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ZAMBIAN SMALLHOLDER BEHAVIORAL RESPONSES TO FOOD RESERVE AGENCY ACTIVITIES (REVISED VERSION)

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Key Points:

1. Only a small percentage of well-capitalized smallholders are able to sell maize to the Food Reserve Agency (FRA) and take advantage of the maize price support. For example, in the 2007/08 marketing year, only 10% of smallholders sold maize to the FRA and these households had larger landholdings, more farm assets, and higher education levels than smallholders that did not sell maize to the FRA.
2. An increase in the FRA farmgate maize price influences smallholder behavior by increasing the farmgate maize price that smallholders expect to receive at the next harvest.
3. Smallholders respond to an increase in the FRA price by both intensifying and extensifying their maize production. On average, a 1% increase in the FRA price is associated with a 0.14% increase in smallholders' fertilizer application rate on maize and 0.06% increases in their maize area planted and maize quantity harvested.
4. Empirical results do not support the claim that the increase in maize production stimulated by FRA policies comes at the expense of other crops.
5. Compared to poorer households with smaller landholdings, relatively better off households with larger landholdings are more likely to sell maize to the FRA and have a larger maize supply response to changes in the FRA price.
6. Between 2004 and 2011, an average of 25% of Zambia's annual agricultural sector Poverty Reduction Programmes budget was allocated to the FRA. The concentration of FRA benefits in the hands of a small, relatively well-off group of farmers calls into question the efficacy of maize price supports as a poverty reduction tool in Zambia.

INTRODUCTION: More than two decades after the initiation of agricultural market reforms in eastern and southern Africa (ESA), governments in the region are increasingly using parastatal grain marketing boards (GMBs) and/or strategic grain reserves (SGRs) to directly influence the prices faced by farmers and consumers (Jayne Chapoto, and Govereh 2007). In Zambia, the government through the Food Reserve Agency, an SGR/GMB, purchased nearly 400,000 MT of maize from smallholders in 2006/07 and 2007/08, or more than 50% of the maize marketed by this group. This marked a sharp increase in the level of FRA purchases: between its establishment in 1996 and the 2005/06 marketing year, FRA's annual

maize purchases only once exceeded 100,000 MT. The FRA ramped up its maize purchases even more in 2010/11, and bought 878,570 MT or more than 80% of expected smallholder maize sales.

The FRA buys maize at a pan-territorial price that often exceeds market price levels. Private trade is legal and private buyers are allowed to buy maize at prices above or below the FRA price. Significant public resources are devoted to the FRA. During budget years 2004 through 2011, the Agency's budget allocation averaged 25% of the total allocation to agricultural sector Poverty Reduction Programmes (PRP) in Zambia, and 18% of the total budget allocation to the

Ministries of Agriculture and Cooperatives, and Livestock and Fisheries. Despite the high level of resources devoted to the FRA, little is known about how the Agency's scaled-up activities are affecting fertilizer use and crop production by smallholder households in Zambia.

OBJECTIVES: The objectives of this policy brief are: (1) to examine how changes in the FRA's maize purchase price and quantities purchased affect the maize price smallholders expect to receive at the next harvest; (2) to measure the effects of changes in smallholders' expected maize price on various dimensions of their behavior, namely, how much fertilizer they use on maize (kg/ha), the acreage they plant to maize and other crops, and the crop yields and output levels they achieve; (3) combining the results from objectives #1 and #2 to estimate smallholders' behavioral responses to changes in FRA policies; and (4) to identify the policy implications of the findings.

DATA: The data used in this policy brief are drawn mainly from the Supplemental Survey, a three-wave, nationally representative household-level panel survey of Zambian smallholders (i.e., households cultivating less than 20 hectares of land). This survey was conducted by the Government of the Republic of Zambia (GRZ) Central Statistical Office (CSO) and Ministry of Agriculture and Cooperatives (MACO) in conjunction with the Food Security Research Project (FSRP). These data cover the 1999/2000, 2002/03, and 2006/07 agricultural years and the 2000/01, 2003/04, and 2007/08 maize marketing years and therefore capture years before and during the recent scale-up of FRA activities. A total of 5,358 households were interviewed in both the first and second waves of the panel survey, and 4,286 households were interviewed in all three waves of the panel survey. We use these observations (15,002 total) in the analysis.

Other data used in the study are: (i) FRA administrative records on yearly maize purchase prices and district-level maize purchase volumes from 1996/97 to 2006/07; (ii) dekad (10-day period) rainfall data covering the 1990/91 to 2006/07 growing seasons and collected from 36 stations throughout the country by the Zambia

Meteorological Department; (iii) producer-level crop prices from MACO/CSO Post-Harvest Surveys for 1998/99, 2001/02, and 2005/06; and (iv) monthly maize wholesale prices from trading centers in each of Zambia's nine provinces from MACO's Agriculture Market Information Center.

