IFPRI RWANDA

STRATEGY SUPPORT PROGRAM | POLICY NOTE 06 MARCH 2022

Expected impacts of increases in international prices of fertilizer in Rwanda

Estimates from a microsimulation

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International fertilizer prices have increased rapidly since 2020 due to multiple factors. This note assesses the impact of these price increases on Rwanda's agriculture sector, with an emphasis on implications for crop production, subsidy costs, and the Government of Rwanda's agricultural budget.

Using data from the Seasonal Agricultural Surveys, we simulate the impact of increasing fertilizer prices on fertilizer demand and use, which in turn affects fertilizer value-cost ratios at the plot level and, ultimately, maize, rice, and Irish potato output and the Government's fertilizer subsidy bill. Findings indicate the following.

- At current subsidy rates and market prices, national output across all seasons could decrease by up to 3 percent for maize, 2 percent for rice, and 12 percent for Irish potato under strong assumptions about farmers' sensitivity to fertilizer prices. Weaker assumptions about their sensitivity result in much smaller decreases in output.
- At current subsidy rates and market prices, the fertilizer subsidy bill may increase from 7 percent of MINAGRI's budget—inclusive of funds earmarked for districts—to 12 percent.

Ultimately, the policy challenge will be to determine whether a return to the original subsidy levels and rates is feasible and under what conditions. In the short term, volatility in international fertilizer prices may continue, particularly in light of the conflict in Ukraine, making it necessary to maintain the current subsidy regime. But in the medium term, it is possible to move towards market prices for fertilizer without dramatically affecting output, thereby providing more fiscal space for other priorities.

Rising international fertilizer prices

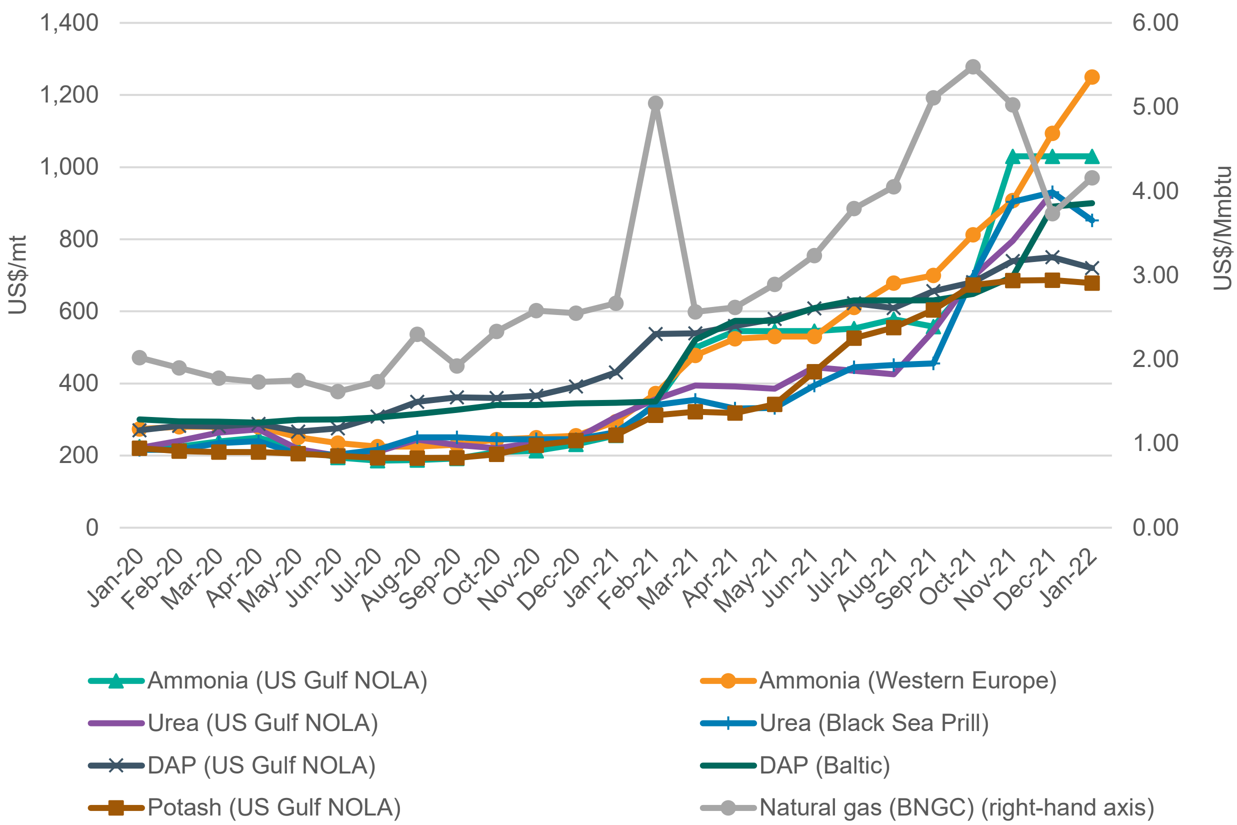
Fertilizer prices have been increasing since mid to late 2020 (Figure 1). Multiple factors in the international market are driving these increases, including increased global demand for fertilizer fueled by rising agricultural commodity prices; global supply chain disruptions affecting fertilizer shipping; rising energy prices, particularly natural gas; and a series of trade disruptions and export restrictions in several key fertilizer-exporting countries. The COVID-19 pandemic has been a significant driver of the observed trends. Experts are making only tentative projections and forecasts for the future (IFDC 2022; AMIS

2021, 2022). At best, they suggest that high fertilizer prices may persist through 2022, though even that prediction remains uncertain.

