MYANMAR

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The outlook for Myanmar's inorganic fertilizer use and 2021 crop harvest

An ex-ante assessment

CONTENTS

TABLES

FIGURES

ABSTRACT

International inorganic fertilizer prices and shipping costs substantially increased in 2021 compared to a year earlier. This will lead to significantly higher border prices for fertilizer in Myanmar, an important development as Myanmar imports almost all of its fertilizer from abroad. The impacts of the current political crisis on the local transport sector and the depreciation of the Myanmar currency, the kyat, will further increase domestic fertilizer prices. Based on a survey of agro-retailers in March 2021, fertilizer prices were estimated to be 22 percent higher for urea and 10 percent higher for compound fertilizer compared to the same period a year earlier. In addition to these supply-side challenges, effective demand for inorganic fertilizer is expected to be lower in 2021 due to significantly reduced farmer incomes, lower credit availability, and more uncertain agricultural profitability. Given these international and local developments, fertilizer use in Myanmar in 2021 will be substantially less than normal. Ex-ante simulations, which assume a ratio of additional crop output per unit of fertilizer applied between three and five, indicate that a reduction of fertilizer use–all else equal–in the country to half the level of a normal year would reduce agricultural output in 2021 by between 9 and 15 percent. Particularly, monsoon rice production will be affected. The Delta region produces half of Myanmar's monsoon rice and uses about half of the inorganic fertilizer imported annually. Thus, the expected shocks to fertilizer markets in 2021 may have outsized effects on rice production levels in particular.

1. INTRODUCTION

Agro-chemicals are important inputs for crop production and increasingly so in many low and middle-income countries. Inorganic fertilizers, in particular, are often the most important purchased input for farmers. Thus, farmer access to affordable fertilizer is an important concern for governments, development partners, and farmers. Current international and local disruptions to fertilizer supply chains threaten farmer's access to fertilizer in Myanmar. Moreover, effective farmer demand for fertilizer in Myanmar has taken a crucial hit as well due to the COVID-19 pandemic and the political crisis. This will likely lead to significantly lower fertilizer use in the country in 2021.

International fertilizer markets have undergone several recent changes. First, international fertilizer prices are rapidly increasing. In March 2021, US prices of urea and diammonium phosphate (DAP) were estimated to be 27 and 48 percent higher, respectively, than a year earlier (Quinn 2021). Higher prices are expected globally through 2021 due to high prices of feedstock (Ibendahl 2021). Second, international shipping costs in 2021 are substantially higher due to a global shortage of containers, which is especially problematic in Asia due to COVID-19 related trade reductions.[1] International freight costs in the Southeast Asian region in the beginning of 2021 were estimated to be two to four times higher than during normal times (USDA 2021b, Fitch Ratings 2021[2]).

Locally, COVID-19 and political crises have created unprecedented challenges to the functioning of agricultural value chains and the agri-food system. The COVID-19 crisis has led to large income declines in the country overall and to substantial disruptions in Myanmar's agri-food system (Boughton et al. 2021; Headey et al. 2020). The political crisis has caused large problems in the banking and finance sector, in international trade, and in the local transport sector, among others (USDA 2021a). Moreover, the currency of Myanmar, the kyat (MMK), is rapidly depreciating. This is important as most inorganic fertilizer used in the country is imported. By early April 2021, the MMK had depreciated by almost 20 percent in USD terms compared to early February 2021, according to a licensed moneychanger in Yangon (USAID 2021). At the farm level, the political crisis is leading to lower credit availability for farmers, a decrease in farm prices for some crops, and more uncertain agricultural profitability (MAPSA 2021).

The purpose of this research note is to assess how both international developments and domestic crises might affect fertilizer use in Myanmar in the upcoming agricultural year. We discuss in turn the data and methods used for our assessment, the functioning of inorganic fertilizer value chains in normal years in Myanmar, recent increases in fertilizer prices and decreases in use, and the expected implications of reduced fertilizer use on crop output in 2021.

2. DATA AND METHODS

To assess the current situation of the fertilizer sector in Myanmar, we rely on three sources of data. First, 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 (CSO, UNDP, and WB 2020) as well as on agricultural practices in the country. The 2017 MLCS 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. 5,409 of the surveyed households reported operating agricultural land. For the present analysis, we

[1] https://www.hillebrand.com/media/publication/where-are-all-the-containers-the-global-shortage-explained

[2] https://www.fitchratings.com/research/corporate-finance/global-container-shipping-rates-are-high-unsustainable-23-02-2021

rely on data from these latter households. We further divide the country into four major agro-ecological zones.[3]

Second, import data for the last decade were obtained from the UN Comtrade database (United Nations 2020). These data include information on quantities, country of consignment, and values of imported fertilizers.

