742 (2014)	194,546 (2013)	146,773	35%
North	43,837 (2011)	71,649 (2013)	58,358	-12%
Northeast	48,871 (2008)	104,143 (2013)	65,933	16%
South	46,707 (2009)	64,658 (2010)	56,150	3%

**Figure 10.** Trendlines for Thailand job vacancies by month and region for year 2017 (*left*), trendlines for total migrant stock versus migrant stock in agriculture (*upper right*), and migrant inflows by employment sector (*lower right*). Data sources: ILO (2018), Thailand National Statistical Office (2019), and FAO (2019).

Northeastern soil infertility

Districts throughout the Kingdom experience infertile soils, but nowhere is soil as problematic as in the NE. The map shows the Udon-Sakon Nakhon Basin in the north and Korat-Ubon Basin in the south, under which lies Maha Sara Formation of rock salts. The geological formation underlies over one-third of the NE and is the source of saline soils in the region (Mongkolsawat and Paiboonsak 2006). The map is color-coded where the darker colors indicate more problematic soils as reported by Thailand's Land Development Department (2019) in their analysis of 62 soils found throughout the Kingdom. Just under 12 percent of the nearly 169,000km² in the NE are plagued by saline soils. High-salinity soils cover more than 1,000km² more than 15,000km² are moderately saline; greater than 16,500km² have low salinity. Not all saline soils are found on agricultural lands. Coincidentally, Nakhon Ratchasima and Khon Kaen provinces both have highly problematic soil and have the lowest percent of their economies in agriculture. Farmers in those provinces, and elsewhere around the region, still struggle with soil fertility. To make matters worse, farmers may not be planting the best crops or using optimal fertilizers for their soils; their knowledge deficit precludes their independent soil analysis and mitigation strategy deployment, and their lack of capital, or

access thereto, prevents them from outsourcing services. Soil fertility limits the variety of crops suitable for a farm; it contributes to production, yield, and quality which affect pricing in the market after harvest.

Agriculture and food markets

Price and production indices for agricultural commodities peaked in the years prior to the coup, after which time they consistently fell. Government subsidies artificially raised prices, and Yingluck Shinawatra's infamous rice-pledging scandal artificially increased production where demand had not increased, leaving behind warehouses full of decaying rice. Figure 12 shows cyclical production rises and falls against peaking and declining prices over more than a decade.

While production peaks maintain near-record highs, prices slump downward. Inflation in food products was significantly higher than other commodities earlier in the cycle, which benefitted farmers and others downstream in the value chain. Previously erratic prices were tamed under the Prayut government, which benefitted consumers, but without government handouts or price controls, food sellers faced deflationary pressures. Data shows food sellers experienced a growth market in the mid-00s, which attracted workers. The larger, more-profitable sector could

support more laborers, but when inflation dropped below ten percent and then again into negative territory, wages were some of the first accounting entries to get cut. Figure 13 shows deflation hit all commodities in 2016, signaling trouble in the larger economy and pushing food prices further downward and into negative territory in 2017.

Volatile inflation plagued meat, eggs, and dairy for over a decade. Figure 13 shows inflation for eggs hit 13.41 percent in 2005, and then fell to negative 12.93 percent in 2006, and again rose to 13.56 percent in 2008. Inflation for eggs was highest in 2013, only one year after negative 8.83 percent movement in price. Meat inflation peaked in 2008 at 19.67 percent, one year after experiencing deflation of 6.92 percent. Fresh vegetables and to a lesser extent fresh fruits experienced similarly unpredictable inflationary swings between 2005 and 2018, during which time vegetable prices fell from over 32 percent, down to negative territory, then back up to over 20 percent, and more recently bounced between deflation and inflation higher than national averages. Agricultural commodity markets were astoundingly insecure over more than a decade. When BAAC and other banks rate farmer credit based on future crop and food sales, such volatility makes it impossible for lenders to approve larger, longer-term loans. As a result, optimal mechanization has been limited to the largest and most profitable 5-10 percent of all farms. Farmers cannot purchase more land without long-term loans, and without more land they cannot justify short-term losses associated with crop shifting. With less than 2 hectares (ha) of land, farmers cannot afford to lose one single Baht at any time, so they cannot bear the prospect of setting a fraction of that land idle even though shifting crops could make fifteen-sixteenths of the land do more work than the whole by increasing yield, quality, and therefore, price.