This note assesses the impact of these increases in international fertilizer prices on Rwanda's agriculture sector. The note examines trends in fertilizer prices and budget spending within the Rwandan economy, assesses the impact of increasing fertilizer prices on the production of key crops, and offers policy recommendations going forward.

The analysis focuses on three crops—maize, rice, and potato—and three main fertilizers—DAP, urea, and NPK[1]—that are prioritized under the fourth Strategic Plan for Agriculture Transformation (PSTA 4). The analysis relies significantly on a microsimulation model that calculates value-cost ratios (VCRs) for agricultural plots to determine changes in yields, revenues, output, and fiscal costs under alternative fertilizer price scenarios, drawing on several years of data from the Seasonal Agricultural Surveys produced by the National Institute of Statistics of Rwanda (NISR).[2]

Figure 1: International prices for key fertilizers and natural gas, January 2020 to January 2022



Source: Bloomberg
Note: See AfricaFertilizer.org for additional data on price trends for fertilizer in key Middle East markets FOB, and for national prices in the East Africa region (Kenya).

[1] Specifically, NPK 17:17:17

[2] Value-cost ratios greater than 2 are generally considered to indicate profitable use of fertilizer, although this threshold may vary by crop and context (Jayne and Rashid 2013; Morris et al. 2007). The model closely follows Rashid et al. (2013). Estimates of farmers' sensitivity to changes in the price of fertilizer are introduced as a range of assumptions rather than empirical estimates due to limitations in the available data for Rwanda. See International Food Policy Research Institute (2022), *Policy Options for Fertilizer Subsidy Reforms in Rwanda: A Simulation-based Analysis* (Kigali/Washington, DC: IFPRI; forthcoming: drafts available upon request).

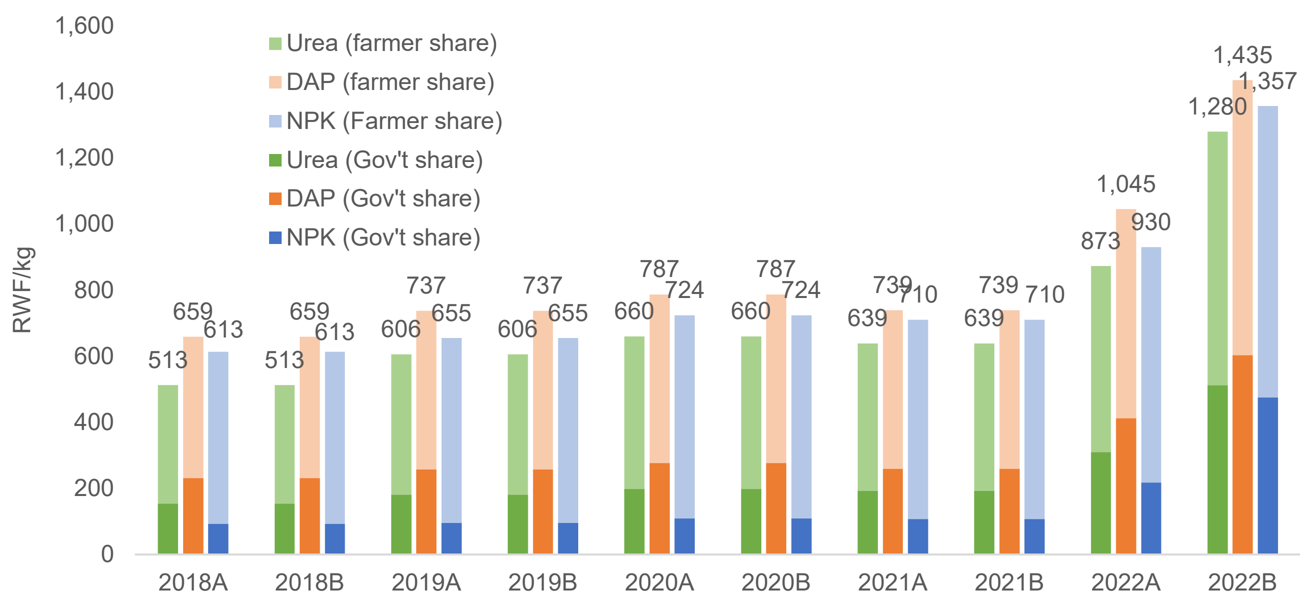
Fertilizer prices and subsidy costs in Rwanda

Rwanda's response to increasing fertilizer prices in the international market has been to increase both the price and subsidy on fertilizer distributed to farmers. This strategy has partly cushioned farmers from the full transmission of international prices. Although the market price for fertilizer in Rwanda is roughly 100 percent higher than it was a year ago, farmers are facing prices that are only 70 percent higher for DAP and urea, and 46 percent higher for NPK.