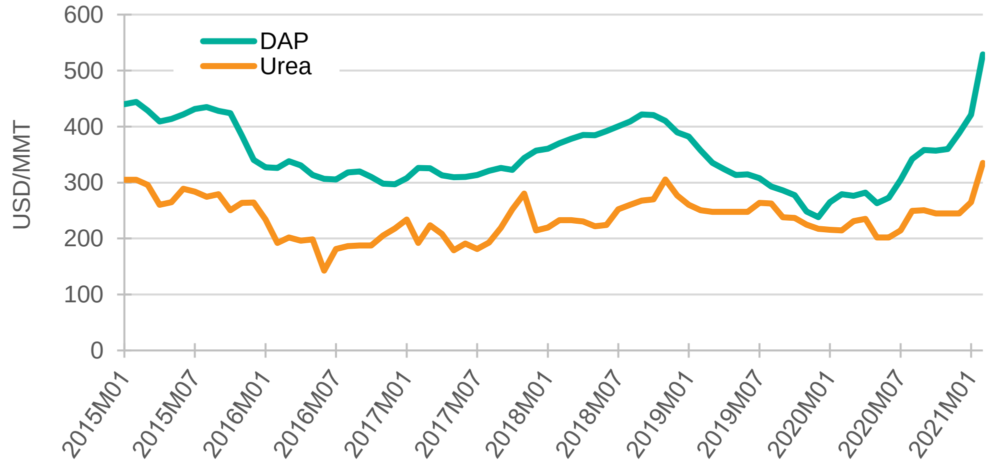
Third, a telephone survey of agro-retailers was conducted in March 2021. This was a continuation of a panel survey of agricultural input retailers from Shan, Kachin, Bago, Ayeyarwady, Sagaing, and Mandalay[4], providing coverage of three different agro-ecologies, the Delta, the Dry Zone, and the Hills and Mountains. The same retailers were called at regular intervals in 2020 to track the effects of the COVID-19 crisis.[5] While there has been some attrition between survey rounds as well as hesitancy to participate in surveys during the current political crisis, 109 retailers were interviewed in the March 2021 round.

3. INORGANIC FERTILIZER IN MYANMAR

International trade

International fertilizer prices are rapidly increasing. Figure 1 shows the international price evolution over the period 2015 to early 2021 of two major inorganic fertilizers used in Myanmar, DAP and urea. Prices of DAP and urea in February 2021 were at 529 and 335 USD per million metric ton (MMT), respectively, 89 and 56 percent higher than 12 months earlier and at their highest levels over the last six years. These higher international prices have been linked to increased feedstock prices (ammonia and sulfur) and favorable commodity prices. Moreover, they are predicted to stay at this level in the near future (Fitch Ratings 2021[6]). These high international prices will influence inorganic fertilizer prices in Myanmar.

Figure 1: International price evolution of the major fertilizers diammonium phosphate (DAP) and urea, nominal monthly prices, 2015 to early 2021



Source: World Bank (https://www.worldbank.org/en/research/commodity-markets)–DAP prices based on (spot, f.o.b. US Gulf) and Urea on (Ukraine, f.o.b. Black Sea)

[3] Delta (Ayeyawaddy, Bago, Mon, Yangon); Coastal (Rakhine, Tanintharyi); Central Dry (Mandalay, Magwe, NPT, Sagaing); Hills and Mountains (Chin, Kachin, Kayah, Kayin, Shan).

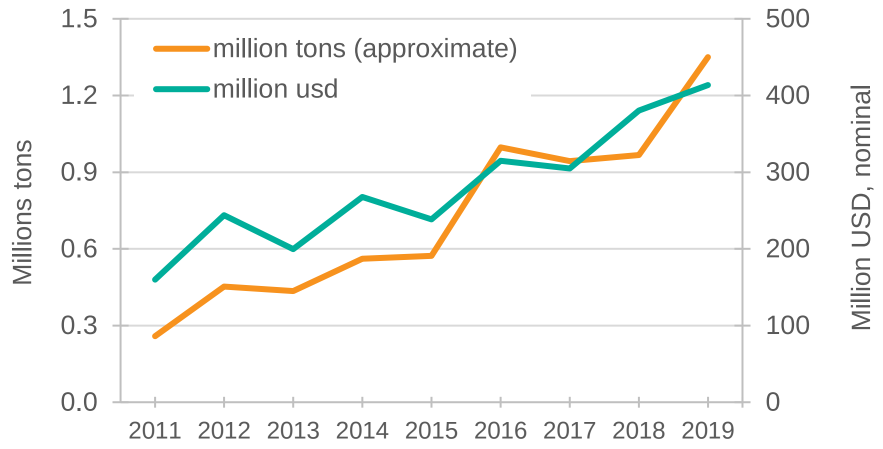
[4] Collectively, these account for about 66 percent of Myanmar's agricultural production by value, cultivated area, and farmers.

[5] We identified a sample of agricultural input retailers through a combination of sources, including previous studies, government registration lists, and private sector contacts. While our sample provides regional and agro-ecological variation, it is not representative at any municipal level. Thus, all analyses and results in this report are illustrative and provide useful insights into the sector, but should not be interpreted as population statistics.

[6] https://www.fitchratings.com/research/corporate-finance/fitch-ratings-raises-most-global-fertiliser-price-assumptions-25-03-2021

Local inorganic fertilizer production makes up a relatively small share of total inorganic fertilizer use in Myanmar. Most inorganic fertilizers are imported from abroad.[7] Figure 2 shows the level of fertilizer imports based on Comtrade data. In 2019, it was estimated that Myanmar spent just over 400 million USD for inorganic fertilizer to import about 1.3 million tons in total. Figure 2 illustrates how fertilizer imports have changed over the last decade. There have been rapid increases over time–values of fertilizer imports have almost tripled over the last decade, while the quantities imported show even greater changes due to declines over this period in real international fertilizer prices.