METHODS: FRA policies are hypothesized to influence smallholder behavior through their impacts on the maize prices that smallholders expect to receive at the next harvest. The empirical models are therefore estimated in two stages. In the first stage, we use a series of econometric models to estimate the effects of changes in FRA maize purchase and pricing policies on the farmgate maize price a smallholder expects to receive at the next harvest. Farmgate maize prices are defined as the maize price received at the point of sale (e.g., at an FRA satellite depot) minus estimated transport costs from the homestead to the point of sale. The expected farmgate maize price is a weighted average of the household's expected farmgate prices in the FRA and private sector maize marketing channels, and is a function of the probability that the household will sell to the FRA at the next harvest.

In the second stage, we estimate the effects of changes in the expected maize price on several dimensions of smallholder behavior: fertilizer application rate to maize (kg/ha) as well as area planted, yield, and output of maize and other crops. The second stage regressions control for the potentially confounding effects on smallholder behavior of other factors such as GRZ fertilizer subsidy programs, rainfall, other crop prices, agro-ecological conditions, and household socio-economic characteristics. These regressions also control for unobserved household-level characteristics that do not change over time and that may affect smallholder behavior using fixed effects and correlated random effects panel data methods.

The first and second stage results are then combined to estimate the effects of changes in FRA maize purchase and pricing policies on the various dimensions of smallholder behavior. For more details on the methods used in this policy

brief, please refer to the full working paper, available at <http://ageconsearch.umn.edu/handle/126927>.

FINDINGS: The empirical results point to five key findings. First, very few smallholder households sell maize to the FRA, and those that do sell maize to the Agency are relatively better off in terms of landholding size, value of farm assets, and level of education completed (Table 1).

As shown in Table 1, less than 1% of smallholder households sold maize to the Agency in 2003/04. This percentage rose to nearly 10% in 2007/08 as the FRA scaled up its activities. (The FRA did not buy maize from smallholders in the first marketing year covered in the panel survey, 2000/01.) In 2007/08, participating households sold an average of 2.76 MT to the FRA (1.25 MT at the median). Households that sold maize to the Agency were also less likely to be female-headed than households that did not (Table 1).

Second, based on the first stage regression results, an increase in the FRA farmgate price faced by the household at the previous harvest has a positive effect on the household's expected maize price. As shown in Table 2, a 1% increase in the lagged FRA farmgate price increases households' expected maize price in 2006/07 by 0.09%. The magnitude of this elasticity is larger for smallholders that cultivate two or more hectares of land or are located in areas that are well suited for low input rainfed maize production. Changes in the FRA's maize purchase volumes have no

Table 1. Smallholder Socioeconomic Characteristics by Participation in FRA

Descriptive result	Marketing year	Sold maize to FRA?	
		Yes	No
Share of smallholder households	2003/2004	0.8%	99.2%
	2007/2008	9.7%	90.3%
Mean kg of maize sold to FRA	2003/2004	2,315	0
	2007/2008	2,764	0
Median kg of maize sold to FRA	2003/2004	600	0
	2007/2008	1,250	0
Mean landholding size (ha)	2003/2004	3.65	2.11
	2007/2008	3.65	1.84
Mean value of farm assets (100,000 ZMK, 2007/08=100)	2003/2004	59.4	23.1
	2007/2008	65.7	18.8
Share female-headed	2003/2004	8.6%	21.9%
	2007/2008	14.0%	25.0%
Median education of HH head (highest grade completed)	2003/2004	8	5
	2007/2008	7	5

Sources: CSO/MACO/FSRP 2004 and 2008 Supplemental Surveys. Note: Farm assets are plows, harrows, and ox carts.

statistically significant effect on farmers' expected maize price; rather, the FRA farmgate price captures most of the FRA effects.

Third, based on the second stage regression results and as shown in Table 3, an increase in the expected maize price has a positive effect on smallholders' fertilizer application rate on maize as well as their maize area planted and maize quantity harvested. Changes in the expected maize price have no statistically significant effect on maize yields or on the area, yields, or output of other crops. In other words, the maize area expansion is not coupled with a decline in the area planted to other crops.

Table 2. Estimated Percentage Change in a Smallholder's Expected Maize Price in 2006/07 Given a 1% Increase in the Previous Year's FRA Farmgate Maize Price or the Previous Year's FRA District-level Maize Purchases

Population	Percentage change in a household's expected maize price given a 1% increase in:			
	FRA farmgate maize price in the previous year		FRA district-level purchases in the previous year	
	Estimate	p-value	Estimate	p-value
All households	0.088	0.005	0.055	0.167
<i>Farm size category:</i>				
Less than 2 ha cultivated	0.060	0.021	0.044	0.188
2+ ha cultivated	0.168	0.001	0.085	0.145
<i>Suitability of area for low input management, rainfed maize:</i>				
High/moderate	0.107	0.001	0.068	0.193
Marginal/unsuitable	0.064	0.047	0.038	0.170

Source: Authors' calculations.

