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Farm commercialization in Myanmar: A transformation on hold or in reverse?

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ABSTRACT

Over the last decade, farms in Myanmar have gone through important market transitions. On the input side, imports of chemical fertilizer increased four-fold and agro-chemicals eight-fold while 55 percent more farmers were using mechanization rental services between 2011 and 2020. On the output side, three-quarters of Myanmar's crop production is sold, indicating high market orientation, especially so for non-paddy crops. However, farm commercialization in Myanmar started from a low base and is still lagging peer countries in the region. The twin crises in 2020 and 2021 (the covid-19 and the political crisis) and international market developments have further led to increasing worries for an agricultural market transformation on hold or in reverse, as seen by a decline in imports of modern inputs, driven by price increases of inputs, currency policy changes, insecurity, and reduced profitability for most crop farmers. To improve farm commercialization and to catch up with peers, a better and secure business environment, openness to trade, further diversification, and improved infrastructure is called for.

1. INTRODUCTION

When food systems transform, farmers' interactions with markets change dramatically. With changes from traditional to transitional to modern systems – as defined by Reardon and Minten (2020) – farmers move from mostly subsistence-oriented agriculture with few market interactions towards a heavy reliance on spot markets for inputs, outputs, and services, and ultimately to contract farming respectively. Such reliance on markets by farmers during these transformation processes have been shown to lead to significant improvements in farm performance and in agricultural households' welfare (Stifel and Minten 2017, Carletto et al. 2017, von Braun and Kennedy 1994, Minten et al. 2013).

However, it is often not well understood in a number of low- and mid-income countries which stage of transformation farms are in and how it can possibly be expedited. Agricultural markets and commercialization at the farm are especially not well understood in the case of Myanmar because of lack of nationally representative and updated data on the farm sector. Moreover, Myanmar has over the last decade gone through substantial changes with respect to economic and agricultural market policies, as well as through major shocks, greatly impacting farm commercialization changes. To understand farm commercialization and its evolution, an overview of policy changes and these shocks is therefore first needed.

In the beginning of the 2010s, an economic policy reform program was implemented, with the government more sincerely liberalizing Myanmar's agricultural economy compared to before. Before 2011, the main objective of agricultural policies was ensuring stability of rice supplies through a government-managed system such that rice would be available at a low price and social unrest would be avoided (Okamoto 2008). This involved government intervention in export and domestic rice markets, compulsory cropping plans, and state-owned farmland. The move away from the socialist legacy in the beginning of the 2010s was seen through new farmland legislation, the relaxation of cropping controls, and a shift from the focus on production quantities to the quality of people's life, as noted in the setting of poverty reduction targets (Okamoto 2020). This gradual liberalization of Myanmar's economy led to significant economic growth and poverty alleviation over the last decade (CSO, UNDP, and WB 2020, Ferreira et al. 2021).

The economic transformation was however interrupted by twin crises in the beginning of the 2020s. The COVID-19 and political crises created unprecedented challenges to the functioning of Myanmar's economy. The COVID-19 crisis led to large income declines overall and to substantial disruptions in Myanmar's agri-food system (Boughton et al. 2021; Headey et al. 2020). The political crisis caused substantial problems in the banking and finance sector, in international trade, and in the local transport sector, among others. Moreover, the currency of Myanmar, the kyat (MMK), has been rapidly depreciating. At the farm level, the political crisis in 2021 led to lower credit availability for farmers, a decrease in farm prices for some crops, and more uncertain agricultural profitability (MAPSA 2021c).

The different policy reforms and twin crises – together with external international developments in the region – have greatly impacted the functioning of farms and their engagement with markets. The objective of the paper is four-fold. First, an overview of the state of commercialization in agricultural input markets and of the ongoing transformation is given. We pay in particular attention to chemical fertilizer, the most important commercial input (in value terms) used by farmers in Myanmar. Second, we assess farmers' crop output markets and commercial surpluses. Third, we look at the issue of market access and its influence on farm performance and commercialization, important in Myanmar given low levels of urbanization and poor infrastructure in the country (ADB 2017). Fourth, we assess the impact of the twin crises, and international market developments, on farm commercialization.

2. DATA

We rely mainly on two sources of data, the Myanmar Living Conditions Survey (MLCS) and the Myanmar Agricultural Performance Survey (MAPS). To present data from these household surveys, we divide the country into four major agro-ecological zones, i.e. the Delta (Ayeyawaddy, Bago, Mon, Yangon), the Coastal zone (Rakhine, Tanintharyi), the Central Dry Zone (Mandalay, Magwe, NPT, Sagaing) and the Hills and Mountains (Chin, Kachin, Kayah, Kayin, Shan).

The Myanmar Living Conditions Survey (MLCS), fielded in 2017, is a comprehensive household survey that provides information on the living conditions of the Myanmar people as well as on agricultural practices in the country (CSO, UNDP, and WB 2020). It provides data representative at the level of the Union and its states/regions. The sample was designed to cover all districts and 296 of Myanmar's 330 townships. In total, 13,730 households participated in the survey. 5,013 of the surveyed households reported operating agricultural land. For the analysis in this paper, we rely on data from these latter households only.[1]

The Myanmar Agricultural Performance Survey (MAPS) is a sub-sample of 12,100 households interviewed by phone during the first round of the Myanmar Household Welfare Survey (MHWS) that was fielded in the beginning of 2022 (MAPSA 2022a). In the MHWS, information was collected, among others, on the background of these households, welfare indicators, and livelihoods. The follow-up MAPS focused on the agricultural activities of 5,465 households that were identified as crop farmers in the MHWS. This survey was implemented by phone by Myanmar Survey Research (MSR) over the period February 11th until March 25th, 2022. Approximately 71 percent of the farmers (3,891) that were interviewed in the first round of the MHWS could be reached for a second follow-up interview.[2]

We further rely on three other datasets. For the assessment of international trade in agricultural inputs, we rely on the United Nations' Comtrade data.[3] For the longer time trends of farmers using modern agricultural inputs, we use household data from the Integrated Household Living Conditions Assessment (IHLCA), fielded in 2009/2010, and the Myanmar Poverty and Living Conditions Survey (MPLCS), fielded in 2015.

3. AGRICULTURAL INPUT MARKETS

3.1 Commercial agricultural input use – Levels and associates

Based on the 2017 MLCS data, Table 1 shows average expenditures for all major (non-labor) agricultural inputs used in crop production as well as income from crop sales and overall crop income (valuing own consumption) at the national level and by agro-ecological zone. Three-quarters of farm households purchased inorganic fertilizer, 60 percent bought other agro-chemicals, and 54 percent paid for agricultural machinery rental.[4] We see significant differences between different agro-ecological zones. The adoption of modern inputs (inorganic fertilizer, agro-chemicals, and machinery rental) is overall higher in the Delta and the Dry Zone than in other areas, possibly linked to higher levels of access to credit of the Myanmar Agricultural Development Bank (MADB) for lowland regions.

[1] Out of the 5,013 households operating land, 4,750 households reported sufficient harvest and input expenditure data as to be useful for analysis.

[2] 1131 respondents could not be reached (no answer or lack of power), 326 refused, 70 terminated mid-interview, 40 were not eligible and 10 could not be interviewed because of language barriers.

[3] http://comtrade.un.org/

[4] Mechanization use is higher given that a number of farmers own machines themselves and do not rely on rental markets.

In 2016, farmers annually spent 380 USD per farm on commercial agricultural inputs and these were estimated to make up 20 and 26 percent of the value of crop production and crop sales respectively (Table 1). Expenditures on inorganic fertilizers alone are as high as 7 percent. These farm expenditures need to be paid upfront, before crops are sold, often requiring access to credit that has been partly provided, at the time of the survey, by the government through the Myanmar Agricultural Development Bank (MADB) as well as by micro-finance organizations (MFIs), cooperatives, and government-supported village credit schemes (Okamoto 2020).

An average Myanmar farmer spent 108 USD per year on inorganic fertilizer in 2016. The Delta had the highest fertilizer expenditures in the country at 155 USD per farm and 108 USD per hectare, significantly higher than in other agroecological zones. Average fertilizer expenditures for the other zones were 98 USD per farm in the Hills and Mountains, 84 USD per farm in the central Dry Zone, and 67 USD per farm in the Coastal region. Standard deviations on fertilizer expenditures per farm are high, indicating large variation in fertilizer use by farm within each agroecology, particularly in the Delta.

Table 1 further shows that fertilizers are the largest purchased input for Myanmar farmers, constituting 28 percent of all inputs purchased. The second and third largest purchased inputs are machine rental and agro-chemicals at 20 and 14 percent, respectively. While absolute expenditures for fertilizer are the highest in the Delta, overall expenditures on purchased inputs are also almost 50 percent higher in the Delta compared to the national average. Thus, the share of inorganic fertilizer in overall purchased inputs in the Delta is like the rest of the country.

To analyze the associates of expenditure on agricultural inputs (in USD per farm per year) by farmers in Myanmar at the farm level, a Tobit regression is run based on data from the MLCS (Table 2). The regression is left-censored because there are a number of agricultural households which do not use any commercial inputs. The right-hand side variables used in the regression are the types of crops grown, operated land size, irrigation access, and intensity of land cultivation within a year, and household characteristics. This analysis is done at national and the agro-ecological zone level.

Several important associations show up. First, maize, dry season paddy, and pulses cultivation is associated with increased commercial input use. Maize cultivation in Myanmar (mostly in Shan State) is a high input cash crop relative to most other crops in the country (Fang and Belton, 2020). Paddy planted in the dry season in Myanmar is also highly commercialized and uses more commercial inputs (World Bank, 2016). Pulses are Myanmar's most important export crop. These data therefore suggest that more market-oriented crops are associated with higher commercial input use. Second, irrigated land is associated with 53 percent (169 USD) higher expenditures on agricultural inputs, often linked to more reliable water supply and therefore more secure returns to input use. Third, larger farms are associated with more input use. An additional hectare of land operated is associated with 87 USD higher expenditures on agricultural inputs, an increase of 27 percent. Fourth, household characteristics matter for adoption of commercial inputs. Households with the head having an education level of higher than primary school spent 21 percent (or 67 USD) more on agricultural inputs than did other households while an additional family worker is associated with 14 USD lower expenditure on agricultural inputs, possibly because of substitution from commercial inputs towards labor use. Finally, a comparison of these results over agro-ecological zones mostly indicate similar associates.