To fully appreciate how fertilizer costs are distributed between farmers and the Government of Rwanda, it is important to understand how fertilizer market policy is implemented in the country. Since 2015, fertilizer has been distributed to Rwandan farmers under a subsidized price scheme with little or no variation in prices at the farm or market level. Typically, market and subsidized prices are announced by the Ministry of Agriculture and Animal Resources (MINAGRI) at the beginning of each fiscal year, which begins on July 1 and occurs just prior to Season A. These discrete (rather than continuous) changes in fertilizer prices and subsidies follow from the fact Rwanda procures fertilizer at relatively fixed points in time before each season, while international prices have shown relatively little variation between seasons.

In 2021, fertilizer prices were announced as usual, and reflected both rising international fertilizer prices and an increase in the subsidy (Figure 2). This was followed by an unprecedented mid-year announcement in January 2022 of another round of price and subsidy increases. In both rounds, the Government of Rwanda effectively split the cost of the change in fertilizer prices equally with farmers, although this split changed slightly in the second round with the Government absorbing 60 percent of the increase in NPK prices and farmers absorbing 40 percent.

Figure 2: Market and subsidized prices for fertilizer, by year and season, 2018A to 2022B

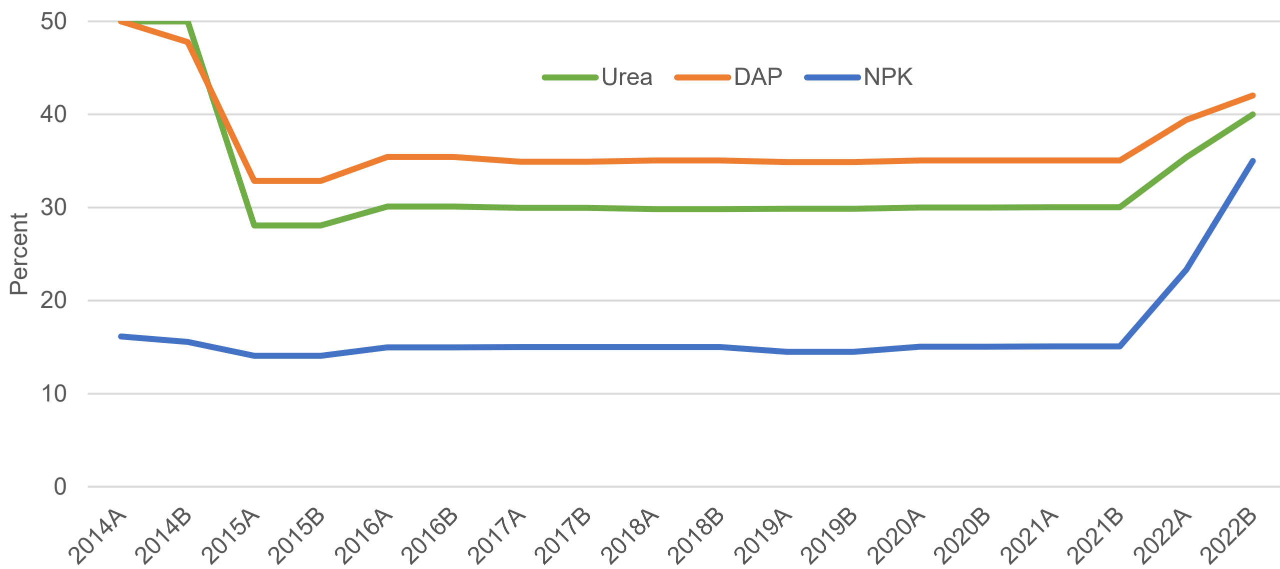


Source: Authors, based on MINAGRI data

In effect, these decisions altered the rate at which fertilizer subsidies were provided. Between 2015 and 2021, the subsidy rate was relatively constant: 35 percent for DAP, 30 percent for urea, and 15 percent for NPK. In response to rising international prices, the subsidy rate increased in July 2021 to 40 percent for DAP, 35 percent for urea, and 23 percent for NPK. In the second round of subsidy increases in January 2021, the subsidy rates increased to 42 percent for DAP, 40 percent for urea, and 35 percent for NPK (Figure 3).

But the increase in international prices may not be the only factor in play. Inland transport costs or other costs incurred once the fertilizer arrives at port may also be on the rise. Additional data that is currently unavailable is required to derive a complete cost build-up for fertilizer in Rwanda.

Figure 3: Fertilizer subsidy rates (%), by season and year, 2014A to 2022B



Source: Authors, based on MINAGRI data
Note: The change in subsidy rates between 2014B and 2015A indicate a deliberate policy shift from a fertilizer price ceiling to the current subsidy scheme.

Simulated impacts of rising fertilizer prices

We conduct a relatively simple simulation to estimate the impact of alternate subsidy rates on output and on the MINAGRI budget, using the subsidies announced by MINAGRI in January 2022 as our starting point. The simulations consider a gradual phase-out of the current subsidies using both the market and subsidy rates set forth in that announcement.