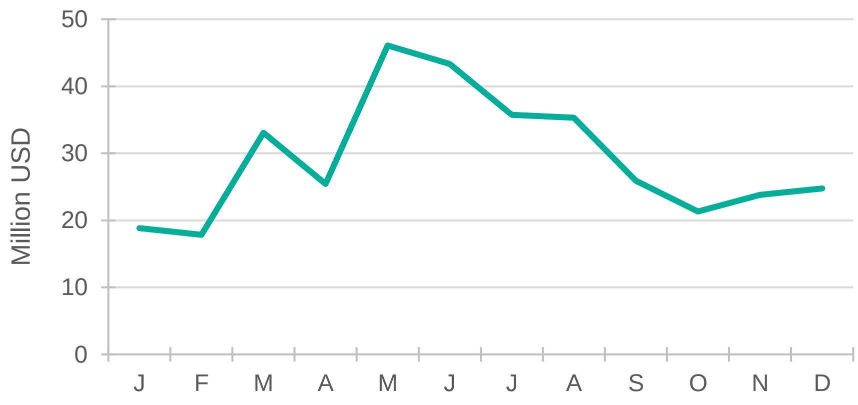
Figure 2: Value and quantity of fertilizer imports into Myanmar, 2011 to 2019



Source: Comtrade

Fertilizer use follows the seasonal trends of the agricultural calendar. Myanmar's largest agricultural production period is the monsoon season. Farmers typically plant their monsoon crops in May, June, and July, with fertilizers usually being applied at planting time and in the first months of plant growth. While fertilizer imports occur throughout the year, imports spike ahead of the monsoon season (Figure 3). Over the last four years, the largest amounts of fertilizers were imported during the months of May and June, making up on average a quarter of all annual fertilizer imports.[8]

Figure 3: Seasonality in fertilizer imports into Myanmar, monthly average value of imports, 2017 to 2020



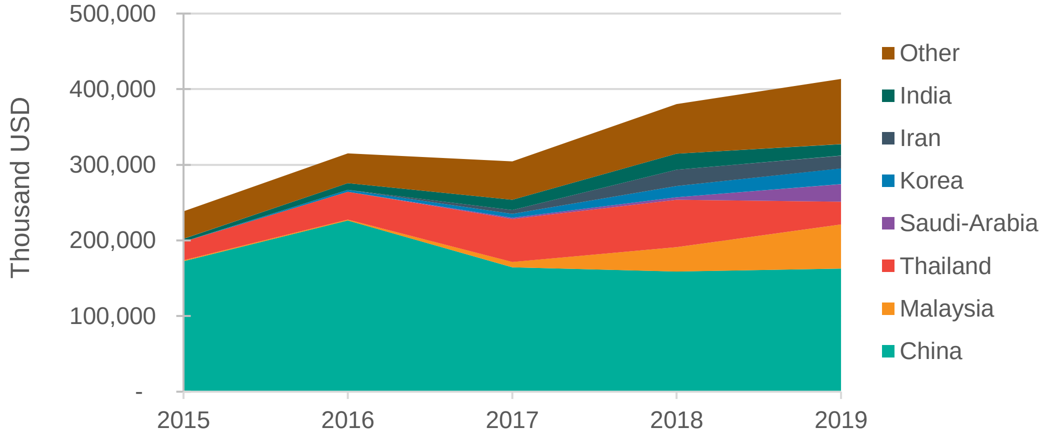
Source: ITC Trade Map

[7] IFDC (2018) estimated that in 2016/17 about 7 percent of the fertilizers consumed in Myanmar was 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).

[8] it is unclear though how much delay there is between reporting of imports and the actual imports.

Neighboring countries supply most of Myanmar's inorganic fertilizer imports. China is the largest source, supplying an estimated 39 percent of all fertilizer imports in 2019, with Malaysia and Thailand being the next largest sources (Figure 4). Fertilizers are imported into Myanmar by land and through the port of Yangon. Using country of origin as an indication of the importance of land and sea access–imports from China and Thailand mostly come into Myanmar over land–it can be inferred that about half of all inorganic fertilizer was imported by land in 2019. That percentage was significantly higher in previous years. For example, China and Thailand combined made up 82 percent of all fertilizer imports in 2015. The disruption of activities in Yangon's port due to the political crisis and the effects of those disruptions on fertilizer imports through the port from overseas will therefore have important adverse effects on inorganic fertilizer availability in the country.

Figure 4: Source countries of inorganic fertilizer imported into Myanmar, by value, 2015 to 2019



Source: ITC trade map

Fertilizer use by farmers

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. An average Myanmar farmer spent 112 USD per year on inorganic fertilizer. The Delta had the highest fertilizer expenditures in the country at 179 USD per farm, significantly higher than in other agroecological zones. Average fertilizer expenditures for the other zones were 94 USD per farm in the Hills and Mountains, 83 USD per farm in the Central Dry Zone, and 56 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 30 percent of all inputs purchased. The second and third largest purchased inputs are machine rental and agro-chemicals at 19 and 15 percent, respectively. While absolute expenditures for fertilizer are the highest in the Delta, overall expenditures on purchased inputs are also 60 percent higher in the Delta compared to the national average. Thus, the share of inorganic fertilizer in overall purchased inputs in the Delta is similar to the rest of the country.