Whereas overall, the Thai economy has been improving, growing, and trending consistently upward, agricultural earnings peaked during the corruption years and have only trended downward to the extent that no growth is present over a decade. Agricultural workers and people involved in trade of raw foods have no higher income than they did ten years ago but their costs are higher. In fact, producers in agriculture and food sectors experienced greater cost inflation than most other sectors (Thailand Bureau of Trade and Economic Indices 2019). Agriculture and food sectors were once a source of inflationary pressure, but by 2019 their personnel was in a market where the price of virtually everything except food was rising. To make matters worse, in rural areas where agriculture provides the most jobs, inflation is generally higher than in more urbanized areas. Inflation was even higher in the poorest NE region (Thailand National Statistical Office 2019).

Value-added in agricultural sectors went into decline starting in the 2014 coup period that saw an end to the Shinawatra administration's controversial rice subsidy program. Deeper examination shows growth in agriculture was flat in 2008-09, and the growth spurt the sector experienced from 2010-14 was probably due only to the

artificially-inflated prices the government paid farmers under the scheme, which cost the government as much as \$16 billion (Corben 2014). Agriculture dominates the economy in the Northeastern region where adults have the lowest education on average compared to other regions. When agriculture slumps, labor cannot easily migrate into other industries due to lack of knowledge and skills. People in the Northeast were particularly susceptible to Thaksin and Yingluck Shinawatra political appeal as their governments provided income where none was otherwise present; that the subsidy programs were corrupt and put the nation in debt hardly mattered to many citizens as much as the cash in hand they enjoyed under Shinawatras. Life was easier for farmers when they could upsell low-quality crops to a government that financed and forgave debts. Those farmers developed dependency on government rescue funding because local economies have been otherwise depressed compared to more urbanized provinces where average incomes are 10-20 times higher. Farmers in a post-Shinawatra nation were left to deal with economic realities that previous policies and regimes hid from the populace.

The price of most food products has been flat over nearly two decades. Food exports fell and imports rose between 2011 and 2018 (Thailand Office of Agricultural Economics 2019), during which time Thailand lost its top ranking for rice exports. During the Yingluck years, Thailand's share of the Hong Kong rice market fell from 90 to 45 percent because the government outpriced the market trying to pander to farmers stuck in a market of stagnant prices (Janssen 2018). Understandably, Thai farmers are frustrated that they cannot push a higher price in the market, and unlike potato chip or ice cream producers, farmers cannot adjust the size to reduce costs and improve profits – a kilogram of rice or fruit or vegetable is always going to have a kilogram of that food in it. Similarly, the price of Coca-Cola was stuck at five cents for 70 years, through three wars, the Great Depression, the rise of Pepsi as a competitor, and of course, rises in producer costs. "Prices have this psychological component," explained David Kestenbaum (2015). Coke's consumers rejected attempts to raise the prices for decades, and the only way for Coca-Cola to make more money was to sell more sodas. Using data from Thailand's National Statistical Office (2019), a Pearson product-moment correlation showed that, for years 2009-2016, the Baht-value of Thailand's Agricultural GDP shared a strong, positive association with rice production in tons ($r(8)=0.899$, $p=0.002$) none with rice yield ($p=0.206$). Kendall's Tau and Spearman Rho correlations confirmed strong, statistically significant relationships between Agro-GDP and rice production ($r_s(8)=0.905$, $p=0.002$), ($\tau_b(8)=0.786$, $p=0.006$) but not rice yield ($r_s(8)=0.473$, $p=0.105$), ($\tau_b(8)=0.599$, $p=0.117$). These statistical tests are only crude measures of association, but given all other conditions and factors detailed in this report, they are not without merit. Like Coca-Cola, for Thai farmers to make more money, they may have to make and sell more food.