To do this, we simulate the impact of rising fertilizer prices paid by farmers on plot-level value-cost ratios, national demand for fertilizer, and national crop production, similar to an approach used by Rashid et al. (2013) to study similar issues in Ethiopia. We run this simulation with a step-wise reduction of the subsidy rates in 25 percent increments until market price is reached.

Results are specific to the three priority crops and fertilizers. Unless otherwise specified, the results show the impacts of rising fertilizer prices across all seasons (Seasons A and B for maize and rice, and Seasons A, B, and C for Irish potato). Note that these simulations fix the market price of fertilizer (but not the subsidized price) and assume that farmgate prices of the three priority crops do not change across seasons.

Prices used in the simulations are provided in Table 1. In all simulations, the farmgate price for each commodity was estimated by using the December 2021 breads and cereals component of the consumer price index (CPI) to scale up farmgate prices reported in the 2019 SAS.[3]

Table 1. Simulated subsidy rate reductions and resulting fertilizer prices paid by farmers

Subsidy rate reduction (%)	Fertilizer price paid by farmers (RWF per kg)		
	DAP	Urea	NPK
Current subsidy (as of 2022 Season B)	832	768	882
Subsidy -25%	983	896	1,001
Subsidy -50%	1,134	1,024	1,120
Subsidy -75%	1,284	1,152	1,238
Market Price	1,435	1,280	1,357

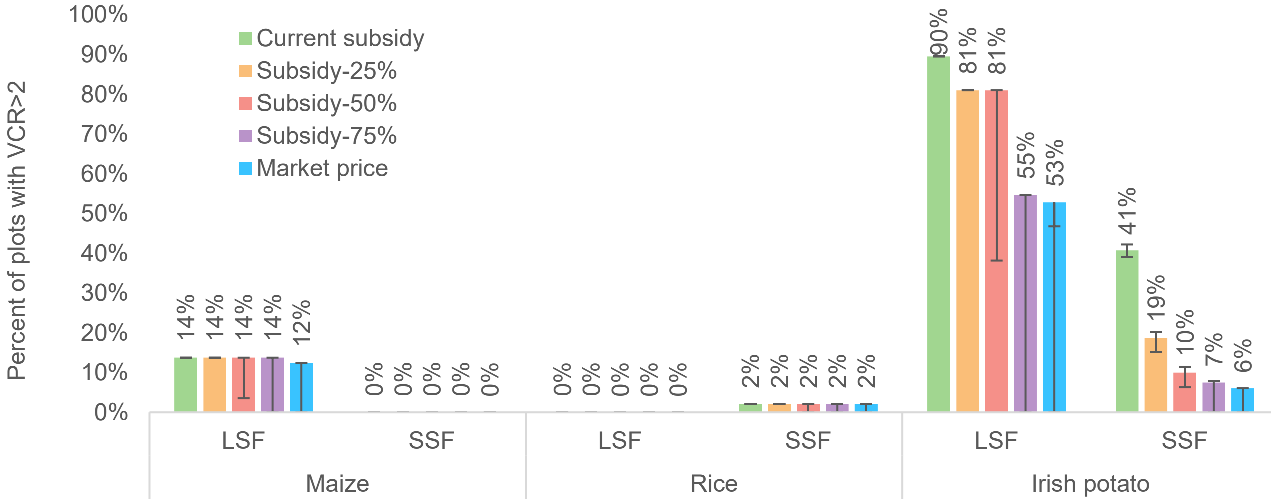
The profitability of using fertilizer is driven by a variety of factors, including farmgate commodity prices, fertilizer prices, and the crop's yield response to fertilizer. In our simulation, we calculate VCRs for each plot in the SAS data to indicate the profitability of fertilizer use. VCRs are defined as the ratio of the value added in production due to fertilizer to the cost of fertilizer use. This is calculated as the additional amount of production due to fertilizer multiplied by the farmgate price of the commodity, which is then divided by the cost times the quantity of fertilizer applied. We use a conventional benchmark of a VCR of 2 or more to indicate the profitable use of fertilizer.

Figure 4 shows the share of plots in Season A that are profitable across a simulated phase-out of the fertilizer subsidy. Results are disaggregated by crop and between small-scale farmers (those operating plots of less than 10 ha) and large-scale farmers (those operating plots greater than or equal to 10 ha).

Results indicate that as fertilizer subsidies are reduced, farmer's fertilizer costs increase, and the share of profitable plots decreases. The current subsidy regime ("current subsidy") leads to a larger share of plots with VCRs greater than 2 for both large- and small-scale famers in Season A when compared to the subsidy phase out (Subsidy -25%, -50%, and -75%) and eventual removal ("market price"). Similar results are obtained for Season B and C.

[3] The average breads and cereals CPI across September 2018-September 2019 was used as the base CPI since this is the time period when the SAS 2019 data was collected. These estimates were then triangulated with the eSoko market price data, which was slightly higher than the CPI-scaled SAS prices due to the additional cost build-up between farmgate and market prices (e.g. transport, aggregation, and trader fees).