Table 1: Average expenditures on crop inputs per farm in Myanmar

		Delta	Coastal	Dry	Hills	National
Share of households that purchased each input						
Inorganic fertilizer	%	84	62	77	66	75
Organic fertilizer	%	12	17	17	16	15
Seed	%	55	35	50	48	50
Agro-chemicals	%	77	27	66	41	60
Rent machinery	%	66	35	62	35	54
Hiring cattle	%	10	12	30	12	18
Irrigation	%	1	3	7	1	3
Cost (USD)						
Inorganic fertilizer	mean	155.3	67.4	83.9	98.5	108.1
	st. dev.	226.4	139.9	142.2	163.3	179.6
Organic fertilizer	mean	11.9	11.1	10.5	15.6	12.3
	st. dev.	70.4	58.4	50.6	60.7	60.3
Seed	mean	71.6	15.5	55.5	40.6	53.6
	st. dev.	139.1	37.7	126	92.3	119.1
Agro-chemicals	mean	104.3	9	43.8	24.1	54.3
	st. dev.	164	39.5	97.6	68.2	118.6
Rent machinery	mean	107.5	34.5	98.7	27.2	77.9
	st. dev.	237.3	81.2	658.6	75.6	421
Hiring cattle	mean	9.2	11.5	16.1	9.9	12
	st. dev.	39.1	43.8	46.1	39.5	42.3
Irrigation	mean	0.6	1.1	0.6	0.1	0.5
	st. dev.	6.8	8.2	3	0.8	4.7
Purchased inputs	mean	568.4	213	359.8	239.2	380.3
	st. dev.	878.8	411.3	1024.5	352.2	822
Inorganic fertilizer per hectare	mean	108.5	35.4	46.7	53.1	66.2
	st. dev.	307.4	124.1	127.5	98.5	197.0
Organic fertilizer per hectare	mean	18.5	17.0	8.7	11.8	13.1
	st. dev.	203.4	133.9	52.7	66.7	126.2
Seed per hectare	mean	42.8	12.0	26.6	22.8	29.5
	st. dev.	173.2	40.2	52.8	64.5	106.6
Agro-chemicals per hectare	mean	69.8	6.9	27.0	15.9	35.5
	st. dev.	260.7	48.1	119.5	58.8	165.1
Rent machinery per hectare	mean	45.0	17.5	39.2	17.2	33.6
	st. dev.	85.2	44.1	128.5	55.5	96.2
Hiring cattle per hectare	mean	6.4	7.6	11.6	6.6	8.4
	st. dev.	30.9	28.3	37.8	26.2	32.4
Irrigation per hectare	mean	0.7	2.9	0.4	0.0	0.6
	st. dev.	9.6	32.4	2.5	0.8	10.3
Purchased inputs per hectare	mean	468.5	176.8	181.2	141.9	257.1
	st. dev.	1575.2	1251.8	423.2	246.6	979.7
Share in total purchased inputs per farm						
Inorganic fertilizer	%	27.3	31.6	23.3	41.2	28.4
Organic fertilizer	%	2.1	5.2	2.9	6.5	3.2
Seed	%	12.6	7.3	15.4	17	14.1
Agro-chemicals	%	18.4	4.2	12.2	10.1	14.3
Rent machinery	%	18.9	16.2	27.4	11.4	20.5
Hiring cattle	%	1.6	5.4	4.5	4.1	3.2
Irrigation	%	0.1	0.5	0.2	0	0.1
Crop sales income (USD)	mean	2,331	898	1,292	878	1,467
	st. dev.	4,524	2,167	3,309	1,553	3,384
Crop production (USD)	mean	2,873	1,330	1,774	1,278	1,942
	st. dev.	5,361	3,065	3,511	1,830	3,885
Number of households		*1,002*	*510*	*1,194*	*2,066*	*4,772*

Source: Authors' calculations based on MLCS;
Notes: 1) Other inputs include fuels, hire of storage, and seedling. 2) Households with missing harvest data (5 percent of agricultural households) were dropped.

Table 2: Associates of input expenditures

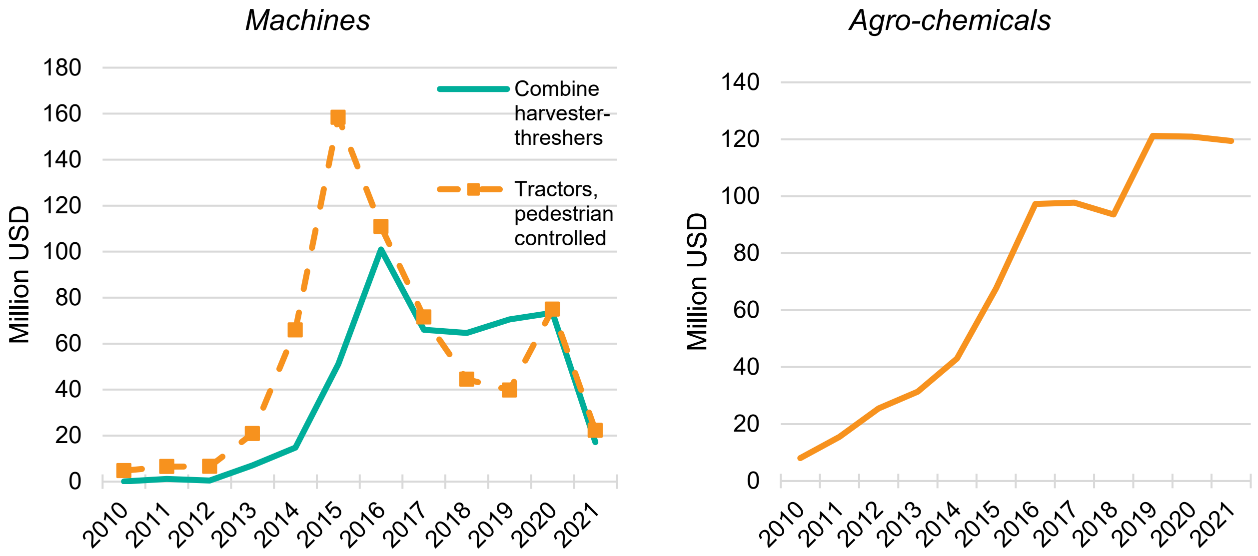
	Mean of variables	National	Delta	Coastal	Dry	Hills
Household grows paddy in wet season	62.2%	37.808	106.460***	180.354***	-90.096	-29.550
		(31.032)	(33.162)	(64.962)	(64.264)	(36.396)
Household grows paddy in dry/cool season	15.5%	101.123***	128.105***	59.257	165.778**	-27.529
		(34.639)	(45.019)	(83.766)	(66.924)	(29.667)
Household grows pulses in a year	43.2%	71.804**	176.377***	94.986*	-44.065	23.449
		(32.583)	(40.929)	(49.796)	(79.541)	(51.879)
Household grows maize in a year	13.3%	167.120***	22.906	509.334*	-67.373	220.590***
		(41.834)	(35.303)	(283.841)	(114.805)	(44.061)
Household grows sesame in a year	15.8%	-13.641	-117.005	-1,398.722***	-7.392	185.446
		(37.624)	(80.581)	(261.908)	(40.556)	(151.149)
Total operated area (ha)	2.6	87.095***	95.976***	25.223***	110.587***	54.053***
		(11.099)	(15.486)	(5.366)	(30.396)	(9.057)
Share of land irrigated (%)	24.6	1.692***	0.744**	0.855**	2.875***	1.469***
		(0.264)	(0.352)	(0.432)	(0.498)	(0.383)
Times land being used in various seasons in a year	1.8	-4.268	87.668***	-9.738	-32.230	-19.963
		(23.391)	(25.275)	(35.202)	(45.058)	(21.417)
Household head has more than primary education	59.0%	67.396***	38.459	-2.696	108.173**	85.489***
		(20.474)	(29.276)	(22.644)	(49.552)	(20.562)
Household head is female	15.7%	-15.035	21.577	-11.779	-21.481	-12.768
		(20.246)	(37.367)	(25.680)	(34.865)	(25.816)
Age of Household head/10	52.1	-16.317**	-12.963	-5.172	-40.440**	7.628
		(7.665)	(10.814)	(9.479)	(18.456)	(8.686)
Number of adults (>=15)	2.9	13.509*	13.236	7.716	8.695	13.359
		(7.040)	(11.669)	(6.565)	(12.194)	(9.264)
Coastal (base = Delta)	8.0%	-269.566***				
		(41.142)				
Dry (base = Delta)	36.0%	-142.134***				
		(42.880)				
Hills (base = Delta)	26.0%	-209.852***				
		(39.298)				
Observations		*4,772*	*1,002*	*510*	*1,194*	*2,066*
Pseudo R-squared		0.0166	0.0377	0.0225	0.00908	0.0300

Source: Authors' calculations based on MLCS; Note: Robust standard errors in parentheses. Asterisks indicate statistical significance: *** p<0.01, ** p<0.05, * p<0.1. Agricultural inputs consist of chemical and organic fertilizer, seed, agro-chemicals. The means of age of household head are in their original form, not the transformations used in regression.

3.2 Changes in modern agricultural input use over time

Transformation has been happening in agricultural input markets over the last decade. Agricultural mechanization has rapidly taken off and is now being used by a large majority of farmers (Belton et al. 2021). Increasing mechanization has been driven by better access to machinery and by rapid increases in rural wages. Figure 1 illustrates the changes in imports of combine-harvesters and pedestrian tractors over the last decade. While very few tractors or combine-harvesters were imported in 2010 to 2012, these imports have quickly taken off since, with peak imports seen in 2015 and 2016. It is noteworthy that imports dropped off significantly in the 2021 crisis year. Imports of agro-chemicals have also rapidly increased. Myanmar imported 8 million USD of agri-chemicals in 2010, but that value went up to 120 million USD in 2021, 15 times as high. Over time, we have also seen more reliance on purchased as well as hybrid seeds, as noted in the case of maize (Fang and Belton 2020).

Figure 1: Imports of machines and agro-chemicals in Myanmar, 2010 to 2021



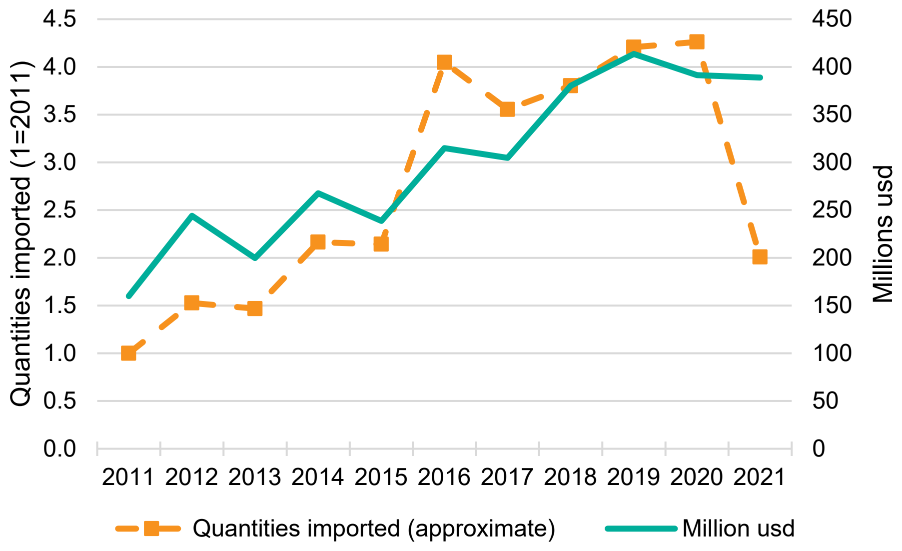
Source: Comtrade
Note: Agro-chemicals are approximated by HS code 3808 and therefore slightly larger than agro-chemicals as it includes insecticides, rodenticides, fungicides, herbicides, anti-sprouting products, plant growth regulators, disinfectants and the like.

Large changes have occurred in chemical fertilizer imports as well. Local inorganic fertilizer production makes up a relatively small share of total inorganic fertilizer use in Myanmar (IFDC 2017, 2018). Most inorganic fertilizers are imported from abroad.[5] Figure 2 shows levels of imports of chemical fertilizers, based on Comtrade data, between 2011 and 2021. In 2019, it was estimated that Myanmar spent just over 400 million USD for inorganic fertilizer to import approximately 1.3 million tons in total.[6] There have been rapid increases over time–values of fertilizer imports have almost tripled over the last decade, while the quantities imported quadrupled in 2020 compared to 2011. However, fertilizer imports dropped off significantly in the crisis year 2021 and quantities imported fell back to the level of 2015.

[5] IFDC (2018) estimated that in 2016/17 about 7 percent of the fertilizers consumed in Myanmar were locally produced. This local production mostly consists of urea, using the abundant natural gas resources in the country. While annual domestic production of urea – primarily by parastatal firms - was as high as 200,000 tons in the mid-2010s, it had declined to approximately 50,000 tons in 2017, a small share of the over 1.3 million mt of inorganic fertilizer used in the country (https://knoema.com/atlas/Myanmar/topics/Agriculture/Fertilizers-Production-Quantity-in-Nutrients/Urea-production).

[6] Given the lack of quantities available in the Comtrade dataset, we used the international urea price (the Black Sea f.o.b price) and divided the value of imports by that price to understand trends in quantities imported. Urea is the most imported fertilizer used in Myanmar (MAPSA 2022c). These data were downloaded from https://www.indexmundi.com/commodities/?commodity=urea&months=180).