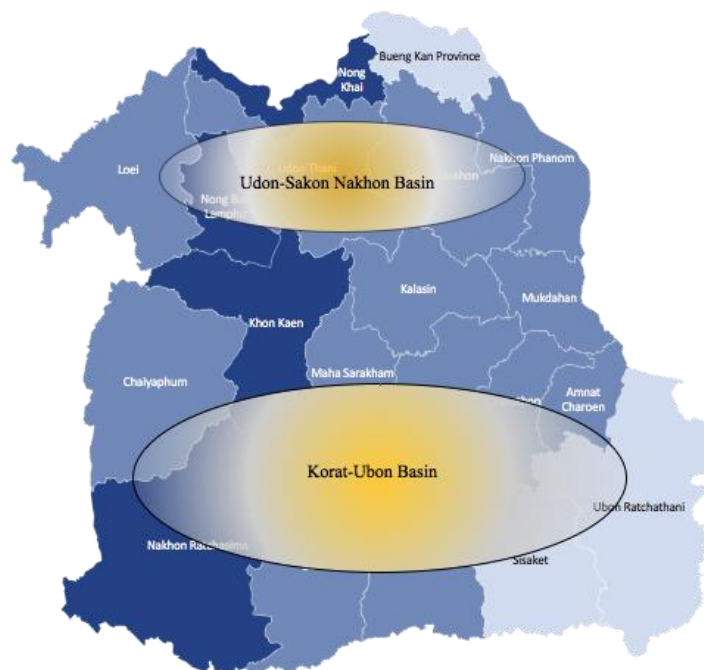


Figure 11. Northeastern region soil quality. Darker colors represent less fertile soils. Korat-Ubon and Udon-Sakon Nakhon Basins are rock salt formations that reduce soil quality. Data sources: Thailand Land Development Department (2019).

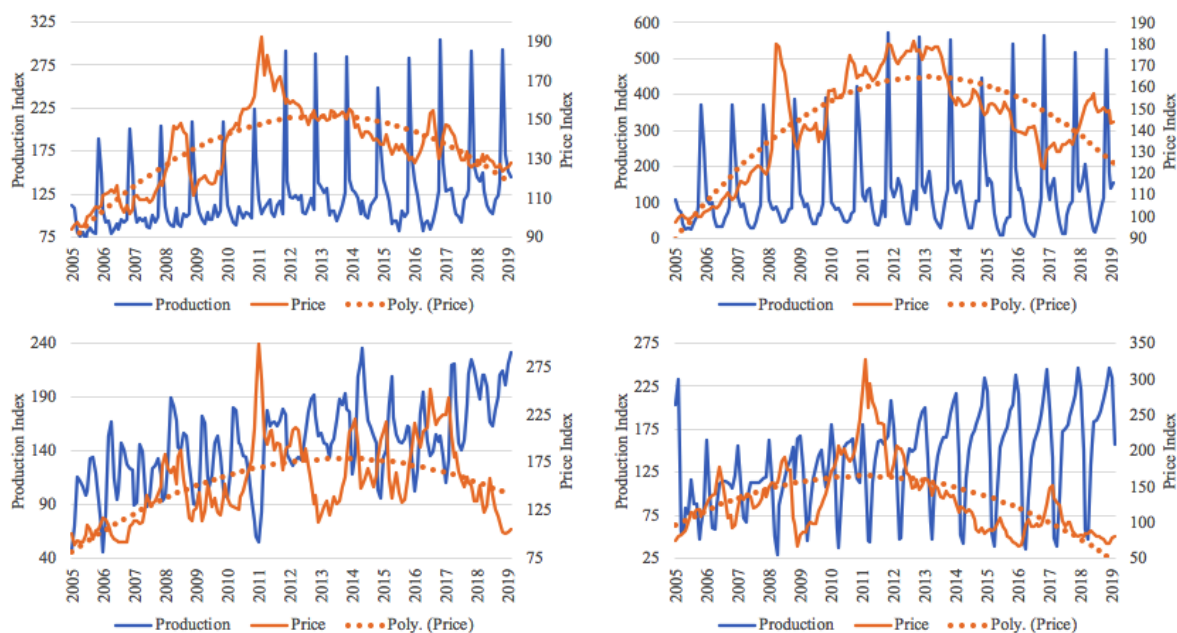


Figure 12. Price and production indices and price trendlines for all agricultural (*upper left*), grains (*upper right*), oilseeds (*Lower Left*), and perennial crops (*lower right*). Data sources: Thailand Office of Agricultural Economics (2019).