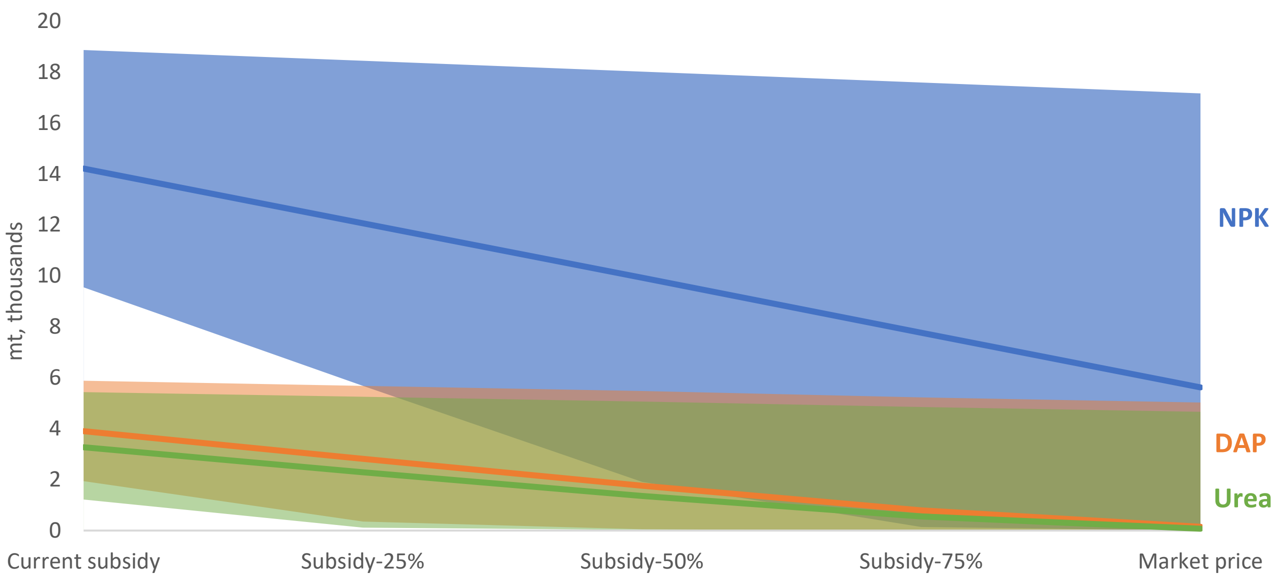
Figure 4. Simulated share of plots with value-cost ratios greater than 2 in Season A, by farm size and crop



Source: Authors' calculations using 2019 Seasonal Agriculture Survey (NISR).
Note: Error bars indicate the range of simulated fertilizer demand based on varying assumptions about farmers' sensitivity to fertilizer prices. LSF=large-scale farmers (>10ha plots); SSF=small-scale farmers (<10ha plots); VCR=value-cost ratio.

Having calculated changes in plot-level VCRs, we then simulate the effect of fertilizer prices and subsidies on total demand for fertilizer. We use a range of assumptions about farmers' sensitivity to changes in fertilizer prices (i.e., the price elasticity of fertilizer demand). Assuming that farmers are highly price-sensitive, results indicate that demand for all three fertilizers may drop to zero as the subsidy is removed. This drop is shown along the bottom border of each shaded region in Figure 5. If farmers are highly price-insensitive, the removal of all subsidies leads to a 9 percent decrease in demand for NPK, and a 14 percent decrease in demand for DAP and urea compared to demand at the current subsidy rate. This is shown along the top border of the shaded regions in Figure 5.

Figure 5. Simulated yearly national fertilizer quantities demanded, in thousands of metric tons