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

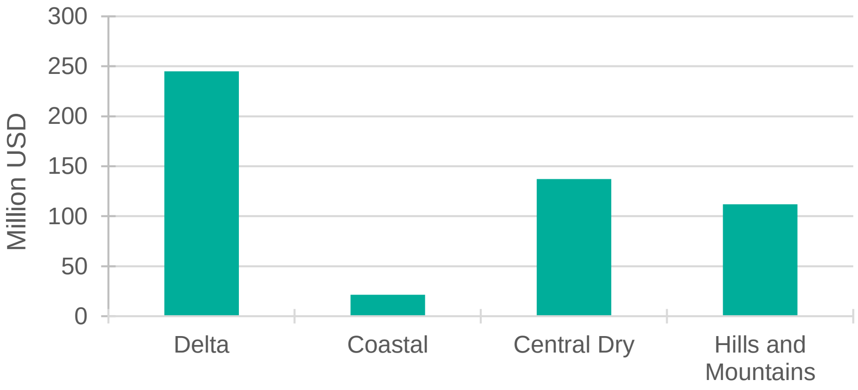
	Delta	Coastal	Central Dry	Hills and Mountains	Total
Average cost, USD					
Inorganic fertilizer					
Mean	179.4	56.2	82.9	94.2	112.3
Standard deviation	416.2	128.8	179.7	166.1	271.3
Organic fertilizer					
Mean	12.5	10.1	9.9	14.6	11.9
Standard deviation	80.5	57.3	41.4	52.5	59.4
Seed					
Mean	71.4	12.8	55.0	38.4	52.1
Standard deviation	168.5	35.4	152.1	96.8	140.0
Agro-chemicals					
Mean	115.3	7.1	41.7	22.9	55.8
Standard deviation	380.9	35.1	112.1	71.9	225.1
Rent machinery					
Mean	99.9	27.1	9.05	25.7	71.3
Standard deviation	230.1	73.3	631.3	73.5	403.0
Hiring cattle					
Mean	8.8	9.0	14.8	9.3	11.1
Standard deviation	38.9	39.0	44.4	38.4	40.9
Irrigation					
Mean	0.5	1.1	0.5	0.0	0.5
Standard deviation	6.3	12.0	2.9	0.8	5.2
Purchased inputs					
Mean	602.0	168.4	339.5	227.0	374.2
Standard deviation	1,166.3	376.4	1,037.4	361.9	928.9
Share of purchased inputs, %					
Inorganic fertilizer	29.8	33.4	24.4	41.5	30.0
Organic fertilizer	2.1	6.0	2.9	6.4	3.2
Seed	11.9	7.6	16.2	16.9	13.9
Agro-chemicals	19.1	4.2	12.3	10.1	14.9
Rent machinery	16.6	16.1	26.7	11.3	19.0
Hiring cattle	1.5	5.4	4.4	4.1	3.0
Irrigation	0.1	0.7	0.2	0.0	0.1
Income, USD					
Crop sales income					
Mean	2,161.8	707.8	1,184.7	821.5	1,341.5
Standard deviation	4,396.5	1,953.0	3,188.4	1,521.0	3,261.2
Crop income					
Mean	2,760.8	1,339.4	1,660.2	1,150.8	1,828.9
Standard deviation	5,166.6	7,515.2	3,482.4	1,822.7	4,276.8

Source: Authors' calculations from Myanmar Living Conditions Survey (2017)

Comparing levels of purchased agricultural inputs with overall sales income, i.e., monetary income, Table 1 further shows that overall input expenditures make up 28 percent of the level of income from the sales of crops. Expenditures on inorganic fertilizers alone are as high as 8 percent.

We further assess the total use of inorganic fertilizers in each of the four major agro-ecological zones. Based on data from the MLCS, it is estimated that the total value at the farm level of inorganic fertilizer use in the country in 2017 was 515 million USD. Most of the inorganic fertilizer was used in the Delta (244 million USD or 47 percent of national fertilizer consumption) (Figure 5). Second was the Dry Zone. The least amount of fertilizer used was in the Coastal region with 4 percent of all inorganic fertilizer consumption in the country. Disruption of the inorganic fertilizer value chain will therefore have the largest effects on crop production in the Delta, and on rice production in the country as the Delta zone collectively accounts for almost half of the monsoon rice produced in Myanmar.

Figure 5: Use of fertilizers in Myanmar, by value and agro-ecological zone, million USD



Source: Authors' calculations from Myanmar Living Conditions Survey (2017)

Finally, we analyze the associates of fertilizer expenditures at the farm level. We therefore run a Tobit regression based on data from the MLCS with the annual expenditures on fertilizer in USD per farm as the dependent variable. This regression is left-censored as a significant number of agricultural households do not report the use of any fertilizer. On the right side, we have indicators that reflect the incomes of farmers measured by total annual expenditures, type of crops grown, access to irrigation and intensity of land cultivation over the year, land area operated, and household characteristics. We do this analysis at the national and the agro-ecological levels. The results are presented in Table 2. A number of relevant findings show up.