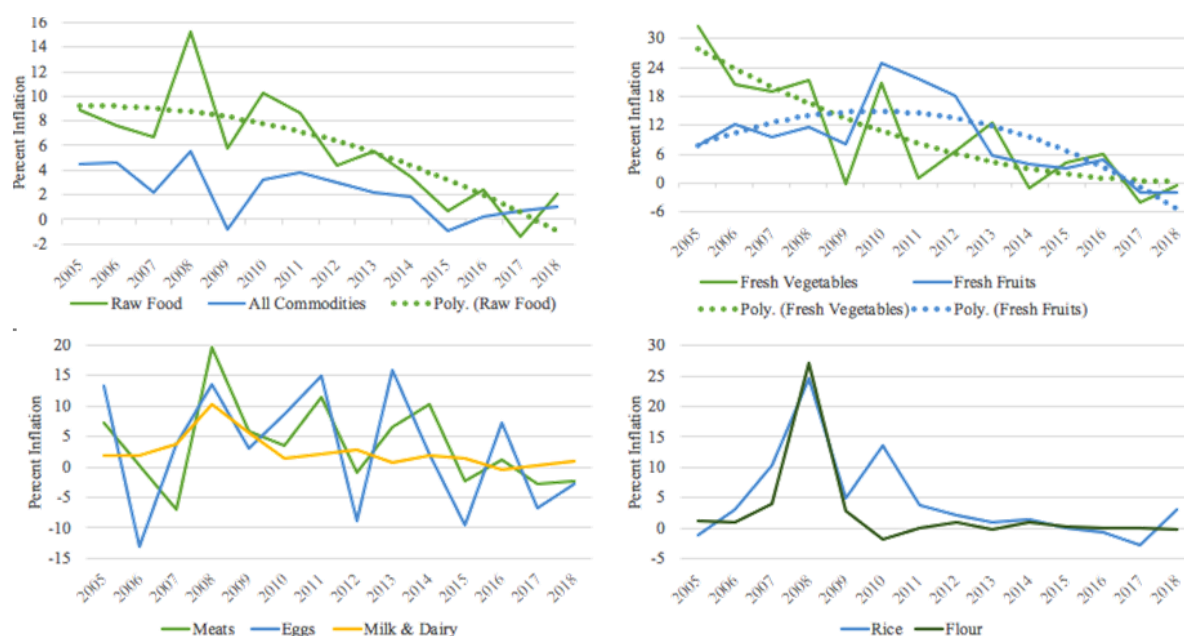


Figure 13. Consumer price index for raw foods and commodities, with trendline for raw food (*upper left*), fresh fruits and vegetables with trendlines (*Upper Right*), meats, eggs, milk, and dairy (*lower left*), and rice and flour (*lower right*). Data sources: Thailand Office of Agricultural Economics (2019).

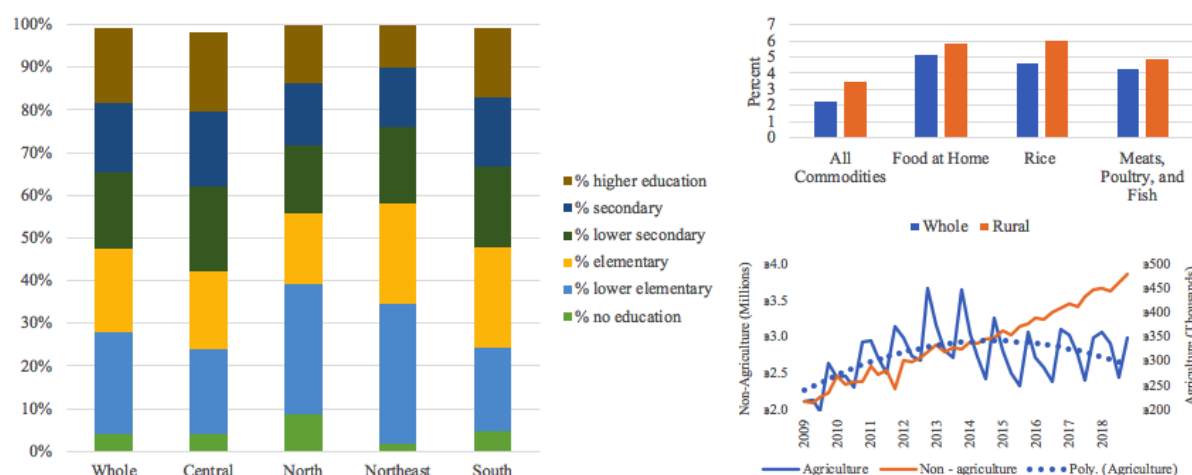


Figure 13. Percent of Thailand's adult population by highest educational attainment, separated by and region (*left*), average national and rural annual inflation for years 2005-2019, for all commodities and select foods (*upper right*), GDP for agricultural and non-agricultural sectors, with trendline for agricultural sector (*lower left*). Data sources: Thailand Bureau of Trade and Economic Indices (2019), Thailand Office of Agricultural Economics (2019).