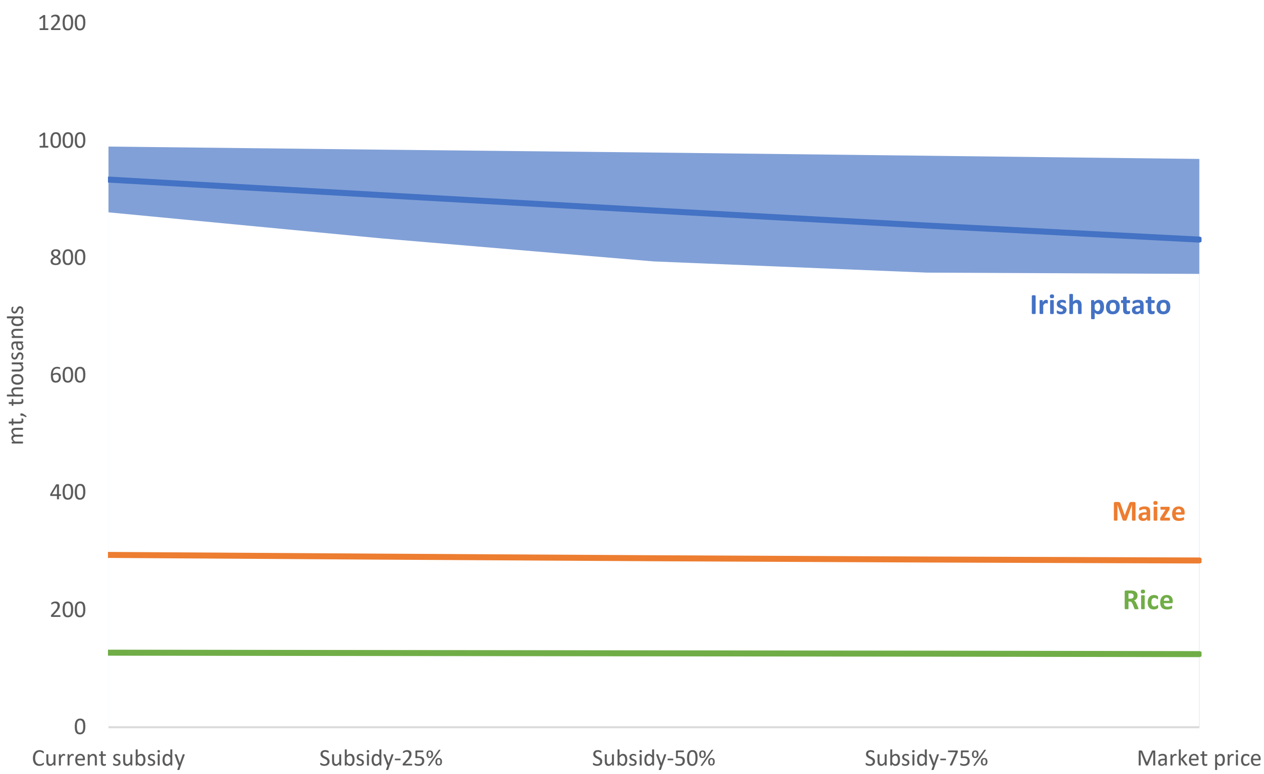


Source: Authors' calculations using 2019 Seasonal Agriculture Survey (NISR).
Note: Shaded areas indicate the range of simulated fertilizer demand based on varying assumptions about farmers' sensitivity to fertilizer prices.

Next, we turn our attention to the impact of fertilizer prices and subsidies on crop output (Figure 6). When comparing the current subsidy regime and the market price, national production for all seasons does not drop by more than 3, 2, and 12 percent for maize, rice, and Irish potato, respectively. In fact, more conservative estimates that assume farmers are relatively price insensitive result in annual production losses of just 0.8 percent for maize, 0.4 for rice, and 2.0 for Irish potato. Although these decreases in output may have a negative effect on prices facing consumers, trade can potentially mitigate these effects.

Necessarily, there are limitations to this simulation model.[4] For example, because the simulations rely on data from the 2019 SAS, we only capture data on those plots that are cultivating the three selected crops, and cannot account for changes in cropping patterns or exogenous shocks such as weather events. Our assessment of the SAS data in subsequent years suggests that cropping patterns have not changed to any significant extent. However, economic shocks associated with the COVID-19 pandemic and climate shocks may have been significant during this period, and may explain the difference between simulated and actual production levels for maize, in particular. The latter may result in downward biased results for maize production in our simulations.

Figure 6. Simulated yearly national production, in thousands of metric tons



Source: Authors' calculations using 2019 Seasonal Agriculture Survey (NISR).
Note: Shaded areas indicate the range of simulated national production based on varying assumptions about farmers' sensitivity to fertilizer prices; mt=metric tons.

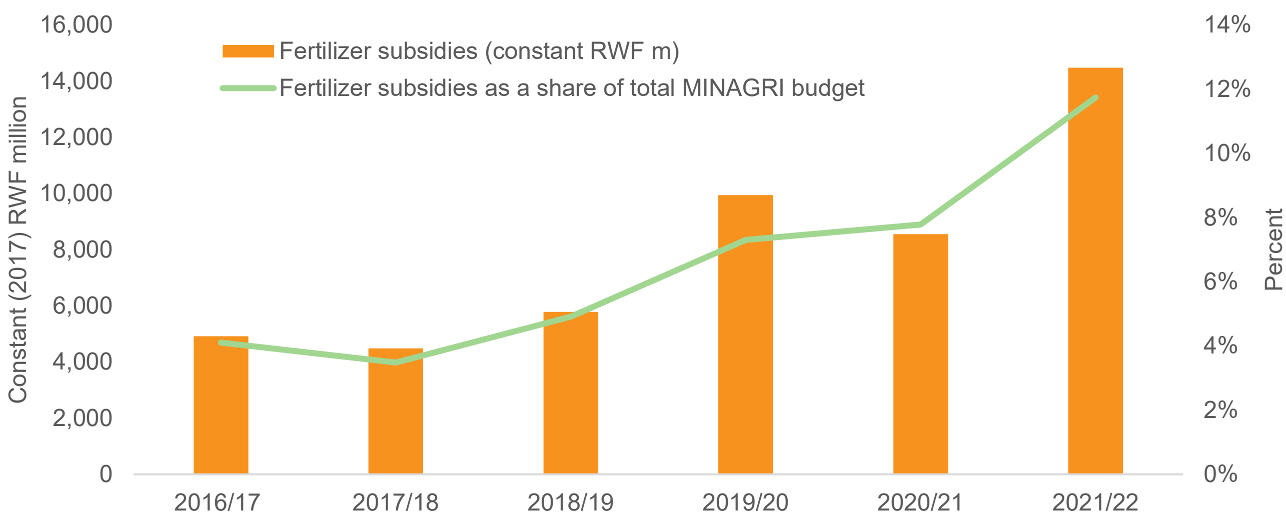
[4] See IFPRI (2022), op. cit.