First, richer farmers use significantly more fertilizer. At the national level, a doubling of income – proxied by expenditures of the household – is associated with a 45 percent increase (51 USD) of expenditures on fertilizer. Conversely, a reduction of overall income of farmers in 2021, linked to the domestic crises in the country, will subsequently lead to substantially lower fertilizer use.

Second, the type of crop grown is strongly associated with expenditures on fertilizers. Farmers that grow pulses are spending significantly less on fertilizers than other farmers. On the other hand, maize and paddy growers are spending significantly more on inorganic fertilizer than farmers that do not grow these crops. These crops will therefore likely be most affected by the potential lower availability or higher prices of fertilizer. Maize, monsoon paddy, and cool/dry season paddy growers spend 95, 44, and 73 percent more (equivalent to 107, 49, and 82 USD more), respectively, on fertilizers than farmers who do not grow these crops. The effect of planting paddy in the monsoon season on fertilizer use is weaker than in the other seasons at the national level, seemingly linked to the lower effectiveness of inorganic fertilizer during that season (Singh et al. 2017). However, as monsoon paddy, which is grown by 57 percent of Myanmar farmers, is significantly more important than paddy grown during other seasons, which only 14 percent of farmers grow, fertilizer used during that season is therefore relatively much more important for overall fertilizer use in the country.

Table 2. Associates of expenditure on inorganic fertilizer by farmers in Myanmar, national and by agro-ecological zone

Dependent variable: annual expenditures on fertilizer, USD	Mean of variables	National	Delta	Coastal	Central dry	Hills and mountains
Log of total expenditure, USD	2,806	51.261***	63.231***	31.875**	23.712**	65.502***
		(10.409)	(22.272)	(15.391)	(10.895)	(14.630)
HH grows paddy in wet season, 0/1	0.57	49.041***	55.786*	96.778***	21.976	15.596
		(12.591)	(29.755)	(19.946)	(15.335)	(18.039)
HH grows paddy in dry/cool season, 0/1	0.14	81.644***	115.469**	-21.882	65.883**	-59.128**
		(23.936)	(46.368)	(52.264)	(31.289)	(26.013)
HH grows pulses in a year, 0/1	0.40	-40.936**	-67.587*	-50.868*	-23.801	-2.622
		(18.589)	(40.938)	(29.426)	(22.786)	(30.121)
HH grows maize in a year, 0/1	0.12	106.780***	-0.137	302.508	-20.579	123.658***
		(21.480)	(50.043)	(185.048)	(22.413)	(23.924)
HH grows sesame in a year, 0/1	0.15	9.174	-29.796	-960.338***	23.737*	44.498
		(19.374)	(34.578)	(138.762)	(14.323)	(93.847)
Total operated area, ha	2.6	45.143***	70.225***	13.713***	23.788***	35.235***
		(6.531)	(13.230)	(3.888)	(5.783)	(7.564)
Share of land irrigated, %	0.23	1.228***	1.638***	-0.347	1.133***	0.696**
		(0.189)	(0.398)	(0.485)	(0.211)	(0.343)
Intensity of land cultivation	1.5	15.849**	33.777*	29.070	15.815*	14.968
		(8.049)	(17.538)	(22.560)	(9.263)	(12.156)
HH head has more than primary education, 0/1	0.59	20.904**	15.571	7.887	23.591	24.017**
		(10.448)	(25.444)	(14.550)	(14.364)	(11.496)
HH head is female, 0/1	0.17	23.359*	46.417	15.998	0.689	25.199
		(13.844)	(37.805)	(18.281)	(13.050)	(20.216)
Age of HH head (years, divided by 10)	52	-5.551	-6.740	0.380	-4.204	-0.054
		(4.032)	(10.501)	(5.443)	(4.563)	(4.939)
Coastal (base = Delta), 0/1	0.08	-140.773***				
		(27.743)				
Central dry (base = Delta), 0/1	0.36	-86.852***				
		(19.835)				
Hills/mountains (base = Delta), 0/1	0.26	-96.346***				
		(24.044)				
Observations		5,409	1,106	685	1,310	2,308
Pseudo R-squared		0.026	0.028	0.024	0.02	0.04
H0: variables jointly insignificant		0.000	0.000	0.000	0.000	0.000

Source: Authors' estimation using the MCLS.
Note: HH = household. Robust standard errors in parentheses. Asterisks indicate statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The means of total HH expenditure and age of HH head are in expressed in USD and years, respectively, instead of the transformations used in the regression.

Third, fertilizer use is associated with farm size and land characteristics. Farms operating more land are associated with significantly higher fertilizer expenditures. An additional hectare of land operated is associated with 45 USD higher expenditures on inorganic fertilizer, an increase of 40 percent. Irrigated land is associated with 109 percent higher expenditures on fertilizer, while land that is cultivated for more than one season is also associated with higher fertilizer expenditures (14 percent, or 16 USD, higher).

Fourth, regarding household characteristics, households with the head having an education level of higher than primary school spent 19 percent (or 21 USD) more on inorganic fertilizer than did other households. Households with female heads spent 20 percent (or 23 USD) more than male-headed households, but this coefficient is only statistically significant at the 10% level. The age of the head of household is not associated with fertilizer expenditure levels.