DISCUSSION

The Thailand Constitution (2017) at §75 mandates that the State organize a fair and equitable, competitive economic system devoid of monopolistic practices, and in accordance with the Sufficiency Economy. Section 75 also recommends the State “promote, support, protect and stabilize the system of various types of cooperatives, and small and medium enterprises of the people and communities”. The 2017 Constitution mentions the

sufficiency economy twice and sustainability thirteen times; both can be the basis of actions under Chapter XVI on National Reform, which requires the government to work diligently and consistently toward ideals in several areas: politics, administration of State affairs, law, judicial processes, education, economics, sustainable water and waste management, fair land distribution, and appropriate health care regardless of socioeconomic status. The Constitution sets out such ambitious goals that it can easily justify virtually any bona fide project intended to relieve

symptoms of poverty and help lift people into higher income classes effectively and efficiently. The Constitution at §52 provides that armed forces shall be deployed for national development; under that section, the government could employ new personnel or redirect existing military human resources to conduct in-depth social, economic and market research, then develop plans that satisfy local needs, carry out such plans until incremental and collective change occur, and follow up with the next generation of locally-tailored initiatives.

The future is mobile, connected, interactive and within reach. That future could include a \$13,000 annual income for the average Thai farmer if Thailand's government can muster the resolve to pursue overarching Constitutional goals of fairness, inclusion, socioeconomic equity, and sustainable development. Achieving the government's income objectives for farmers would bring the agricultural sector back on track to perform on par with the rest of the economy and may ultimately be the key to moving Thailand out of the middle-income trap. To spur growth, increase opportunity, and organize the collective effort, the government should partner with private individuals and organizations with the aim of modernizing the agricultural sector.

Creating opportunity via licensed agencies and collectives

Once people have a taste of cash and credit subsidies, a democratically-elected government cannot easily withdraw such "entitlements" as they may be perceived on the receiving end because the duty of such a democratic government is to deliver the will of the people. Indeed, even the fiscally-conservative Prayut junta government reintroduced soft loans to village lending funds, \$365 million in price subsidies for rubber farmers, and \$1 billion in aid to rice farmers (Lefevre 2015). There is implicit social and moral value in any policy or program aimed to improve the quality of life for millions of people who live on \$5-7 per day or less. OECD governments spent \$228 billion on agricultural producer subsidies in 2016. Indonesia spent over \$30 billion in 2014 and 2015, and the Philippines consistently provide more than \$6 billion in annual producer support (OECD 2017). Branding itself as the "kitchen of the world," Thailand has a compelling interest in ensuring the agricultural sector establishes and maintains a sustainable competitive advantage (Arunmas 2018).

Thailand is a good candidate for agricultural subsidies considering how integral the sector is to the Thai economy and global food security. The government provides foreign billions of dollars in tax and non-tax subsidies to private corporations (PWC 2018), mainly in non-agricultural sectors which propelled overall economic growth beyond the plateauing agricultural sector. The government, under its campaign for fairness and equity, should then have no clear reason not to provide billions of more dollars in aid to farmers who collectively comprise some 80 percent of the sector. However, the government should know by now that merely intervening in commodity pricing is not an appropriate measure; instead, the state should turn to a more holistic aid package, including education and training

on farming methods, mechanization, optimal pesticide, and fertilizer utilization. Rather than distort prices of the commodities, the government should continue to subsidize interest on loans for machines and seek to erase pricing discrepancies for chemical and organic inputs across the country, so poorer farmers do not suffer higher prices. Finally, the government needs to help get farmers and collectives organized. Luckily, there are several ways the government can both aid and collect revenues from expanded work visa and permit processing. Joint public-private agricultural cooperatives can also help to streamline the recruitment, processing, transfer, and compliance assurance for seasonal migrant workers from neighboring Cambodia, Laos, and Myanmar.

Government-sponsored education and training

In 2012, integrated or diversified farms accounted for 0.01 percent of agricultural lands in the Kingdom (Thailand Land Development Department 2012). About half of those roughly 44,000 farms were in the North and slightly more were in the Northeast, with virtually none in any other region. More recently, rubber farmers have begun intercropping to offset lost income due to depressed global rubber market prices, but still, most farmers practice monoculture (Jongrungrat, Thungwa, and Snoeck 2014). Maize farmers have reduced crop diversity in response to increased demand for corn feed for animals, especially from the domestic Thai poultry industry (Nusch 2018). The National Statistical Office (2019) provided data showing maize-corn production increased by 15 percent from 2008 to 2017 without increasing overall land use, suggesting a combination of increased fertilizer use and monocropping. Panyalue, et al. (2018) found intercropping legumes with maize reduces erosion, increases soil fertility and grain yield, but farmers are either not privy to such information or do not know how to use it to their advantage. In the same vein, swine rearing in the Central, Northern, and Northeastern regions grew by 85, 60, and 51 percent, respectively, between 2008 and 2017 (Thailand National Statistical Office 2019), but the resulting organic manure fertilizer cannot be properly capitalized upon without proper animal waste management. Sub-optimal waste management is likely a contributory cause of Thailand's higher agricultural emissions compared to Canada, Korea, Malaysia, Myanmar, Philippines, and the UK (FAO 2019).