Figure 2: Value and quantity of fertilizer imports into Myanmar, 2011 to 2021



Source: Comtrade

These changes in imports are showing up in farm surveys as well. Looking at the extensive margin and comparing the share of households using modern inputs between 2009 and 2021, some noticeable differences are seen (Table 3). In 2016, 73 percent of crop farmers were using chemical fertilizers whereas in 2021 80 percent were using them (surprisingly similar usage levels were seen in 2009). The share of farmers using agrochemicals and renting in machinery increased by 10 and 55 percentage points respectively over the last 12 years. Given that the questions in MAPS survey in 2020 and 2021 focused on the monsoon season only, while the IHLCA data in 2009 dealt with the whole agricultural year, increasing usage in the last years might be an underestimation. The renting of machinery increased but we note also significant increases in machine ownership over time, with 24 percent of the farmers reporting to own a tractor mostly power tillers - in 2021 while only 10 percent reported so in 2009.[7]

Table 3: Share of crop farmers using modern inputs (percent)

	Year				
	2009	2014	2016	2020	2021
Data source	IHLCA	MPLCS	MLCS	MAPS	MAPS
Share of households that used:					
- inorganic fertilizer*	81	73	73	84	80
- pesticides*	61	58	58	71	71
- rented in machinery	10	45	54	65	65
Share of farm households that own a tractor/power-tiller	10	24	17	24	24

Source: Authors' calculations
Note: *= "paid for" in IHLCA and MPLCS

Although we see significant transformation over the last decade, the negative changes in imports in the last two years are disconcerting, seemingly indicating a transformation on hold or even in reverse. The imports of combine-harvesters and tractors dropped to 1/4th the 2020 level in 2021. While the value of imports of agro-chemicals and chemical fertilizers were stable in the last 3 years – at 120 million USD for agro-chemicals and about 400 million USD for fertilizers – the quantities imported dropped because of substantial international price increases (Hebebrand and Laborde

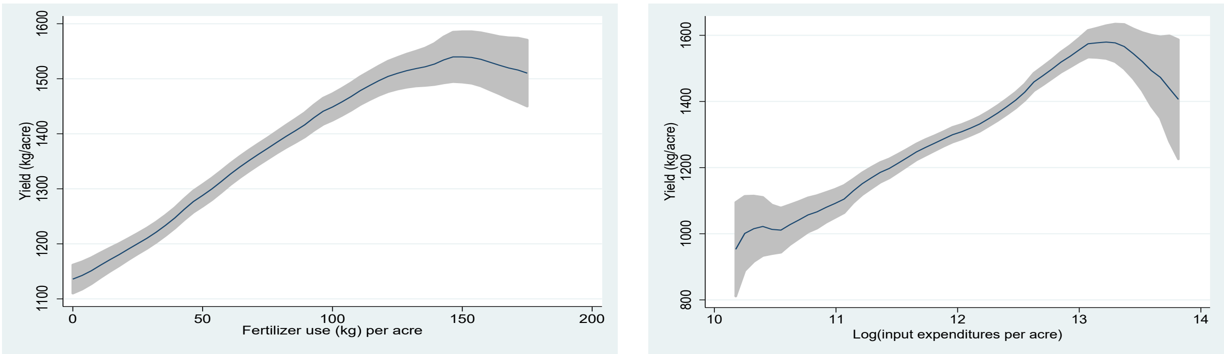
[7] While the MPLCS also shows a 24 percent ownership of tractors or power-tillers in 2014, the sample of the survey was small and estimates are therefore less precise than with the other surveys.

2022). In the case of chemical fertilizers, it is estimated that imported quantities might have dropped by half in 2021 compared to 2020 (Figure 2). In the case of agro-chemicals, prices for glyphosate, an important herbicide, were two to three times higher in 2021 than they were in 2020 and quantities imported might have dropped accordingly.[8]

3.3 Chemical fertilizer, commercial input expenditures, and crop performance

As commercial inputs imported in the country increased, we further want to understand their relationship with crop performance. Given the importance of chemical fertilizers, we focus most of the discussion on those. We look at rice in particular, using MAPS. Chemical fertilizer use is shown to be strongly linked to rice yields (Figure 3).[9,10] The graph shows that at average fertilizer use (69 kgs per acre in 2020 and 59 kgs in 2021), 1 kg of fertilizer generates between 4 and 5 kgs of extra paddy rice. We also note diminishing marginal returns when more than 150 kgs of fertilizer per acre is used. The figure on the right illustrates the strong positive linkages between total commercial input expenditures (e.g. fertilizer, mechanization, agro-chemicals, and hired labor use) and rice yields, suggesting an important association of market orientation with better crop performance.

Figure 3: Fertilizer use and commercial input expenditures on paddy rice yields, monsoon 2020 and 2021 data combined



Source: Authors' calculations based on MAPS

Returns to fertilizer use can differ because of agro-ecological conditions, shocks during the growing season, upland or lowland growing conditions, assets owned by farmers, and other factors. To assess returns when we control for a number of these different factors, we rely on a multi-variate regression analysis. As suggested in the exploratory graphs above, we specify a quadratic relationship by using quantities and squared quantities of chemical fertilizer use to allow for curvature in the returns to fertilizer use. Five different specifications are presented in Table 4.

In the parsimonious model where we only control for agro-ecological zones, the returns to 1 kg of fertilizer are 4.3 kgs of paddy rice at low levels of use. Due to a significant negative quadratic term, marginal returns decrease with increasing use, becoming zero at 244 kgs of fertilizer applied. Returns to fertilizers for an average rice plot during the monsoons of 2020 and 2021 would be 3.1 and 3.3 kgs respectively. Returns are slightly lower when we control for township dummies instead of agro-ecological zones only (model 2). Returns to urea and non-urea fertilizers are similar but are a bit lower than when overall fertilizer is used (model 3). When we control for other inputs in the longer specification, the estimates of these returns decrease and overall returns at low levels of use are 3.6 kgs of paddy rice (model 4). Other explanatory variables of rice yields show expected

[8] https://www.agribusinessglobal.com/agrochemicals/china-price-index-downward-price-trends-for-glyphosate-glufosinate-a-tipping-point-for-key-herbicides/

[9] We exclude approximately 5 percent of the highest users of urea and non-urea fertilizers because of possible measurement error.

[10] This is in line with a survey of rice producers in Myanmar (World Bank 2016). They find that an increase in fertilizer use from low to medium use (by 107 kgs per hectare) increases productivity by 360 kgs/ha, a return of 3.64 kgs rice per kg of fertilizer.

associations. Upland fields and fields where seeds are broadcast instead of row-planted or transplanted and where Meedon/Pawsan seeds were used show lower yields. Plots where organic fertilizer, lime, pesticides, and mechanization are used have higher yields. Controlling for inputs and shocks, yields in the monsoon of 2021 were not significantly different than those in 2020, indicating that the variables used in the model mostly explain the differences in these two crisis years. In a final fifth model, we look at how total commercial expenditures affect rice yields, ceteris paribus. We find strong and significant effects, with a doubling of input expenditures leading to an increase of rice yields by 210 kgs per acre, indicating the importance of market orientation for higher paddy yields.

Table 4: Associates of paddy rice yields (kgs per acre), monsoon 2020 and 2021

Variable	Unit	Model 1		Model 2		Model 3		Model 4		Model 5	
		Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
Fertilizer use											
Quantity	kg	4.34	11.71	4.13	11.86			3.61	10.07		
Quantity squared	kg	-0.01	-4.77	-0.01	-4.82			-0.01	-4.05		
Urea	kg					3.87	6.71				
Urea squared	kg					-0.01	-1.71				
Non-urea	kg					3.73	7.35				
Non-urea squared	kg					-0.01	-2.99				
Other inputs											
Purchased seeds	1=yes							89.87	5.37		
Seed variety (default = Emata)											
Letywesin	1=yes							43.01	2.44		
Meedon/Pawsan	1=yes							-190.92	-9.9		
Other	1=yes							7.77	0.18		
Upland field	1=yes							-196.82	-5.71	-274	-7.89
Broadcast	1=yes							-46.75	-2.86		
Organic fertilizer used	1=yes							47.4	3.22		
Lime used	1=yes							35.77	1.57		
Pesticides used	1=yes							22.54	1.49		
Mechanization used	1=yes							115.3	3.9		
No hired labor used	1=yes							-18.39	-0.89		
Working hh members	number							-3.36	-0.54	0.68	0.11
Total input expenditures											
Commercial inputs	log (MMK/acre)										
Other controls										210.11	17.16
Agro-ecological zone (Delta = default)											
Dry Zone	1=yes	177.17	11.17			180.73	11.31	153.27	8.49	173.97	10.38
Coastal Area	1=yes	31.13	1.03			32.68	1.09	148.83	4.84	66.12	2.13
Hills and Mountains	1=yes	-54.42	-2.39			-56.86	-2.5	-31.94	-1.19	1.96	0.08
Time (default = year 2020)											
Year 2021	1=yes							13.47	0.89	-45.42	-2.9
Shocks dummies								yes		yes	
Farm asset dummies	1=yes	no		no		no		yes		yes	
Township dummies	1=yes	no		yes		no		no		no	
Constant		1044.23	63.14	683.6	8.17	1060.48	66.89	978.17	19.04	-1182.41	-7.79
Number of observations		5,262		5262		5,262		5,262		5,063	
R2		0.10		0.27		0.10		0.16		0.13	

Source: Authors' calculations based on MAPS

4. AGRICULTURAL OUTPUT MARKETS

The average and variation in the value of crop production and sales per farm in Myanmar are presented in Table 5. We do so at the aggregate level and national level, by agro-ecological zone, and by crop category. Except for paddy which we analyze separately, we aggregate the other crops into the following crop categories, i.e. other cereals (mostly maize), pulses, oil seeds, vegetables, fruits, and cash crops. We further define the commercialization rate by dividing the value of crops sold by the value of total production in Table 6. We present the share of each crop in total sales income for the farm, at the national and the agro-ecological zone level. It is estimated that 76 percent of all crop production in Myanmar is sold. When we look at agro-ecological zones and aggregated crop sales, commercialization rates are the highest in the Delta zone where 81 percent of all production is sold, followed by the Dry Zone with 73 percent. Coastal areas have the lowest commercialization rate but still two-thirds of crop production is sold.

Paddy is shown to be a dominant crop with the highest value of production nationally (901 USD per year). Paddy makes up 46 percent of the total value of crop production and is also value-wise the most important crop in every agro-ecological zone. Average paddy production per farm in the Delta zone is considerably higher than the other three zones (2 to 3.5 times as high). Paddy is also the most important crop in crop sales, making up 39 percent of crop sales of an average farm. Average paddy sale per farm is the highest in Delta zone (2 to 8 times higher than the other zones). The commercialization rate of paddy is also the highest in Delta zone. Three-quarters of paddy produced by farm households in Delta zone is sold. That rate drops to 55 percent in the Dry zone and one-third in the Hills, where the majority of paddy is seemingly produced towards own consumption. We further estimate that 56 percent of all paddy production and two-thirds of commercial surplus of paddy in the country originates from the Delta zone.[11]

The second most important crop group are pulses, with a value of production of 324 USD per year at the national level. Much more than paddy, pulses are a commercial crop with 85 percent of the production being sold.[12] At the national level, pulses represent 19 percent of crop sales income. Pulses as a source of crop sales income are especially important in the Delta and the Dry Zone. They are highest in the Delta zone with crop sales income of 525 USD per year, but still significantly less important than paddy there (sales are 41 percent the level of sales of paddy). For the Dry Zone, income from pulses is almost at the same level as paddy, at 301 USD per year.

The cash crop group – including tobacco, betel nut, tea, coffee, sugarcane, cotton, rubber, and medical plants for this analysis – are the third most important source of sales income at the national level (198 USD per year per farm). Maize - covered under other cereals - is the most important commercial crop in the Hills and Mountains zones. More than 90 percent of the maize produced there is sold. Oilseeds are mainly produced and sold in the Dry Zone. About two-thirds of oilseeds produced in Myanmar are sold. While the productions of vegetables (127 USD per year) and fruits (57 USD per year) are both low relative to the other crops, they are highly commercialized: about 90 percent of vegetables and fruits produced are sold[13].