Finally, the Delta zone is overall characterized by higher fertilizer use than the other regions, ceteris paribus. This is consistent with what was seen in the descriptive data above. Separate regressions by agro-ecological region further show that a few factors, including income effects, planting in dry/cool season, access to irrigation and intensity of land cultivation, are more pronounced in the Delta zone.

4. FERTILIZER PRICE INCREASES AND IMPLICATIONS ON FERTILIZER USE AND CROP OUTPUT

Given the expected decline in 2021 in fertilizer use in Myanmar because of the supply and demand shifts described, we further assess the magnitude of expected changes in fertilizer use as well as the implications of these changes on crop output. However, we first report price increases in fertilizer markets in March 2021 as stated by agro-retailers and expected declines in fertilizer use because of these price increases.

Fertilizer price changes and their expected impacts on fertilizer use

In the agricultural input retailer survey, we asked respondents to report fertilizer prices (urea and compound fertilizer) in three time periods: (i) current (late March 2021) prices; (ii) prices in January 2021; and (iii) prices in March 2020. Table 3 shows the average percentage changes in fertilizer prices for the full sample and for each of the three agro-ecologies covered in the agricultural input retailer survey. Prices in March 2021 were noticeably higher than in January 2021, prior to the political unrest. Urea prices show larger increases than compound fertilizer prices, with a 14 percent rise compared to 6 percent.[9] Compared to one year prior, March 2021 prices had increased even more, 22 percent for urea and 10 percent for compound fertilizer. There is some regional variation in the changes. The Dry Zone shows the highest average price increases for urea. Overall availability did not seem to be an issue as yet in March 2021–the survey indicated that almost three-quarters of input retailers continued to be active since February 1 and that most retailers continued to sell compound and urea fertilizer.

Table 3. Average fertilizer price changes in March 2021 relative to March 2020 and January 2021, by percent

	Urea		Compound	
	Since March 2020	Since January 2021	Since March 2020	Since January 2021
All	22	14	10	6
Hills	21	12	12	5
Dry Zone	26	17	8	7
Delta	19	14	10	7

Source: Authors' calculations from Input Retailers Survey (March 2021)

The increases in fertilizer prices contrast with changes in crop prices. A crop survey fielded in March 2021 indicates that procurement prices by traders were down for three of five crops (Table 4). While price increases were seen for maize and groundnut, these increases were lower than those for fertilizer, most in particular for urea, therefore reducing benefit-cost ratios for the use of inorganic fertilizer by farmers.

[9] The higher percentage increase in urea compared to compound fertilizer reflects the fact that transport costs are based on volume not price (related to nutrient content). The median price of compound fertilizer in March 2020 was 38,000 MMK per bag compared to a median price of 26,000 MMK per bag for urea.

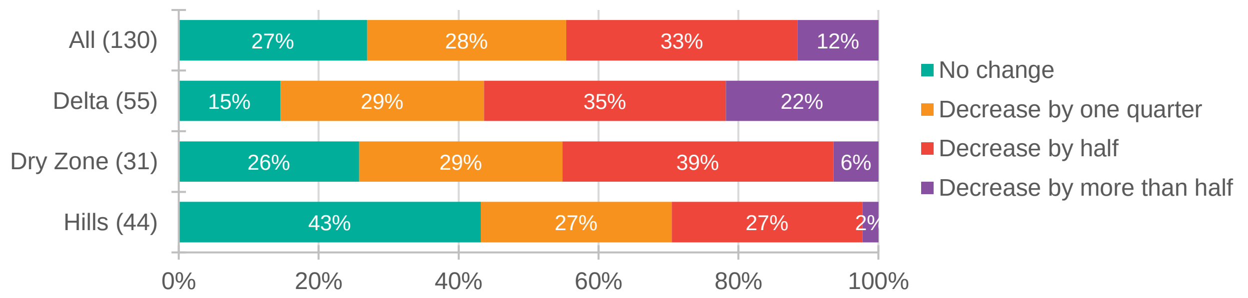
Table 4. Percent change in purchase prices for crop traders in March 2021 relative to January 2021 and March 2020

	January 2021 to March 2021 (%)	March 2020 to March 2021 (%)
Pigeon pea	-2	-2
Maize	6	10
Sesame	-3	-21
Groundnut	0	4
Chickpea	-10	-10

Source: MAPSA, 2021

To understand the effect of price increases of fertilizers, agro-retailers were asked at the end of March 2021 how they expected fertilizer sales to change relative to last year if prices increased by 10,000 MMK per bag, representing a 26 percent increase for compound fertilizer and a 38 percent increase for urea (Figure 6).[10] About three-quarters of the interviewed input retailers expect fertilizer sales to decline. One in three expect a decline of 50 percent. There are interesting patterns across agro-ecological zones, however. Agro-dealers in the Hills and Mountains region–where the primary monsoon crop is maize–expect the smallest sales declines, and 43 percent expect no change in fertilizer sales. The Dry Zone agro-retailers reported larger expected declines, with only one in four expecting no change and 39 percent expecting a decline of 50 percent. Lastly, agro-retailers in the Delta–the main rice producing region of the country–expect the largest sales declines; only 15 percent expect no change and 22 percent expect a greater than 50 percent decline in sales. Overall, demand seems highly affected by expected output prices, as shown by steady expected fertilizer demand in maize growing areas, as maize prices were stable at the time of the survey.