Farmers may lack more than a few years of formal education, and they may not have an iota of knowledge on issues of agricultural economics or ecology even in cases where they attained higher levels of education. Thailand has some of the highest rates in the world for internet use, smartphone use, and mobile commerce penetration (Magenat 2018). Thailand's twenty-first-century farms are globally connected. The government can exploit the Kingdom's mobile-mania by developing sleek, user-friendly apps to engage farmers with instructional videos, illustrations and graphics, tutorials, volumes of data and information, and real-time consultations with experts on issues affecting their livelihoods. Government-funded smartphone apps can help academicians and local farmers coordinate meetings, site visits, and practicum

demonstrations. Governments can further engage the public with increased social media presence, and actively market their services directly to farmers' mobile accounts.

Government-backed financial collectives

Barnaud et al. (2006) estimated 85 percent of NE farmers are smallholders. If all agricultural land were split evenly between all 5.9 million farm holders, the average farm size would be just over 4 ha. Sources suggest as many as 90 percent of Thai farmers have less than 2 ha – not nearly enough for commercial operations (Gypmantasiri et al. 2001, Pensupar 2015; Soni 2016). Chainuvati and Athipanan (2001) found several past development initiatives failed because they did not realistically consider the limited resource base of smallholder farms. FAO (2018) reported that five million of the country's poorest seven million people live in rural Northern and Northeastern districts. In 2016, average incomes in 14 of 20 NE provinces, 4 of 17 N provinces, 2 of 14 S provinces, and 1 of 20 C provinces were below the national minimum wage of 300 Baht per day (Herbert Smith Freehills LLP 2016), and that is assuming 20 working days in the month when, for farmers, there may be 30 working days in a month, thereby decreasing the value of their labor even further. Meanwhile, the government set a goal of achieving per capita farmer income of \$13,000 per year over 20 years (FAO 2018) – or 20-40 percent average annual increase through the year 2040. If farm wages are to grow even half as much as the government proposes, capital cannot remain a scarce resource for smallholders.

The government already backs BAAC and community-based lending through the Village Fund, welfare cash assistance to 5.8 million people living on 100,000 Baht or less, and other initiatives (FAO 2018), but millions of people still fall through the cracks. Saengpassa (2017) reported the Village Fund sparked the creation of 2,560 community-based financial institutions, and its non-performing loan rate is around 4 percent – equal to that at BAAC. Lewis, et al. (2013) recommended expanding Village Fund-style community micro-loans to reach the poorest of the poor. Winn (2018) reported on a mobile app called Ricult that uses GPS, weather, and satellite data to predict yields for a farmer's plot of land. Ricult has partner banks in Thailand that use the app's forecasts as an alternative or supplement to the bank's credit metrics. Unfortunately, very few farmers can afford to pay for such services, but the idea is revolutionary. The government has the know-how and funds to independently construct or commission development of a competing app that targets the poorest smartphone users in agricultural sectors. Just as social media and cellular data are collected for private monetization, the government could use personal data to target microloans and extend the reach of subsidized credit to the poorest 1 percent. Strategic distribution of medicinal marijuana production licenses under Thailand's revised Drug Abuse Act (2019) could reduce risks that financial institutions face in lending based on future crop yields as the value of marijuana crops are stable, high, and sustainable. Albeit a significantly impactful advancement

in domestic legislation that stands to benefit the agricultural community immensely, these new opportunities in licit marijuana cultivation are no panacea for the Thai agriculture sector as the market cannot realistically sustain hundreds of thousands of licensed suppliers.