While paddy is dominant in production and sales, we see over time relatively small changes in this share of paddy in gross area sown (talking into account areas that are cultivated twice or more over the year) and there has been no substantial diversification away to other crops over the last

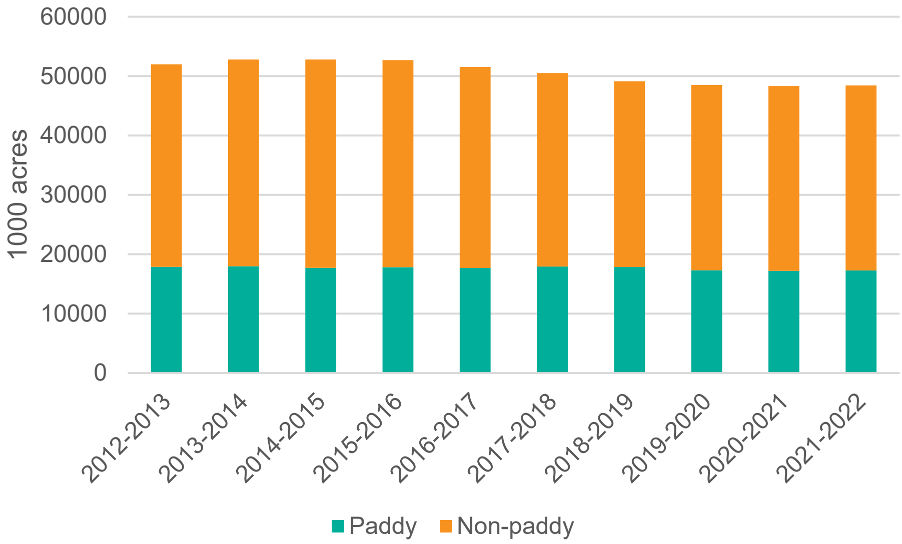
[11] These numbers are consistent with the official data which that paddy production of the Delta zone accounts for 57 percent of the national total production (Myanmar Agricultural Statistics, 2017).

[12] What is retained is mostly seed and pulses are often not consumed by farm households in Myanmar.

[13] The households with only small garden parcels (i.e. only grow vegetables or fruits on land smaller than 0.1 hectare) are not considered as farm households, so they are not taken into account for this analysis. They tend to keep more vegetables and fruits for own consumption given that they are likely high-income non-agricultural households.

decade. Based on data from MoALI, paddy made up 34 percent of the sown area in Myanmar in 2012/13 and this slightly increased to 36 percent in 2021/22 (Figure 4).

Figure 4: Area cultivated (gross area sown) of paddy and non-paddy crops



Source: Ministry of Agriculture, Livestock and Irrigation (MoALI)

Table 5: Values of crop production and sales (USD/year) per farm in Myanmar, MLCS (2017)

		Delta	Coastal	Dry	Hills	National
Paddy production	mean	1,682	700	592	488	901
	st. dev.	4,093	2,570	1,275	1,045	2,581
Paddy sales	mean	1,278	375	328	164	574
	st. dev.	3,123	1,747	1,001	780	1,974
Other cereals production	mean	26	2	28	354	112
	st. dev.	169	26	391	1,060	618
Other cereals sales	mean	23	1	22	318	99
	st. dev.	161	15	387	817	506
Pulses production	mean	634	5	342	34	324
	st. dev.	1,278	64	1,671	163	1,252
Pulses sales	mean	525	4	301	31	276
	st. dev.	1,091	60	1,641	157	1,175
Oil seeds production	mean	46	31	408	35	173
	st. dev.	387	140	837	203	585
Oil seeds sales	mean	38	24	270	23	117
	st. dev.	333	118	627	134	441
Vegetables production	mean	155	89	133	97	127
	st. dev.	2,083	611	792	424	1,268
Vegetables sales	mean	154	81	120	82	118
	st. dev.	2,082	600	748	358	1,253
Fruits production	mean	42	96	76	39	57
	st. dev.	270	1,086	827	287	613
Fruits sales	mean	41	59	72	38	52
	st. dev.	268	457	783	272	528
Cash crops production	mean	247	344	173	175	208
	st. dev.	2,203	1,187	2,302	841	1,916
Cash crops sales	mean	233	321	164	171	198
	st. dev.	2,170	1,129	2,284	837	1,894
All crops production	mean	2,873	1,330	1,774	1,278	1,942
	st. dev.	5,361	3,065	3,511	1,830	3,885
All crops sales	mean	2,331	898	1,292	878	1,467
	st. dev.	4,524	2,167	3,309	1,553	3,384
Sample N		*1,002*	*510*	*1,194*	*2,066*	*4,772*

Source: Authors' calculations based on MLCS

Table 6: Commercialization rates (value of sales/value of production) for each crop (group), MLCS (2017)

	Delta	Coastal	Dry	Hills	National
Share of crop (group) produced that were sold					
Paddy (%)	76	54	55	34	64
Other cereals (%)	89	61	79	90	89
Pulses (%)	83	82	88	91	85
Oil seeds (%)	81	79	66	66	67
Vegetables (%)	99	91	90	86	93
Fruits (%)	97	61	94	96	91
Cash crops (%)	95	93	95	98	95
All crop sales (%)	81	67	73	69	76
Share of each crop (group) sales in total crop sales					
Paddy (%)	55	42	25	19	39
Other cereals (%)	1	0	2	36	7
Pulses (%)	23	0	23	4	19
Oil seeds (%)	2	3	21	3	8
Vegetables (%)	7	9	9	9	8
Fruits (%)	2	7	6	4	4
Cash crops (%)	10	36	13	20	13
All above crops (groups) (%)	98	96	99	94	98
Share of total paddy production and sales by AEZ					
Total paddy production (%)	56	6	24	14	100
Total paddy sales (%)	67	5	21	8	100
Sample N	*1,002*	*510*	*1,194*	*2,066*	*4,772*

Source: Authors' calculations based on MLCS

To analyze associates of commercialization, we categorize crop farmers into three categories based on commercialization rates: 1) "subsistence farmers": farmers that reported no sales of crops produced; 2) "commercial farmers": farmers that sold less than 80 percent of their crop production; 3) "highly commercial farmers": farmers that sold more than 80 percent of crop production. These three categories represent 18, 40, and 42 percent of crop farmers respectively. We run a multinomial logistic regression to explore the associates of a household being grouped into one of these three commercialization categories. Table 7 present the descriptive statistics for each group as well as the relative risk ratio (RRR) based on the multinomial regression.[14] The RRR shows how one unit change in the value of the explanatory variable changes the relative probability of being in a category of the dependent variable compared to the base category (the commercial farmers). The explanatory variables included relate to crop choice, farming practices, off-farm income, and household characteristics.

We find that households that grow paddy are less likely to be highly commercial relative to commercial farmers, indicating that paddy is partly used for household own consumption and not often completely sold. For the growers of the other crops (pulses, maize, and sesame), they are more likely (significantly) the commercial farmers (i.e. sold some crops, but less than 80 percent of production) relative to subsistence farmers (and this in contrast to paddy growers where this category is not significant). Maize, pulses, and sesame are mostly sold, but still partially used for own

[14] RRRs are analogous to odds- ratio used in bivariate logit models. RRR>1 means a higher probability of being in the compared category relative to the base category, and RRR<1 the reverse.

consumption. Maize tends towards high commercialization (with a coefficient higher than 1 for commercial farming), but the coefficient is insignificant.

Higher land area and more intensive use of land is associated with higher commercialization. Farmers with larger cultivated land are less likely to engage in subsistence production, i.e. they have sufficient land to produce crops their household requires and can produce some surplus for sale. Access to irrigation is strongly associated with commercialization. Households engaging in subsistence production have the lowest share of land being irrigated while highly commercial farmers have the highest share of irrigated land. Households that cultivated more seasons in a year on a parcel are less likely to be subsistence producers and more likely to be highly commercial farmers.

Household characteristics also matter for commercialization. Household heads having more than primary education have higher levels of commercialization while households with older heads are less likely to be highly commercial. Households with a higher ratio of family workers are more likely to be commercial relative to both subsistence and highly commercial farmers while those with a larger household size are more likely to keep part of crops produced for own consumption, instead of selling all and therefore being a highly commercial farmer.

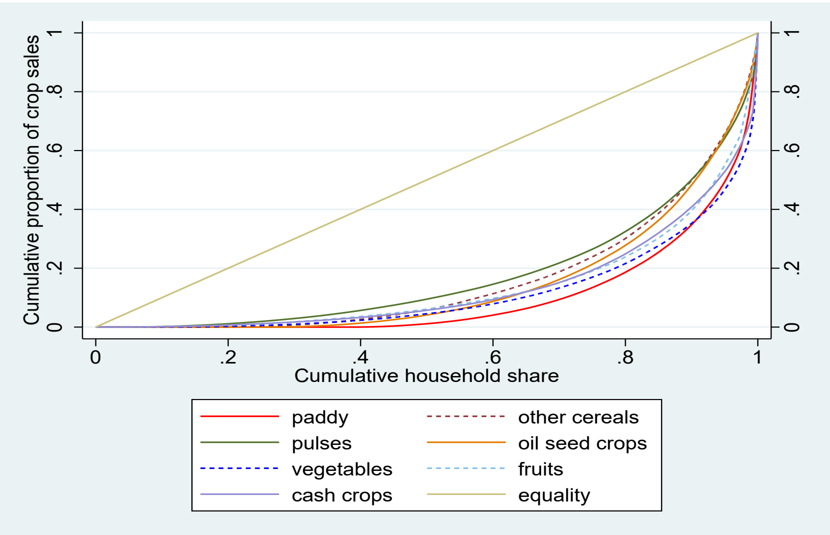
Table 7: Associates of commercialization rates – multinomial regression (MLCS 2017)

	Mean of variables			Multinomial logit - Relative Risk Ratio		
	Subsistence No sales of crops produced	Commercial Sold some crops, less than 80% of value produced	Highly commercial Sold nearly or all of crops produced, more than 80%	Commercial Base category: sold some crops, less than 80% of value produced	Subsistence No sales of crops produced	Highly commercial Sold nearly or all of crops produced, more than 80%
Crop choices						
HH grows paddy in wet season	84%	79%	43%		1.182	0.151***
					-0.233	-0.022
HH grows paddy in dry/cool season	12%	17%	15%		1.111	0.725**
					-0.26	-0.113
HH grows pulses in a year	19%	50%	42%		0.451***	0.749**
					-0.09	-0.107
HH grows maize in a year	11%	11%	16%		0.430***	1.273
					-0.122	-0.24
HH grows sesame in a year	7%	21%	13%		0.545**	0.635***
					-0.148	-0.11
Farming practices						
Total operated area (ha)	1.5	2.8	2.6		0.677***	1.037*
					-0.047	-0.021
Share of land irrigated (%)	17%	23%	28%		0.683	1.518***
					-0.169	-0.219
Times land being used in various seasons in a year	1.3	1.7	1.9		0.467***	1.511***
					-0.077	-0.131
Off-farm incomes						
Income from non-farm enterprise, 000' USD	0.46	0.37	0.38		1.01	0.979
					-0.038	-0.016
Income from agricultural wage work, 000' USD	0.18	0.12	0.15		1.034	1.188*
					-0.145	-0.122
Income from non-agricultural wage work, 000' USD	0.3	0.24	0.27		1.115	1.042
					-0.111	-0.063
Household characteristics						
HH head has more than primary education	44%	59%	63%		0.778*	1.227**
					-0.102	-0.112
HH head is female	14%	16%	16%		0.861	0.926
					-0.152	-0.115
Age of HH head/10	51	53	51		1.019	0.897***
					-0.054	-0.031
Workers: Household size, %	62%	67%	64%		0.530**	0.503***
					-0.137	-0.094
Household size	4.9	4.8	4.4		1.028	0.908***
					-0.036	-0.024
Coastal (base = Delta)					1.288	0.244***
					-0.393	-0.057
Dry (base = Delta)					1.477	0.271***
					-0.385	-0.048
Hills (base = Delta)					2.138***	0.372***
					-0.528	-0.077
Observations	868	1,897	2,007	4,772		
Pseudo R-squared				0.205		

Source: Authors' calculations based on MLCS

To further understand the contribution of large and small farms in aggregate sales, Figure 5 presents Lorenz-curves of the value of crop sales for respective crop growers. To construct this Lorenz-curve, households are ranked from lowest to the highest in terms of crop sales. Then, their importance (share) in total crop sale is calculated and shown on the y-axis. The closer the line to the diagonal line (perfectly equal), the more equal the distribution. Crop sales are shown to be highly concentrated among large sellers: the bottom 80 percent of paddy growers accounts for only about 20 percent of total paddy sales. Almost half of paddy growers do not make any sales and they grow paddy only for own consumption. The paddy sales distribution is the most unequal of all crops. For the other crop categories, the bottom 80 percent of the respective growers account for about 20 to 35 percent of total sales.