Figure 6: Agro-input dealers' expectations on changes in fertilizer sales for the 2021 monsoon season compared to 2020 with a 10,000 MMK/bag increase in fertilizer prices



Source: Authors' calculations from Input Retailers Survey (March 2021)
Notes: Number of input retailers selling fertilizer in parentheses (10 retailers interviewed did not sell fertilizer in 2020).

The higher expected decline in the Delta seemingly reflects the composition of fertilizer use there. According to data from the input retailer survey, farmers in the Delta purchase twice as much urea as compound fertilizer, whereas farmers in other zones purchase similar quantities of each type. The higher use of urea in the Delta is consistent with cropping patterns, as rice requires nitrogen for grain filling. An increase in fertilizer costs due to shipping and transportation has a much larger relative impact on urea prices compared to compound fertilizer.

Simulations of effects of reduced fertilizer use on crop output

To simulate the impact of a reduction in fertilizer use on crop output, estimates of the returns to fertilizer use on crop output are needed. Several studies have been done in experimental settings and show high rates of additional crop output per unit of fertilizer applied. For example, Singh et al.

[10] Estimate suggested by industry experts.

(2017) analyzed potential rice yields in wet and dry conditions in Myanmar and found that increasing the nitrogen applied per hectare would raise rice yields substantially. Considering an increase in nitrogen application per hectare from 50 to 100 kilograms for the sites they analyzed, they found that an extra kg of nitrogen per hectare would lead to an average increase in rice yields of 15 kilograms in the wet season and 41 kilograms in the dry irrigated season. In the case of maize, they estimated a response rate of 30 kg of maize per kg of nitrogen applied. However, problems with flooding, droughts, salinity, fertilizer and crop management, pest and diseases, the difference between nitrogen and commercial fertilizer, and fertilizer quality make these ratios in farmer settings often significantly lower. For example, the World Bank (2019) identified wrong combinations of inorganic fertilizer use as a major issue related to a lack of knowledge by farmers on optimal fertilizer use, which leads to lower returns to fertilizer use than seen in experimental settings and in other countries in the region.

Unfortunately, on-farm field response rates of inorganic fertilizer are not easily available in Myanmar. We therefore rely on approximations.

- First, we rely on the field estimates by Than et al. (2017) of benefit-cost ratios for fertilizer use on a limited number of Myanmar farms. They estimated benefit-cost ratios of fertilizer use between 1.50 and 1.95, depending on the crop. When we use an average ratio of 1.7 and use actual fertilizer prices from our agro-input dealer survey (median of 25,000 MMK per 50 kilogram bag) and average paddy prices in the Delta in 2020 of just under 150 MMK per pound (Goeb et al. 2021), we arrive at an approximate ratio of additional crop output per unit of fertilizer applied of 3.0.
- Second, we employ a commonly used rule of thumb from the economics of fertilizer use in developing countries that farmers are incentivized to use fertilizer when benefit-cost ratios reach 2.0 or greater (Morris et al., 2007; Yanggen et al., 1998). When we use a slightly higher than 2.0 benefit-cost ratio for fertilizer, we get an overall ratio of additional crop output per unit of fertilizer applied of 4.0, our second scenario.
- Third, we relax these profitability assumptions even further and also simulate a high response rate of an average national ratio of additional crop output per unit of fertilizer applied of 5.0.

For each approximation, we simulate the impacts under four scenarios of fertilizer use reduction–by 25, 50, 75, and 100 percent (i.e., no fertilizer used at all). In each case, we report a reduction in crop output (using the 2017 USD value baseline numbers) as well as percentage points reductions.

Table 5 shows the results for these different scenarios of fertilizer use reduction. A reduction in fertilizer usage by 50 percent in 2021 would lead to a reduction in crop output of 774 million USD (9 percent) in Scenario 1, a reduction of 1,031 million USD (12 percent) in Scenario 2, and a reduction of 1,289 million USD (15 percent) in Scenario 3. In the hypothetical case that total fertilizer use would stop in the country in 2021 (all else equal), we would see an expected reduction of total crop output by 18 percent in Scenario 1, 25 percent in Scenario 2, and 31 percent in Scenario 3.

Table 5: Impact of lower fertilizer use on the value of total crop production, national and by agro-ecological zone