Extending financial services in the form of microloans to millions of people turns the flywheel another time, but it does not have the potential to raise incomes by 20-40 percent per year for 20 years as would be required to reach the government's \$13,000 per capita farm income goal. In macroeconomics, participants use debt to increase growth, but banks cannot realistically offer Thai farmers as much debt as they would need to develop their farms into \$13,000 per year systems; there is too much risk involved in beginning stages when farms are virtually worthless in their commercial capacities. Only government institutions can sustain the type and magnitude of risk and stress involved in shepherding the poorest people out of poverty through loans, grants, and other forms of assistance. As such, the Thai government should take steps to inaugurate and oversee agro-union-collectives that organize relief, aid, and assistance for smallholders who are largely detached from formal economies.

Local unions could manage collectively-owned machines, seed stocks, fertilizers, pesticides, and herbicides. Farmers could buy into a union on fee schedule, and their membership class would entitle them to certain rights to use machinery or take seed or other inputs. Army engineering corps could be involved in operation and maintenance of heavy equipment. A mobile phone app could simultaneously serve as a means of organizing distribution of inputs, scheduling of machine usage, and as a connection portal for farmers to share ideas, research market prices, and seek credit. As mobile phone dongles continue to improve, the app could provide real-time soil analysis. Farmers could take samples from parts of their fields as directed by the app which uses GPS coordinates and cloud-based soil reference data to provide the best possible advice to each unique farm and its many parts. All of this could occur remotely and with only limited human resources due to advances in artificial intelligence. Thailand's Land Development Department (2019) already categorizes 62 unique soil profiles, providing geographical information of each soil and potential mitigation strategies for problem soils.

Government-assisted purchasing and distribution collectives

Economic and financial data have consistently shown that the average Thai farmer lacks access to capital in amounts necessary to make big purchases like, for example, a truck to haul the harvest away from the farm and to a market where multiple buyers compete to purchase the crop. Throughout the Kingdom's rural districts, particularly in mountainous regions where there are few and unsteady roads, farmers are isolated and subject to unfair pricing by buyers who drive out to villages and pick up crops. A farmer may only have a few such potential buyers in a season and must choose to sell at a low price because there is no other way to find a buyer. Wholesalers

and middlemen who troll villages looking for the lowest possible purchase price may engage in price-fixing, territorial restrictions, or other anti-competitive practices, but the Thai courts have yet to resolve this complicated problem. By connecting buyers and sellers, the Ricult (2016) mobile app provides solutions to problems of low bargaining power and exploitative commissions, but again the farmers facing the most unscrupulous treatment cannot afford more than a few dollars for an app. The government is the only possible sponsor for a comprehensive online service that could link millions of poor farmers with buyers who make competitive offers at or near market prices.

The government could provide funding and support for the launch of a mobile service that would radically change agricultural markets. Rather than the government buying rice, it could facilitate proper futures and spot contracts for all sizes of harvests, in every raw food category, and local union collectives could help with hauling in collectively-owned freight vehicles. The Stock Exchange of Thailand, Ministry of Agriculture, and National Statistical Office could use data collected via the app to forecast commodity prices, and to develop crop-science and agronomics-based responses to volatile or falling prices. Such an app could revolutionize agricultural economies throughout the Kingdom and beyond, but only the government can bear the upfront financial costs and short to medium-term risks that bringing such an app to market would entail. Local agro-unions could use the same app to make bulk purchases of chemical and organic fertilizers, pesticides, herbicides, seeds, and other agricultural commodities. Bulk purchasing arrangements would allow farmers to drastically reduce their cost per input.

Government-licensed agencies for recruitment and handling of foreign labor

Small landholdings in the less productive areas of the country make it impossible for all the individual families to get the help they need during peak seasons. Smallholders do not have the budget or human resources to recruit anybody except neighbors or whoever may be around in the village or nearby. Government-licensed staffing agencies, working in concert with local agro-unions could ease logistical burdens for smallholders who might only need a week or two of labor. Alternatively, the government could support development of a mobile app that linked farmers with labor. A team of businesspeople, software developers, and farm representatives could develop an ad hoc platform that matches farm employers and employees. In cases involving foreign labor, licensed agencies could purchase a subscription to the app service that allowed them to act as intermediaries between employers and employees who all bid on jobs of all sizes. Whether through an app or a more old-fashioned process at union offices, a foreign labor agency could organize temporary work permits for any number of people with specific skills and then manage transportation, housing, payroll, and compliance with immigration law to prevent visa overstay. Some workers could stay in one farm for the duration of their visa while others may work on a different farm every day, or every week, or intermittently as demand requires.