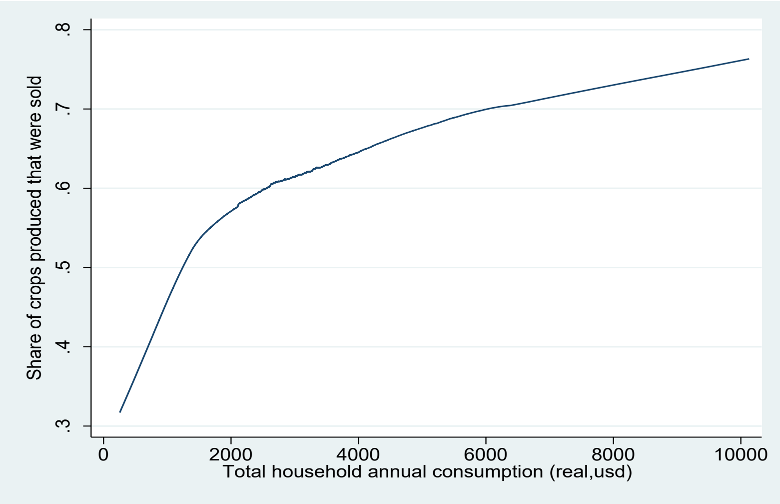
Figure 5: Cumulative distribution graph (Lorenz-curve) on value of crop sales



Source: Authors' calculations based on MLCS

We further assess the link between crop commercialization and welfare. Figure 6 shows that the agricultural commercialization rate overall is positively associated with household income. Households with a commercialization rate of 60 percent have an annual consumption level of approximately 3,000 USD per household, while those with commercialization rates of 70 percent have consumption levels that are double that level. Association is not causality. Richer households might participate more in agricultural markets and households that participate more in markets might be able to achieve higher incomes. Further studies to better understand this relationship in the Myanmar context are called for.

Figure 6: Commercialization and welfare



Source: Authors' calculations based on MLCS

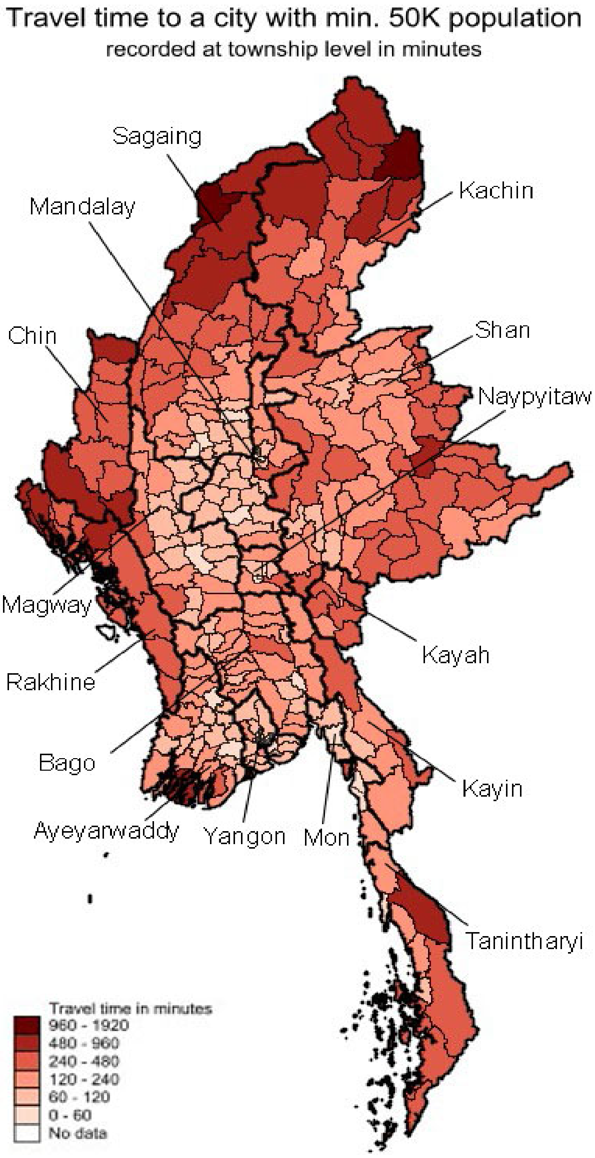
5. THE ROLE OF MARKET ACCESS

Market access has been shown to be an important determinant of farm commercialization as well as welfare (Vandercasteelen et al. 2018, 2021; Stifel and Minten 2017). Remoteness and lack of access to urban markets are seemingly major constraints for rural Myanmar and its agricultural economy. The urban share of Myanmar's population is 35 percent, significantly below most other Asian countries (Annex Table A1). Almost 40 percent of Myanmar's rural population and 27 percent of its overall population is located further than two kilometers away from a paved road, a larger share than in other Asian countries (Annex Table A2). 20 million people in Myanmar live in villages without access to an all-season road and about 25,000 villages and 9.2 million people are residing in villages that are not connected by any road (ADB 2017). Another 20,000 villages and 11.3 million people are connected by a road that is not all-season, likely leading to increased seasonal stress. Market access in Myanmar is therefore still a major issue for a large part of its rural population, likely hampering agricultural performance for these remote villages.

To evaluate market access of farmers in Myanmar, we calculate travel times of farmers to a major city (of 50,000 people or more).[15] Figure 7 shows these travels times for all townships of the country. Especially the outer and less populated parts of the country - mostly townships in the Hills and Mountains and Coastal areas - are more remote than the rest of the country. At the national level, it is estimated that 20 percent of the farmers in Myanmar can travel to a city in two hours or less (Figure 8). On the other hand, one-third of the farmers would need more than 4 hours while 13 percent of the farmers would need more than 6 hours.

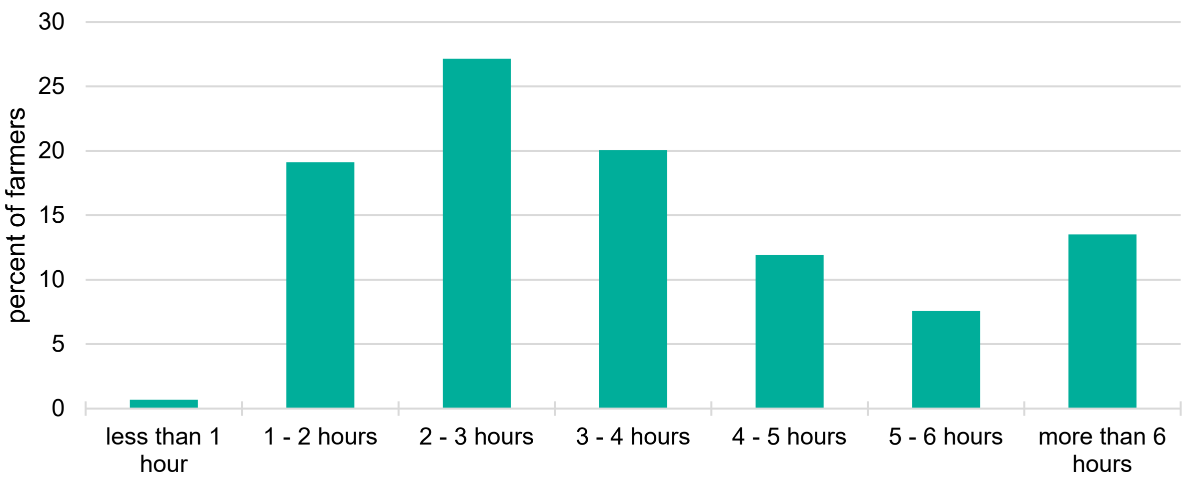
[15] Travel times are estimated from the center of the township using transport infrastructure and landscape features (land use, rivers, lakes, and slope obtained from the Myanmar Information Management Unit). We assigned a travel speed to each of the road types (major, secondary, tertiary, tracks/other) in the geographic information system (GIS) data, ranging from 75 to 10 kilometers per hour. Then we combined the GIS layers into a friction (or impedance) grid converted into one-kilometer grid cell raster layers. Slope is also considered to model uphill and downhill movement. The travel times from farmers to the center of the township was asked for in the survey. We added both these measure to get to total travel times. As travel times to the centroid of the township (as calculated through the GIS friction model) and the center of the township (as asked in the farm survey) are not exactly the same, there are likely measurement issues with this remoteness variable. It will however be a good approximation of travel times - and remoteness - that a farm household faces.

Figure 7: Remoteness of townships in Myanmar



Source: Authors' calculations

Figure 8: Travel time of farmers to a city of at least 50,000 people (in hours)



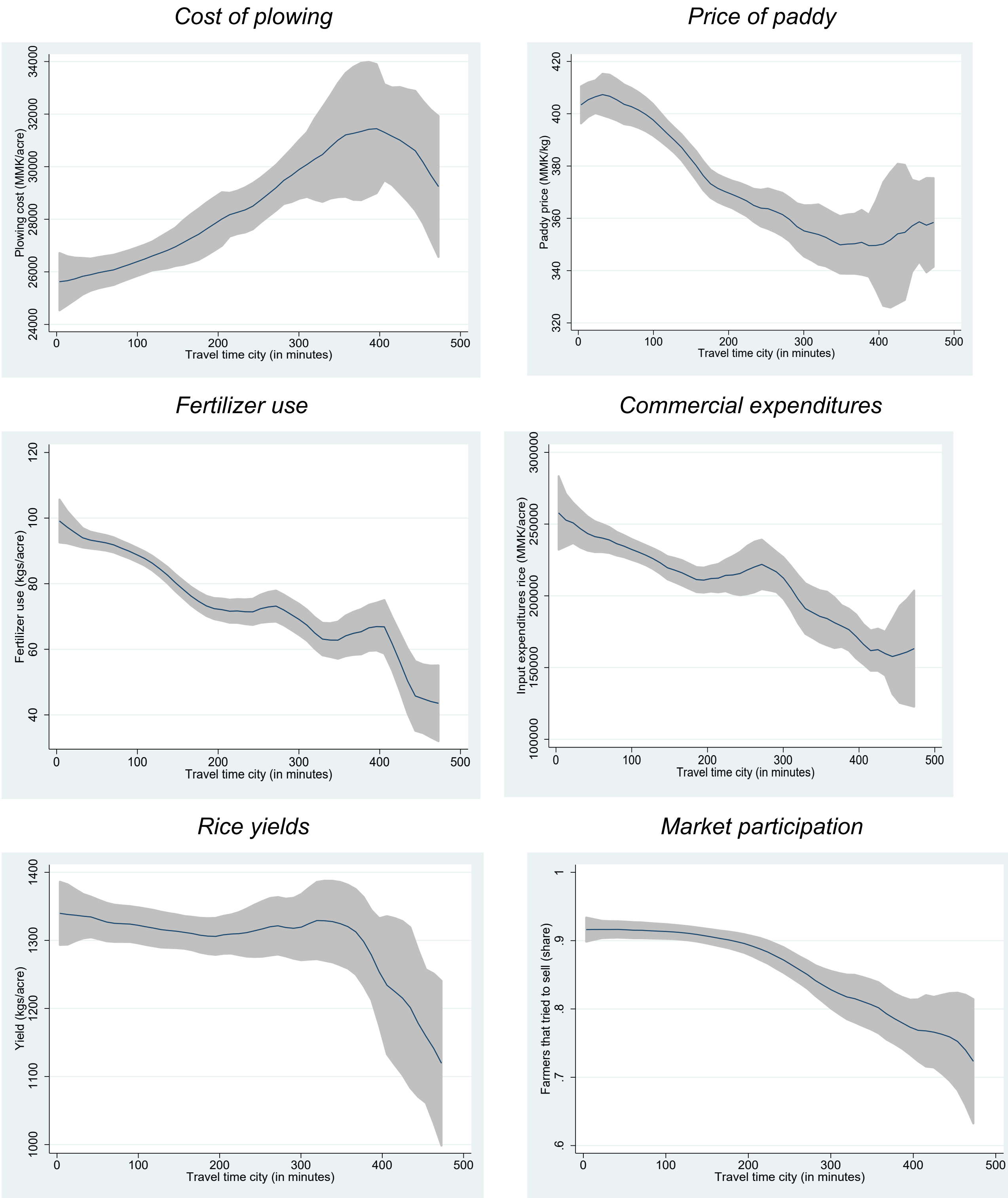
Source: Authors' calculations based on MAPS

Figure 9 further shows the relationships between these travel times with paddy production and commercialization data, based on the MAPS data of 2021. Remoteness reduces incentives for commercialization in two ways. First, prices of commercial inputs are significantly higher. The upper panel in Figure 9 illustrates that over the domain of travel time considered, the costs of plowing an acre of land is 20 percent higher for those villages that are located farthest from a city compared to those that are well-connected. As mechanization service providers operate from better connected areas, the travel costs to remote rural areas must be reflected in the prices that they charge farms there. Second, output prices are lower if villages are more remote (Figure 9, top right). Farmers located in villages farthest out received prices for their paddy that were 15 percent lower than well-connected farmers.