	Unit	Delta	Coastal	Central Dry	Hills and Mountains	Total
Total annual crop output (2017)	billion USD	3.8	0.5	2.7	1.4	8.4
Total fertilizer use normal year (2017)	million USD	245	22	137	112	516
Reduction of crop output due to fertilizer use reduction						
Scenario 1: Ratio of additional crop output per unit of fertilizer applied of 3.0						
By 25% (127 million USD less)	million USD	184	16	103	84	387
	%	4.8	3.2	3.8	6.0	4.6
By 50% (255 million USD less)	million USD	367	32	206	168	774
	%	9.7	6.5	7.6	12.0	9.2
By 75% (382 million USD less	million USD	551	48	309	252	1,160
	%	14.5	9.7	11.5	18.0	13.8
By 100% (no fertilizer used)	million USD	735	65	412	336	1,547
	%	19.3	12.9	15.3	24.0	18.4
Scenario 2: Ratio of additional crop output per unit of fertilizer applied of 4.0						
By 25% (127 million USD less)	million USD	245	22	137	112	516
	%	6.4	4.3	5.1	8.0	6.1
By 50% (255 million USD less)	million USD	490	43	275	224	1,031
	%	12.9	8.6	10.2	16.0	12.3
By 75% (382 million USD less	million USD	735	65	412	336	1,547
	%	19.3	12.9	15.3	24.0	18.4
By 100% (no fertilizer used)	million USD	980	86	550	448	2,063
	%	25.8	17.2	10.4	32.0	24.6
Scenario 3: Ratio of additional crop output per unit of fertilizer applied of 5.0						
By 25% (127 million USD less)	million USD	306	27	172	140	645
	%	8.1	5.4	6.4	10.0	7.7
By 50% (255 million USD less)	million USD	612	54	344	280	1,289
	%	16.1	10.8	12.7	20.0	15.3
By 75% (382 million USD less	million USD	918	81	515	420	1,934
	%	24.2	16.1	19.1	30.0	23.0
By 100% (no fertilizer used)	million USD	1,225	108	687	560	2,579
	%	32.2	21.5	25.4	40.0	30.7

Source: Authors' calculations

5. CONCLUSION

In 2021, three major events are creating dramatic changes to Myanmar's fertilizer markets. First, international inorganic fertilizer prices and shipping costs are substantially higher in 2021 than a year earlier. Given that Myanmar is an importer of most of the inorganic fertilizer its farmers use, this will lead to significantly higher border prices for fertilizer in Myanmar. Second, the impact of the domestic crisis on the local transport sector and on international trade will increase local trading costs, pushing domestic fertilizer prices up even higher. Moreover, the MMK is rapidly depreciating, leading to higher prices in local currency. Based on a survey in March 2021 with 109 agro-retailers, fertilizer prices were estimated to be 22 percent higher for urea and 10 percent higher for compound fertilizer compared to the same period in 2020. Third, in addition to these supply-side challenges, effective demand for inorganic fertilizer is expected to be lower due to significantly reduced farmer incomes, lower credit availability, and more uncertain agricultural profitability.

Fertilizer use in Myanmar in 2021 will therefore be substantially less than normal. In a typical year, inorganic fertilizer is the single biggest monetary expense for crop production in the country. An average Myanmar farmer spends over 100 USD per year on inorganic fertilizer, which aggregates to about 500 million USD at the national level. Ex-ante simulations that assume ratio of additional crop output per unit of fertilizer applied of 3.0 and 5.0 indicate that a reduction of fertilizer use in the country to half the level of a normal year–all else equal–would reduce agricultural output in 2021 by between 9 and 15 percent. The Delta produces half of Myanmar's monsoon rice and uses about half of the nation's inorganic fertilizer. Thus, shocks to fertilizer markets may have outsized effects on monsoon rice production in 2021.[11] Reduction in the use of other agricultural inputs on top of fertilizers, such as improved seeds, agro-chemicals, mechanization, and agricultural labor, while not analyzed in this paper, are expected to reduce crop output even further in 2021.

The implications of reduced crop output for Myanmar will be profound. While agriculture contributes roughly only one-third of Gross Domestic Product (GDP),[12] there is a strong association of agricultural performance with poverty–80 percent of the poor in Myanmar make their living through activities linked with agriculture (CSO, UNDP, and WB 2019). Agricultural growth has been shown globally to have very strong poverty reduction effects, being in general two to three times more effective at reducing poverty than an equivalent amount of growth generated outside agriculture (Christiaensen and Martin 2018). Moreover, the advantage of agriculture over non-agriculture for the reduction of poverty is especially large for the poorest in a society (Ligon and Sadoulet 2018). A decline in agricultural output in Myanmar will therefore lead to increased poverty and more suffering than a decline in any other sector, and this will especially have large effects for the poorest and most vulnerable.

The analysis points to several implications and options to mitigate the effect of the expected large fertilizer use reduction in the country. First, the analysis clearly indicates that fertilizer availability should be given priority in the coming months to reduce the extent of crop output declines in the upcoming monsoon season. Second, some countries have implemented fertilizer subsidies to improve the profitability of fertilizer use and, thereby, maintain crop production (Morris et al., 2007). However, there have been problems in the effective implementation of such programs as well as in phasing them out once they have been started. Third, Myanmar has often resorted to trade policies, particularly export restrictions, to prioritize food security in the country, which may help to assure availability and affordability of rice in the country. While such measures may keep rice prices low, it also will reduce price incentives for farmers to use fertilizer, which may result in further reductions in output. Further assessments of the impacts and the feasibility of these measures are therefore needed.

[11] There are several caveats to this analysis. First, given data limitations, we are unable to split fertilizer use and crop production by season. Several authors have shown different fertilizer use efficiency levels for crop production under wet and dry irrigated conditions, respectively. We are unfortunately unable to account for such differences in this analysis. Second, we lack good nationally representative field estimates of nutrient-to-crop output ratios, requiring us to rely on rough approximations based on international experiences. Third, we are unable to account for the large heterogeneity in crop production and price formation that exist in the country.

[12] About 23 percent directly in farm incomes and another 11 percent in associated income earned in agro-processing, distribution, trade, agricultural export businesses, and food retailing.

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