Budget implications

The effects on fertilizer demand and crop production described above should also be considered in light of MINAGRI's budget. In this analysis, we consider the MINAGRI budget as the total of budgets for MINAGRI central, RAB, NAEB, and earmarks for districts, and convert the budget to constant (2017) RWF to account for inflation. We also note that fertilizer subsidies are actually budgeted under and disbursed through the earmarks for districts. As such, any budget revisions made during the fiscal year to accommodate MINAGRI's announced changes in fertilizer prices will show up as revisions to the earmarked budget for districts.

During FY 2019/20, fertilizer subsidies accounted for only 7.3 percent of the MINAGRI budget, and increased to just 7.8 percent in FY 2020/21. The current subsidy regime will increase this share by about four percentage points, with the new subsidy regime accounting for 11.7 percent of MINAGRI's budget (Figure 7).

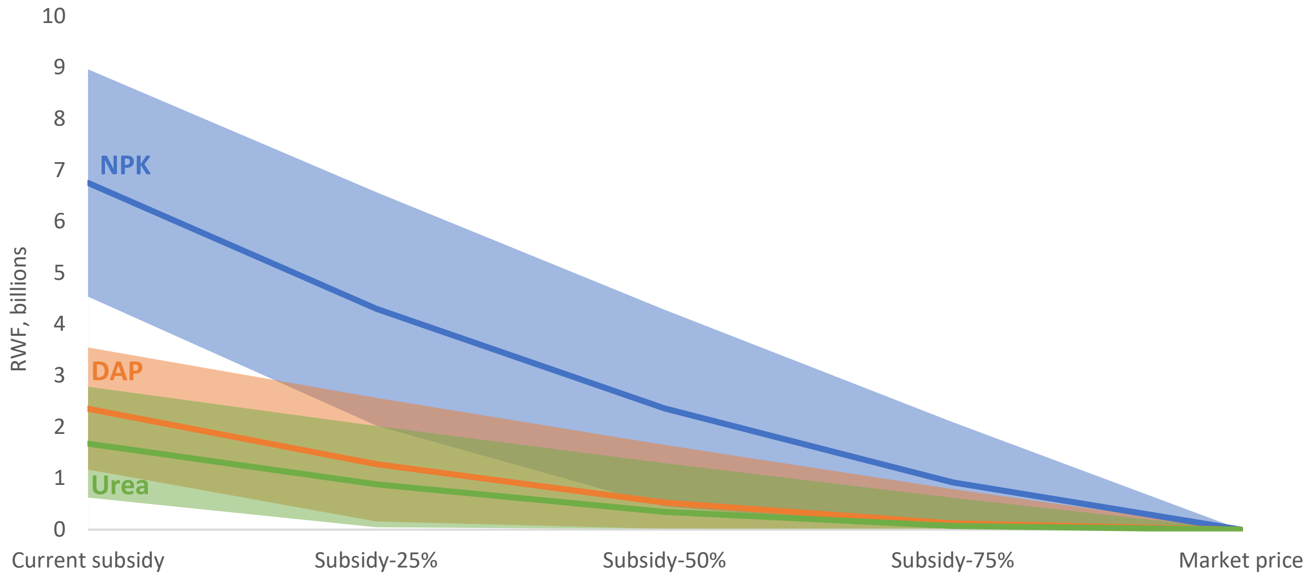
Figure 7. Fertilizer subsidies in constant (2017) RWF millions and as a share of MINAGRI budget, FY 2016/17 to 2021/22



Source: Authors, based on MINAGRI data
Note: Constant RWF figures are based on CPI data from NISR. Note that the CPI used to calculate FY 2021/22 is provision, based only on the CPI as of December 2021 reported by NISR. RWF=Rwandan francs. MINAGRI=Ministry of Agriculture and Animal Resources.

Based on the simulation results discussed above, the estimated total subsidy bill for all three seasons and all three fertilizer products under the current market price and subsidy regime will be between RWF 6.3 and RWF 15.3 billion. The upper estimate of RWF 15.3 billion assumes that farmers are very price insensitive and therefore will continue purchasing similar levels of fertilizer compared to before the shock, whereas the lower estimate of RWF 6.3 billion assumes that farmers are very price sensitive and therefore demand significantly less fertilizer now that prices have risen. The total subsidy bill per fertilizer product is shown below in Figure 8, and is calculated by multiplying the current subsidy rates by the total fertilizer demand.

Figure 8. Simulated yearly national fertilizer subsidy bill, billions RWF



Source: Authors' calculations using 2019 Seasonal Agriculture Survey (NISR).
Note: Shaded areas indicate the range of simulated national production based on varying assumptions about farmers' sensitivity to fertilizer prices.