These reduced incentives for the use of commercial inputs are shown in the second panel of graphs. Farmers that are remote use significantly less fertilizer and spent less on commercial inputs. The most remote farmers use less than half the level of chemical fertilizer than those close by while commercial expenditures drop by 40 percent. This lower use of commercial inputs has important implications for yields – as shown in the case of rice yields dropping by 20 percent for the most remote farmers – as well as on market participation for more remote farmers. The graphs on the bottom panel to the right show that 70 percent of the most remote farmers are participating in output markets (of any crop) while this share is as high as 90 percent for the best-connected farmers.[16]

[16] These results only show simple associations and should be further analyzed in a regression framework.

Figure 9: Market access and prices, commercial input use, yields, and output market participation, monsoon 2021

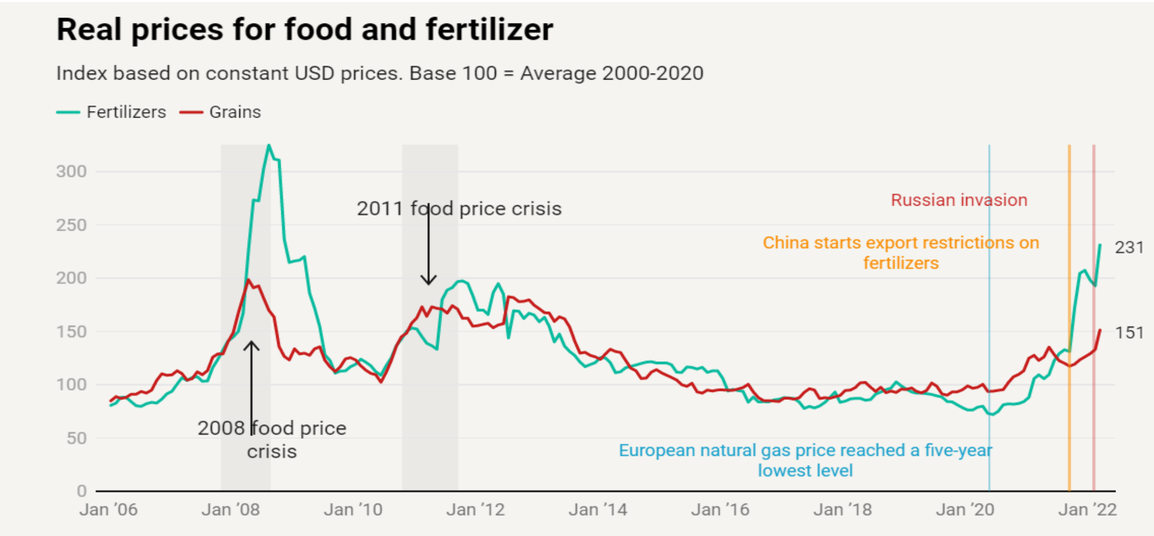


Source: Authors' calculations based on MAPS

6. FARM COMMERCIALIZATION AND THE TWIN CRISES

Large international changes in commodity markets and twin local crises – COVID-19 and political problems due to the military take-over – have hit the agri-food sector of Myanmar hard and have raised doubts on the performance of the agricultural sector overall (MAPSA 2021c, Goeb et al. 2021, Boughton et al. 2021, World Bank 2022). Internationally, there have been large changes in commodity markets in 2021 and 2022. International fertilizer prices have increased by 125 percent between January 2021 and January 2022 due to high prices of feedstock (Hebebrand and Laborde 2022) (Figure 10). Moreover, international shipping costs in 2021 were substantially higher due to a global shortage of containers, which was especially problematic in Asia due to COVID-19 related trade reductions. International freight costs in the Southeast Asian region in 2021 were estimated to be two to four times higher than during normal times (USDA 2021). Following Russia's invasion of Ukraine in February, fertilizer prices have increased even further, given that Russia and Ukraine are major suppliers of feedstock for fertilizers (Hebebrand and Laborde 2022). Fertilizer prices have increased by 17 percent between January and March 2022. These higher prices of fertilizers are leading to large worries about food security, especially in low- and mid-income countries.[17]

Figure 10: International price evolutions



Source: Hebebrand and Laborde (2022)

Input prices for rice farmers in Myanmar have changed dramatically over the last two monsoons (Table 8). First, chemical fertilizer prices reflected by the price of urea, the most important fertilizer used by rice farmers, have increased by 56 percent on average (the median by 68 percent) during the monsoon of 2021 compared to a year earlier. These high fertilizer price increases were mostly driven by international price changes, by the depreciation of the local currency, and increased fuel and transportation costs locally (MAPSA 2021a). Table 8 also shows that urea prices are relatively higher in the Coastal zone and the Hills and Mountains areas compared to the rest of the country, likely reflecting distances from the entry points of fertilizer imports from abroad (MAPSA 2021a).

Second, as a measure of the costs of mechanization, Table 8 presents the prices for plowing 1 acre of land by a four-wheel tractor. Farmers reported that those costs had increased by 19 percent on average, mostly reflecting the higher costs of fuel in the country over these two seasons. However, a survey of mechanization service providers during the monsoon of 2021 showed that they

[17] For food markets, we note important price increases for some major staples. Grain prices in March 2022 were on average 23 percent higher than a year earlier, especially driven by high price increases of wheat (Hebebrand and Laborde 2022).

faced financial challenges and fears of foreclosure on machinery loans due to the worsening demand in the country overall (MAPSA 2021b), possibly contributing to further price increases to farmers.

Third, the use of wage labor in agricultural activities is very common in Myanmar. It has been shown that wage levels before the COVID-19 pandemic had been increasing fast because of the increasing possibilities of alternative employment in cities and neighboring countries. This increase in wages has come to a halt, seemingly due to mobility restrictions linked to COVID-19 as well as the widespread economic problems because of the political crisis (World Bank 2022, MAPSA 2021c). Table 8 shows that average daily wages of hired labor of men and women increased by 7 percent while median wages did not change, in nominal terms, over the two seasons. However, wages decreased in real terms as inflation has been high in the country. MAPSA (2022a) estimated, based on a large food vendor survey in different parts of the country at the same time as the MAPS, that the costs of a typical food basket increased by 41 percent compared to a year earlier, substantially higher than these changes in wages. While bad for the welfare of workers, these wage labor costs did not increase substantially for farmers.

While we see increases in prices for most agricultural inputs, we see a smaller change in output prices at the time of the survey, impacting the profitability of rice production. Table 8 shows that at the national level average prices for paddy increased by 8 percent (the median changed by 7 percent). Paddy prices were relatively lower in the Delta region and the Coastal zones, likely reflecting their surplus status and the distances from those communities to end-markets in big cities (such as Yangon and Mandalay) as well as export markets (rice is shipped out from Yangon or land borders).

Table 8: Input and output prices in paddy rice cultivation, monsoon 2020 and 2021

		Monsoon 2020	Monsoon 2021				
	Unit	National	National	Hills	Dry	Delta	Coastal
Inputs							
Urea price (kg)	Mean	805	1,257	1,253	1,320	1,174	1,393
	Median	740	1,240	1,240	1,300	1,160	1,500
Costs plowing 1 acre (4-wheel)	Mean	29,010	34,503	40,161	30,906	32,291	46,900
	Median	25,000	30,000	35,000	30,000	30,000	45,000
Daily wage man	Mean	6,200	6,666	6,835	6,224	6,615	8,083
	Median	6,000	6,000	6,000	6,000	6,000	8,000
Daily wage woman	Mean	4,972	5,315	5,654	5,076	5,120	6,085
	Median	5,000	5,000	5,000	5,000	5,000	6,000
Output							
Paddy price (kg)	Mean	351	380	401	401	362	347
	Median	335	359	360	383	340	335
Number of observations		2,667	2,672	538	1,002	954	178

Source: Authors' calculations based on MAPS

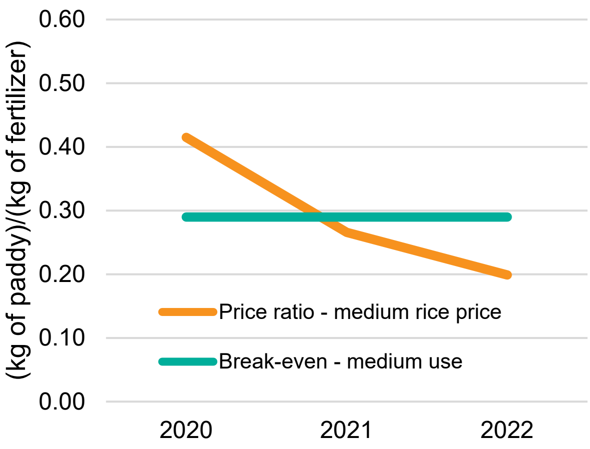
It is expected that fertilizer prices for the upcoming monsoon season will increase further to almost triple compared to two years earlier because of the war in Ukraine.[18] To understand how profitability of fertilizer use in rice production will be affected with these price changes, we compare price ratios

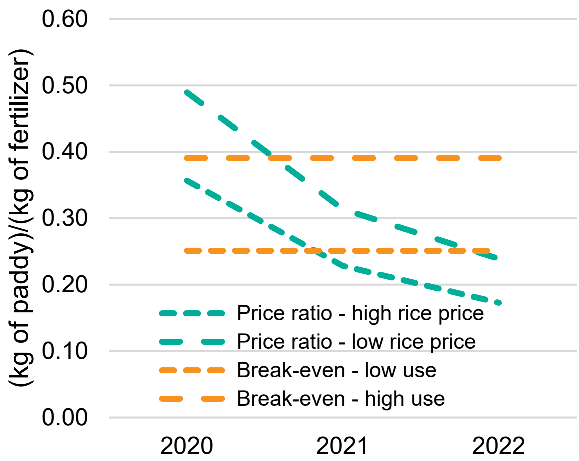
[18] For the range of expected prices for urea in 2022, see https://cdn.myanmarseo.com/file/client-cdn/2022/06/6_June_22_gnlm.pdf

of paddy and urea with a "break-even" situation, relying on the results reported in Table 4.[19] This break-even situation reflects a scenario below which fertilizer use becomes unprofitable. We use the 25th (low price), 50th (medium price), and 75th (high price) percentile of paddy prices reported after the 2020 and 2021 monsoon harvest and divide those by the average urea prices of the subsequent monsoon season, assuming that farmers will use proceeds of rice and paddy sales to pay for fertilizers the season after.[20]

Considering the medium price situation, farmers in 2020 could afford 1 kg of urea when they sold 2.4 kgs of paddy rice (Figure 11). In 2021, 3.8 kgs of paddy rice were required. This was still just around the profitability breakeven point (for medium users, i.e. 50 kgs per acre). However, with the expected increases in fertilizer prices in the next months, 5 kgs of rice are required to pay for 1 kg of urea, making fertilizer use in the medium scenario unprofitable.[21] While the average farmer in 2022 is below the breakeven point, some farmers may be able to benefit from higher paddy prices to justify investing in fertilizers (Figure 11, right). Rice prices were increasing in the beginning of 2022 (MAPSA 2022d), improving this ratio, but it is unclear how much they will increase and what farmers' price expectations are for the future as this ultimately determines their decisions to purchase fertilizer. Moreover, previous research (Morris et al. 2007) has shown that farmers usually require a buffer above the break-even point before they are willing to invest in fertilizers, which does not bode well for fertilizer use during the next monsoon season.