Ideally, the government would revise the Foreign Business Act (1999) to provide opportunities for citizens of neighboring countries to own and operate staffing agencies across the border in Thailand. The Act would have to work in tandem with an updated Alien Working Act (2008) and work permit law (Thailand Emergency Decree on Managing the Work of Aliens 2018). Beyond labor shortages and work permit processing issues, Kampan (2019) found the most common problem employers experienced with migrant workers from Cambodia and Myanmar was breach of contract by foreigners. Bearing in mind the needs of employers to have stable, predictable labor markets, the amended laws could vest most oversight and compliance responsibilities in visa service agencies who would have to submit regular reports to local immigration offices. The laws together could restrict access to this special work permit class to one channel: through licensed agencies. By law, those licensees would maintain contact with the foreigner at a determined frequency and file a report if one is missing for a specified number of days. Foreign workers could be limited to x-number of days of residence or work within the calendar year to ensure fairness in the resident-foreign labor market. Thailand can gain some perspective and guidance on building a new platform for efficient processing of temporary migrant workers by reviewing foreign legal methods. For example, the United States' H-2A visa program provides a means of authorizing and documenting seasonal, peak-load, and intermittent employment (United States Department of Labor 2016). New Zealand's Recognized Seasonal Employer scheme "allows horticulture and viticulture industries to recruit workers from overseas for seasonal work when there are not enough [domestic] workers" (Immigration New Zealand 2019). Ultimately, Thailand's Parliament must craft novel architecture for processing, legalizing, and following each case to ensure compliance at all levels of the hypothetical next version of Thailand's immigration system.

Government-administered resident management app

The government has an opportunity to relieve all foreign workers of responsibilities that call them away from work and to government offices to apply and pay for simple items like re-entry permits, which could be serviced entirely online. Saudi Arabia's Absher web and mobile device applications provide both natural and juristic persons to access and update personal or company data, make requests for permits, licenses, or other services, and then track applications and pay fees remotely. The Saudi system links public safety, traffic, customs, and immigration data with the web-based system so users receive pertinent updates and notifications; it is also a single gateway for multiple government Ministries. An expansive application in Thailand would enable citizens and resident aliens alike to access their own personal data relating to Thai credit scoring data, residential address and contact info, car or motorcycle registration and insurance validity, outstanding traffic penalties, and a range of government services. The government could charge a nominal license fee to users for additional revenues which

would benefit the budget alongside cost-cutting at immigration posts as fewer foreigners would need to visit physical offices. An electronic app via the internet would improve the efficiency and public relations of government offices; it would help organize and streamline communications and data sharing between government offices. Such an app could be the new face of the Thai government – a virtual frontline employee that receives, directs, and works with millions of individuals and businesses across the Kingdom.

CONCLUDING REMARK

This article showed that while agricultural sectors employ one-third of the workforce, the sector receives a disproportionate amount of work permits and thus foreign labor inputs which help keep costs low. Agricultural markets have been erratic, flat, falling, or boasting diminishing returns at best. Government assistance is imperative, but history shows solutions are scarce and each new iteration of past government price interventions, pledging schemes, or cash handouts only touches the surface of the epidemic. Smallholders across the Kingdom are cut off from labor and capital, so they cannot produce high-quality products, and they are choked out of markets by middlemen who troll villages buying bulk harvests for a fraction of the fair market value. The Shinawatra family corruption scandals are partially to blame for stagnant and declining agro-markets; the one saving grace of their legacy is that the family's business was integral in constructing one of the world's best cellular networks. Mobile phone applications and cloud-computing could literally revolutionize millions of Thai farms. The government and private sector have prime opportunities to generate interest in a joint public-private venture which (i) aims to make government interaction more convenient for Thais and foreigners alike, (ii) help smallholder farmers find labor in a timely, cost-efficient manner, (iii) gives farmers direct links to potential buyers who make competing bids for goods, (iv) provides those farmers with information and education services, (v) facilitates community-based resource management forums where members share machinery and make collective purchases of inputs to reduce costs per farm, and (vi) create hundreds of thousands of new jobs. A series of mobile phone apps operated in conjunction with research and development among government Ministries, financial institutions, scientific groups, economic faculties, and academic organizations could provide the spark that unleashes Thailand's greater potential. As the flywheel turns and cybernetic economies of scale emerge from synergies of online databases, portals, and applications, the network could later take on tax collection, voting, health care, customs processing, bank settlements, and more. A time window of 12-36 months between initiating the project and launch date for such an app would not be unrealistic given existing data cataloging and the amount of talent already within Thailand – brilliant people are just waiting to do something meaningful and impactful.

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