Policy recommendations and conclusions

Several policy options emerge from this analysis. First, it is important to recognize that if MINAGRI caps the subsidy rate on fertilizer, it is still exposed to international price changes as well as changes in farmer demand. If farmers are weakly sensitive to fertilizer prices and if international prices remain high or continue to increase, this will result in an increasing fertilizer subsidy bill.

Second, MINAGRI efforts to maintain—or further increase—subsidies on fertilizer may not necessarily result in increased output for the three crops analyzed here. Results show that output is relatively insensitive to fertilizer prices.

Third, if MINAGRI caps the subsidy bill as a share of its budget at, say 10 percent or so, then it will have to closely manage both the subsidy rate and the quantity of subsidized fertilizer provided to farmers. This would require frequent analysis of market data and analysis to calibrate the subsidy rate to market demand. It would also require some degree of rationing of subsidized fertilizer under a targeting system. Both have non-trivial costs of design, implementation, and monitoring, only some of which may be offset by the fiscal space that MINAGRI buys itself with a cap on the subsidy bill.

Ultimately, MINAGRI will have to determine whether a return to the original subsidy levels and rates is desirable and under what conditions. If production losses are small under most price regimes—as shown above—there may be considerable room to maneuver in terms of economic policy in the medium term. With that in mind, the immediate course of action in 2022/23 may be as follows.

- In the short term, if international fertilizer prices are expected to continue rising (e.g., as a result of global market factors including those related to the conflict in Ukraine), it may be necessary to maintain the current subsidy regime irrespective of the budgetary implications. This may send an encouraging signal to farmers that MINAGRI is making efforts to manage the increase in fertilizer prices as best possible.

- If and when international fertilizer prices return to their pre-shock levels, then it may be desirable to *at least* return to the original, pre-shock subsidy rates and levels (DAP subsidized at 35 percent; urea at 30 percent; and NPK at 15 percent). A concerted effort by Government to demonstrate that fertilizer subsidies are a flexible instrument to support agricultural production will ultimately give MINAGRI the ability to respond to future changes as and when needed, rather than letting subsidies at higher rates become a permanent policy fixture.
- Even if fertilizer prices remain high into Q2 2022 when new procurement begins for Season A 2022/23, it may still be desirable MINAGRI to consider reducing the subsidy so that the rates (albeit, not the subsidy levels themselves) remain in line with pre-shock subsidy rates.

Lastly, moving towards market prices in the medium term is feasible, and may have insignificant consequences on production, yet positive implications for MINAGRI's budget and the fiscal space needed to pursue other priorities. But given where fertilizer prices are at present, it may be difficult to move in that direction quickly; a slow easing if and when international prices return to their 2019/20 levels may be advisable.

With all of this said, we recognize that decisions on subsidy rates and levels are not made in a vacuum. The interests of Rwanda's farmers and consumers are at stake, and factors beyond crop production and fiscal effects need to be considered. And keep in mind that the distributional impacts of these fertilizer subsidies—how they affect farmers in different income groups or *Ubudehe* categories—cannot be determined within the context of this exercise.[5]

[5] How the effects of changes in the fertilizer subsidy regime are distributed between poor and non-poor farmers is an important question. However, this cannot be done in a microsimulation without data that integrates farm-level production data with household income and expenditure data. Having said that, we do know from data drawn from the Fifth Integrated Household Living Conditions Survey (EICV5) (NISR 2018) that farm households that are the focus of this paper—households cultivating maize, rice, or Irish potato—are not significantly different in terms of consumption per adult equivalent (measured in RWF terms). Additional data and analysis on these households is important to understanding their capacity to absorb any changes in the subsidy system and the price of fertilizer, and remains a topic for further investigation.

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ACKNOWLEDGMENTS

This note was prepared under the Rwanda Strategy Support Program (Rwanda SSP), a joint initiative of the Ministry of Agriculture and Animal Resources (MINAGRI) and IFPRI. The study was made possible with the generous funding of the European Union, the United States Agency for International Development (USAID), and the CGIAR Research Program on Policies, Institutions, and Markets (PIM) which is supported by the CGIAR Fund contributors (https://www.cgiar.org/funders/).

For their assistance, insights, and comments, the authors thank Gerardine Mukeshimana, Jean Chrysostome Ngabitsinze, Jean Claude Musabyimana, Octave Semwaga, and Peter Ntaganda at MINAGRI; Rob Vos, Will Martin, Brendan Rice, and Soonho Kim at IFPRI; and Sebastian Nduva at the International Fertilizer Development Center (IFDC).

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The Rwanda Strategy Support Program (Rwanda SSP) is managed by the International Food Policy Research Institute (IFPRI). Funding support for Rwanda SSP is provided by the European Union (EU); the United States Agency for International Development (USAID); and the CGIAR Research Program on Policies, Institutions, and Markets (PIM). This publication has been prepared as an output of Rwanda SSP. It has not been independently peer reviewed. Any opinions expressed here belong to the author(s) and do not necessarily reflect those of IFPRI, EU, USAID, or CGIAR.

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