Figure 11: Profitability of fertilizer use (urea) on monsoon paddy rice, 2020 – 2022





Source: Authors' calculations based on MAPS

Table 9 presents the share of farmers that tried to sell crops during the monsoon of 2020 and 2021, the type or crops they wanted to sell, and the challenges encountered during marketing. The large majority of farmers tried to sell their crops of the monsoon (91 percent in 2020 and 88 percent in 2021) and we only see a slight change in the share of farmers that wanted to sell between those two years overall. As expected, the main crop that farmers wanted to sell after the monsoon was rice (Table 9). This has changed little over the years. 41 percent of the farmers in 2020 considered this the main crop that they wanted to sell. This compares to 39 percent in 2021. Rice as the main crop for sales in the monsoon of 2021 was especially important in the Delta (68 percent of the farmers). Rice was much less important in the Hills where only 23 percent of crop farmers reported that this was the main crop that they tried to sell. In contrast, 26 percent of the crop farmers in the

[19] For the calculation of the break-even ratio (0.24 kgs of fertilizer needed to obtain 1 kg of paddy), we rely on the medium quantity of fertilizer used per acre over the last two years (50 kgs) and use the results of model 1 in Table 4.

[20] As paddy prices of the monsoon of 2020 changed little compared to the year before (Goeb et al. 2021), we use the price distribution of the year before as an approximation.

[21] Urea prices are expected to be sold at 90,000 MMK per bag of 50 kgs (personal communication, fertilizer distributor).

Hills and Mountain region reported that maize was their main crop for sales. Pulses were relatively important in the Dry Zone.

Table 9 further shows that 21 percent of the farmers indicated that they had faced challenges (the same number in 2020 as in 2021). For those that faced challenges, low prices for crops were mentioned as a major challenge by 80 percent of the traders for the last monsoon. This had in the most recent monsoon declined to 72 percent, possibly an indication of the increasing farmgate prices for some crops. However, "low prices" are still the main challenge mentioned. This might be due to the much higher price increases seen in agricultural input markets as reported earlier. The second main challenge mentioned was high prices of fuel and transportation costs, complicating the transport of crops. An increasing problem is also the lower number of traders available (3rd most important challenge mentioned) or the fact that farmers cannot reach traders or traders cannot reach them (4th most important reason).

Table 9: Sales of crops and challenges, 2021

		2020	2021				
	Unit	National	National	Hills	Dry	Delta	Coastal
Tried to sell crop of monsoon harvest (%)	yes	91	88	84	86	95	86
Main crop that they tried to sell (%)							
Rice (%)		47	46	23	38	68	62
Maize (%)		7	7	32	2	0	0
Groundnut (%)		7	6	1	14	1	1
Sesame (%)		6	5	4	8	1	1
Pulses (%)		6	8	3	14	5	1
Betel leaves (%)		3	4	0	3	7	4
Other crops (%)		24	24	37	21	17	31
Challenges faced during marketing (%)	yes	20	21	23	20	18	24
Type of challenges (%)							
"low prices for crops"	yes	16	15	17	15	12	21
"high price of fuel / high transportation cost" (%)	yes	9	12	12	12	10	18
"payment problems" (%)	yes	5	5	7	4	4	9
"have to sell crops on credit" (%)	yes	6	6	8	5	8	8
"markets are closed" (%)	yes	6	6	8	7	5	8
"not many traders" (%)	yes	9	10	11	11	8	16
"buyers or traders cannot reach the farm or I cannot reach them" (%)	yes	8	9	10	10	7	10
"insecurity during travel" (%)	yes	3	5	6	7	3	5

Source: Authors' calculations based on MAPS

We also asked farmers to estimate how the overall sales income from crop farming changed in the beginning of 2022, compared to the same time a year earlier (Table 10). Strong heterogeneity in stated evolution of crop sales income is seen. 36 percent of the crop farmers reported lower sales incomes compared to a year earlier while 35 percent indicated higher crop sales incomes. 24 percent of the farmers reported that incomes were about the same. There are no strong regional patterns in these responses, indicating that some farmers in each region/state were doing better while others were not.

Table 10: Changes in sales income, 2021

	Unit	National	Hills	Dry	Delta	Coastal
> 20% decline (%)	%	17	18	18	17	12
20% to 1% decline (%)	%	19	16	19	20	22
The same (%)	%	24	24	22	26	25
1% to 20% increase (%)	%	23	23	20	23	33
> 20% increase (%)	%	12	11	15	10	6
Do not know	%	6	8	5	4	3

Source: Authors' calculations based on MAPS

Relying on an ordered probit model (reflecting the first five categories in Table 10, going from a decline of 20 percent of more to an increase of 20 percent or more), we further analyze how different factors were associated with differential developments in crop sales income after the 2021 crisis year (Table 11). The location of the household mattered enormously as travel became more complicated due to increased transportation costs as well as insecurity. This is shown by the highly significant effect of the travel time to a major city of at least 50,000 people. Farmers located further away from such cities saw lower crop sales increases than those close by. Farmers that were remote within the township also saw negative effects, but the coefficient is not significant at conventional statistical levels. Bigger farmers were able to achieve better increases in sales income than smaller farms.

The security situation of the household mattered for the performance in crop sales. Those households that stated that they live in secure situations were able to achieve higher income increases than those that were not. Finally, the choice of crops grown were also a major reason why households were doing better. Those households that were growing export-oriented crops such as maize and pulses saw significant price increases locally because of international market developments as well as the depreciation of the local currency helping them benefit from significant increases in crop sales incomes.

Table 11: Associates of changes in sales income during the crisis of 2021 – ordered probit

	Descriptives		Regression results		
	Unit	Mean	Unit	Coefficient	z-value
Travel time to major city	hours	172.8	log(hours)	-0.06	-2.12
Distance to township center	hours	0.83	log(hours)	-0.06	-1.19
Area of land owned	acres	8.42	log(acres)	0.09	4.21
Perceived security situation					
default - very insecure	share	0.04	yes=1		
somewhat insecure	share	0.14	yes=1	0.05	0.50
secure	share	0.44	yes=1	0.20	2.05
very secure	share	0.38	yes=1	0.17	1.76
Crops grown					
paddy	share	0.69	yes=1	-0.04	-1.01
maize	share	0.09	yes=1	0.45	6.53
pulses	share	0.31	yes=1	0.21	5.00
Agro-ecological zone					
Delta	share	0.30			
Dry zone	share	0.41	yes=1	-0.06	-1.33
Coastal area	share	0.06	yes=1	0.14	1.95
Hills and Mountains	share	0.22	yes=1	-0.07	-1.25
Number of observations			3,681		
Pseudo R2			0.01		

Source: Authors' calculations based on MAPS; robust standard errors

7. CONCLUSIONS

Over the last decade, commercial farm input usage of chemical fertilizer, agro-chemicals, and mechanization services has increased significantly in Myanmar. Increased usage of such inputs is shown to be linked to better crop performance, ceteris paribus. On the output side, three-quarters of Myanmar's crop production is sold, indicating high market orientation. Paddy and pulses are shown to be the two most important sources of sales income, counting for almost 40 and 20 percent of sales income from crops. The share of paddy in crop area sown is stable over time, seemingly indicating that farmers in Myanmar are not diversifying out of paddy.

A major constraint in farm commercialization in Myanmar is market access, with a substantial number of farmers in Myanmar not having access to all-year round road infrastructure or being remote from major cities. While 20 percent of the farmers in Myanmar can travel to a city of 50,000 people or more in two hours or less, one-third of farmers would need more than 4 hours to travel from their home to such a city. It is found that more remote farmers have worse incentives for crop production, use fewer commercial inputs, have lower yields, and participate less in output markets.

The COVID-19 and the political crises in 2020 and 2021 and international market developments have led to increasing worries about a stalled agricultural transformation towards commercialization. Price changes in modern input markets, currency policy changes, and reduced profitability for most crop farmers may reverse gains made over the last decade. Import statistics show that purchases of agricultural machinery have declined significantly and that the quantities of chemical fertilizers imported in the country fell to half of the 2020 level in 2021. The value of imports of agro-chemicals in 2021 were at similar levels as previous years but quantities have dropped substantially given large international price increases (prices of glyphosate doubled to tripled in 2021 compared to 2020).

While transformation has happened in Myanmar's agricultural sector, the country is still lagging peer countries (Takeshima and Joshi 2019) (see annex). To improve Myanmar's farm commercialization, and therefore agricultural performance, several issues need to be addressed. First, the business environment needs to be improved to allow businesses to deliver required products and services. An international index has been developed to measure the status of an enabling environment for agri-businesses (World Bank, 2019).[22] The results in Table 12 show that regulatory measures limit private agri-business growth in Myanmar and lessen appropriate services for farmers. In 2019 (i.e. before the twin crisis), Myanmar ranked 91st out of the 101 countries where the assessment was conducted, more than 20 places behind the lowest ranked peer country (Malaysia ranks at 69th). Of all peer countries, China is ranked best, at 40th.

The World Bank (2019) report also indicted that Myanmar could possibly improve regulation and business environments by reforming seed and fertilizer regulation, securing water, improving the quality of manufactured feed and veterinary medical products, and quality of phyto-sanitary regulation. With respect to the output side, it seems that Myanmar is not doing well but it is not trailing peer countries as badly as it is on the input side. For example, the index of inclusive finance gives Myanmar a score of 3, which is the same score that 4 out of the 5 peer countries have. The warehouse receipt financing is problematic but so is the situation in Malaysia and Vietnam.

[22] To develop this indicator, the World Bank assessed a number of regulations in eight sectors in agriculture, including supplying seed, registering fertilizer, securing water, registering machinery, sustaining livestock, protecting plant health, trading food, and accessing finance. These data are then weighted and combined in one overall indicator, called the 'Enabling Business of Agriculture' score.

Table 12: Enabling the business of agriculture measures

Index	Unit	China	India	Malaysia	Myanmar	Thailand	Vietnam
Quality of seed regulation	0-9	5	6	4	3	6	7
Quality of fertilizer regulation	0-6	4	4	0	1	3	5
Securing water	0-10	8	2	2	0	0	6
Quality of manufactured feed	0-5	3	2	4	0	4	5
Quality of veterinary medical products	0-6	6	4	5	1	3	3
Quality of phyto-sanitary regulation	0-5	3	3	3	1	3	3
Trading food	0-7	5	5	6	3	3	3
Warehouse receipt	0-5	3	5	0	0	3	0
Inclusive finance	0-5	3	3	3	3	3	4
Enabling the Business of Agriculture Score		70.3	62.2	51.7	31.3	58.5	61.4
Rank (out of 101 countries)		40	49	69	91	59	58

Source: World Bank (2019)

Second, farmers' market access should best be improved. Improving market access by investing in rural road infrastructure should be a priority as it will bring a large, mainly agriculture-dependent, remote population into local and international agricultural value chains. Investments in rural roads have been shown to have high rates of return as it enhances agricultural performance because of access to cheaper modern inputs and higher agricultural output prices. They further increase agricultural and non-farm incomes, improve nutrition, and alleviate rural poverty (Stifel et al. 2016). Improved market access is also achieved through improving the security situation in the country. 18 percent of the farmers in Myanmar in the beginning of 2022 indicated that they felt they were living in an insecure situation, impacting their sales incomes as traders had more difficulties traveling there or because the farmers themselves faced travel problems.

Third, we have noted no diversification away from rice over the last decade. Rice is still overwhelmingly important in Myanmar's agricultural and rural economy, as 36 percent of crop land was devoted to rice in 2021/22 while 40 percent of farmers' commercial crop income was from rice. While rice has an important role to play in Myanmar's agricultural economy and in commercialization, further diversification into high-value commodities should be encouraged to increase crop incomes as well as reduce the risks in the farm sector hugely dependent on one crop, especially given changing demands by consumers and international markets.

Fourth, international trade has in the last decade contributed to better performance of the agricultural sector in Myanmar, helping to reduce rural poverty in the country (Ekanayake et al. 2017) and assure resilience during the twin crises (MAPSA 2022c). It has allowed for the more widespread adoption of modern inputs and better farm performance. On the output side, we note that those farmers that were able to export crops in 2021/2022 could better stabilize and even increase their income from crop sales. Recent international trade hurdles from licensing and foreign exchange distortions, are therefore a hindrance for agricultural trade, farm performance, and consequently rural welfare overall.

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ANNEX: BENCHMARKING MYANMAR

Meta-conditioners and service delivery

Table A1 gives an overview of population, income levels, and availability of natural resources of different Asian benchmark countries (i.e. China, India, Malaysia, Thailand, and Vietnam) compared to Myanmar. Myanmar has one of the lowest levels of urbanization. 35 percent of its population lives in cities, about the same level as in India but significantly lower than the other countries. Malaysia has the highest level of urbanization. Higher urbanization levels are associated with higher income levels (as measured by GDP), and Myanmar trails all. When measured in constant PPP, Myanmar was in 2019 at 77 percent the level of India and 66 percent the level of China. Malaysia and Thailand are the richest of the group and Myanmar reaches 18 percent and 27 percent of their GDP level. On the other hand, Myanmar is relatively well endowed with land and water resources. It has the highest level of internal renewable water resources per person and it has the second highest level of average precipitation and arable land per person. Myanmar is therefore considered a land- and water abundant country.

Table A1: Population, GDP and natural resources of benchmark countries

	China	India	Malaysia	Myanmar	Thailand	Vietnam
Total population (million, 2019)	1,397	1,366	32	54	69	96
Share urban	57	33	76	35	52	57
GDP per capita (constant 2010 US$)	7,347	1,987	11,729	1,483	6,135	1,853
GDP per capita, PPP (constant 2017 international $)	14,344	6,186	26,648	4,740	17,421	7,156
Myanmar GDP compared to benchmark countries (%)	33	77	18	100	27	66
Natural resources						
Long-term average precipitation (mm/year)	645	1,083	2,875	2,091	1,622	1,821
Renewable internal water resources (m3/cap/year)	1,952	1,080	18,341	18,793	3,252	3,762
Arable land (hectares/person)	0.09	0.12	0.03	0.21	0.24	0.07

Source: World Bank Development Indicators; FAO-Aquastat; FAOstat

Access indicators to infrastructure and services for Myanmar are often worse than for benchmark countries, but not for all indicators (Table A2). 60 percent of the rural population has access to electricity, significantly below the other countries. Almost 40 percent of Myanmar's rural population and 27 percent of its overall population is located further than 2 kms away from a paved road, a larger share than in other countries (ADB, 2017). Table A2 further gives an indication of access to communication infrastructure - notably mobile phones - and access to financial services. Myanmar has quickly expanded its mobile phone network since liberalization in the 2010s and mobile phone subscribers make up 93 percent of the population, higher than India and China. However, subscriptions over-estimate the actual share of the population having access to mobile phones as some of the phone cards are out of use. This (imperfect) measure puts Myanmar however at the same level as China and India. The table further shows that formal account ownership at a financial institution are significantly below other countries, except Vietnam.

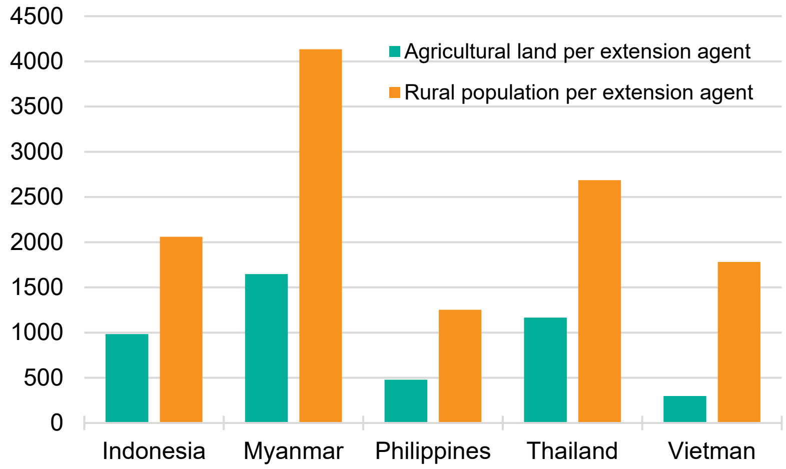
Table A2: Infrastructure and access to overall services

	China	India	Malaysia	Myanmar	Thailand	Vietnam
% of population with access to paved road (within 2 kms)						
Rural	-	-	49	59	87	53
Overall	-	-	88	73	94	80
Access to electricity, rural (% of rural population)	100	89	100	60	100	100
% of population with mobile subscriptions	78	79	139	93	133	131
Account at a financial institution (% age 15+)	80	80	85	26	82	31
Saved at a financial institution (% age 15+)	35	20	38	8	39	14
Made or received digital payments in the past year (% age 15+)	68	29	70	8	62	23

Source: World bank Development Indicators, ADB (2017), and DataReportal (www.datareportal.com)

Agricultural extension has been shown to be crucial to get needed agricultural technologies from the research stage to the farm. While the Ministry of Agriculture, Livestock and Irrigation (MoALI) employed more than 60,000 people before the political crisis, a relatively minor share of their employees was however involved in extension activities. In the Department of Agriculture, one of the biggest departments within MoALI, about 8,200 people are extension agents. While there are also a large number of private extension agents in the country, the number of extension agents overall is still small compared to the total number of farmers and cultivated agricultural land in the country (Figure A1). Extension agents in Myanmar are covering 4,135 farmers per agent. This compares to less than half that number in Vietnam. In Thailand, extension agents cover approximately 2,600 farmers.

Figure A1: Extension agent coverage



Source: Ekanayake et al. (2019)

The upshot of the international comparison is that Myanmar's agri-food system is relatively badly positioned for several access indicators such as infrastructure and electricity, as expected with their overall lower levels of development and income, and for service delivery such as agricultural extension but that the country is relatively rich in land and water resources compared to these other countries.

Agricultural input use and productivity

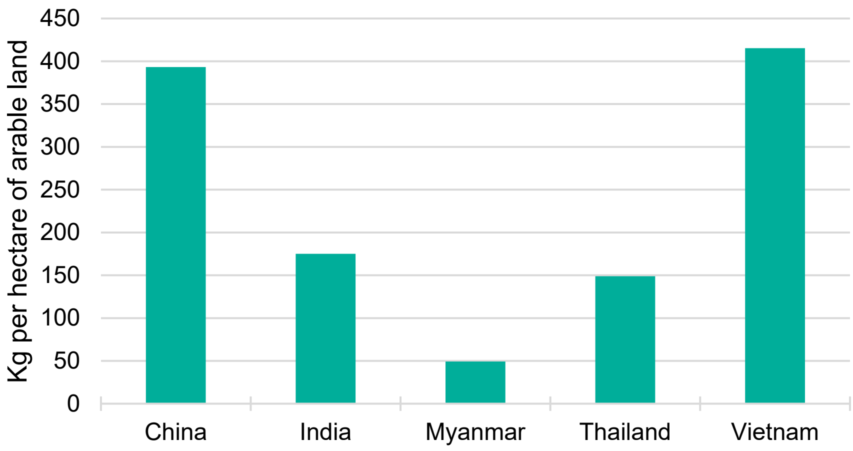
To assess agricultural production performance, we first look at the adoption of improved agricultural technologies. One important input for improved performance is the use of improved seeds. Unfortunately, no good and updated data at the national level are available. The World Bank (2016)

- based on a survey done in 2013 - estimated that less than 7 percent of farmers used certified seeds. They also evaluated that the supply of certified rice seeds was estimated to satisfy less than 1 percent of potential demand. This supply/demand ratio was as high as 117 percent in Thailand and 100 percent in Vietnam. Boughton et al. (2020) conducted more recently a large survey in the Dry Zone of the country. They found that the adoption of improved varieties in their study area was relatively low (the highest adoption of improved seeds stood at 41 percent in the case of sunflower; it was the lowest for pigeon pea at 8 percent) compared to the same crops in Bangladesh, China, India, Thailand and Vietnam where adoption rates were estimated to be more than 90 percent. Access to quality seed is deemed problematic in Myanmar and most of the farmers therefore rely on own saved seeds or informal trusted channels, inhibiting the spread of improved varieties.

International comparative data - i.e. FAO, as reported in the World Bank WDI database - put chemical fertilizer use at relatively low levels compared to other countries in the region (Figure A2), i.e. at 12 percent the level in China (393 kg/ha) and Vietnam (415 kg/ha), 28 percent of India (175 kg/ha), and 33 percent of Thailand (149 kg/ha). It is not clear what the exact source of the data is as MAPSA (2022c) shows that farmers were using 146 kgs per hectare on their rice fields during the monsoon and use might therefore possibly be higher than shown in these numbers. The World Bank (2017) further identified wrong combinations of chemical fertilizer use as a major issue, linked to lack of knowledge in that area, leading to lower returns to fertilizer use than seen in other countries in the region.

Agro-chemical use has expanded quickly in South-East Asia. Takeshima and Joshi (2019) show that in the 2010s, 30 USD of agrochemicals per hectare of cropland was on average imported by South-East Asian countries. That level was 3 to 4 times higher than imports seen in the 1980s and the 1990s, leading to increased worried of overuse of agro-chemicals in agriculture. In their assessment for the 2010s, Takeshima and Joshi (2019) further show that Myanmar and Timor-Leste were the countries that imported the least agro-chemicals per cropland unit in the surveyed South-East Asian countries. While agro-chemical use has significantly increased over the last decade in Myanmar (as seen in section 3.2), the current level - about 9 USD per hectare of cropland in 2019 - is still substantially below the average in South-East Asia.

Figure A2: Fertilizer use by hectare of arable land

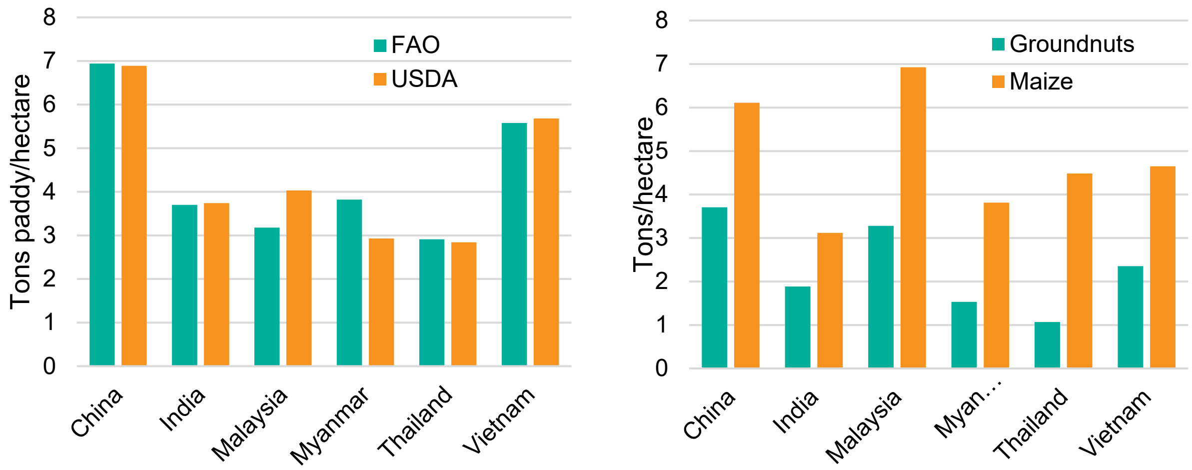


Source: FAO, downloaded from https://data.worldbank.org/indicator/AG.CON.FERT.ZS

Based on data from FAOStat (and USDA), we further compare yields of major crops in the country, i.e. rice, groundnuts (as a crop representing the important pulses sector), and maize (Figure A3). Myanmar is typically among the worst performers for each crop. For rice, Myanmar's most important crop area wise, we see that yields - if we rely on the USDA numbers - are at the same level as in Thailand, but much lower than in other countries. Rice yields are almost twice as high in

Vietnam and more than twice as high in China. In the case of groundnuts, Myanmar performs better than Thailand but still lags other countries. Groundnut yields are more than 50 percent higher in Vietnam. For maize, where Myanmar has recently seen quite some improvements through the widespread adoption of hybrid seeds (Fang and Belton 2020), yields are higher than in India, but it lags all other countries, although not that much compared to Thailand and Vietnam. China and Malaysia top the list, with average yields of about 6 and 7 tons per hectare respectively.

Figure A3: Crop yields (paddy, groundnuts and maize)



Source: FAOstat

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