Notes: p-values based on 500 bootstrap replications. Results in **bold** are statistically significant at the 10% level.

Table 3. Estimated Percentage Changes in Smallholder Behavior Given a 1% Increase in the Expected Farmgate Maize Price

Dimension of smallholder behavior	Percentage change in smallholder behavior given a 1% increase in the expected farmgate maize price	
	Estimate	p-value
Fertilizer application rate (kg/ha)	0.737	0.011
<i>Area planted:</i>		
Maize	0.674	0.023
Other crops	Not stat. sig.	
<i>Yields per hectare:</i>		
Maize	Not stat. sig.	
Other crops	Not stat. sig.	
<i>Crop output:</i>		
Maize	0.670	0.023
Other crops	Not stat. sig.	

Source: Authors' calculations

Notes: Not stat. sig. indicates that the estimate is not statistically different from zero at the 10% level. Total refers to maize and the 16 non-maize crops covered by all three Supplemental Surveys: cassava, sweet potato, sorghum, millet, groundnut, mixed bean, cotton, rice, sunflower, soyabean, Irish potato, ground bean, cowpea, velvet bean, tobacco, and coffee. p-values based on 500 bootstrap replications.

Fourth, together, the first- and second-stage results indicate that for 2006/07, smallholders responded to an increase in the lagged FRA farmgate maize price by both intensifying their maize production (i.e., raising the fertilizer application rate) and extensifying their maize production (i.e., planting more area to maize). We find no evidence to support the claim that the increase in maize production stimulated by FRA policies comes at the expense of other crops. A 1% increase in the lagged FRA price is associated with a 0.14% increase in the fertilizer

application rate and a 0.06% increase in maize area planted and maize quantity harvested.

Fifth, smallholders with larger landholdings are more responsive to changes in the FRA farmgate price. Table 4 shows how the effects of changes in the lagged FRA price vary across households with different landholding sizes. The table also shows the extent to which farmers in each landholding size category sell to the FRA and therefore directly benefit from the above-market prices the Agency pays farmers for their maize.

Table 4. Smallholder Maize Supply Responsiveness to the Lagged FRA Farmgate Price by Landholding Size, 2006/07 Agricultural Year

Landholding size (cultivated + fallow)	% of smallholder households	Maize supply responsiveness to an increase in the FRA farmgate price (t-1)			% of smallholder households selling maize to FRA (2007/08 marketing year)	% of total smallholder sales to FRA (2007/08 marketing year)
		Average elasticity ^a	Estimated changes per 100 ZMK/kg FRA price increase			
	(A)	(B)	Ha planted (C)	Kg harvested (D)	(E)	(F)
0-0.99 ha	37.6%	0.047%	0.00203	4.29	2.2%	1.4%
1-1.99 ha	32.7%	0.056%	0.00441	8.47	7.9%	10.3%
2-4.99 ha	24.3%	0.069%	0.01037	19.28	15.8%	35.2%
5+ ha	5.4%	0.082%	0.02117	41.24	28.1%	53.2%
Overall	100.0%	0.060%	0.00647	13.21	9.7%	100.0%

Source: 2008 CSO/MACO/FSRP Supplemental Survey and authors' calculations.

Note: ^aThe average elasticity is the percentage change in maize area planted and quantity harvested given a 1% increase in the lagged FRA farmgate price. Results are based on CRE-Tobit estimates of the maize ha planted equation and associated derived effects on maize kg harvested. For column (F), the sum of the percentages in the landholding size categories slightly exceeds 100% due to rounding.

Approximately 70% of Zambian smallholders have landholdings of less than 2 ha (column A). The supply responsiveness of these farmers to changes in the lagged FRA price is considerably lower in both elasticity and absolute terms than the nearly 30% of farmers that control 2 ha of land or more (columns B through D). For example, households in the smallest landholding category (0-0.99 ha) have an average elasticity of supply that is only 57% that of farmers in the largest landholding category (5+ ha category, Table 4, column B). In absolute terms, the smallest farms' increase in maize area planted and quantity harvested in response to an increase in the lagged FRA price is only roughly 10% that of the largest farmers' supply response (Table 4, columns C and D).

Farmers' with smaller landholdings are also much less likely to sell to the FRA than are households with larger landholdings. For example, only 2.2% of farmers with landholdings of less than 1 ha sold maize to the FRA during the 2007/08 marketing year, whereas 28.1% of smallholders with landholdings of 5 ha or more sold to the FRA that year (Table 4, column E). Moreover, smallholder sales to the FRA are highly concentrated in the hands of households with larger landholdings. Although farmers cultivating 5 ha or more make up only 5.4% of the smallholder population, they account for 53.2% of smallholder maize sales to the FRA (Table 4, column F). In contrast, farmers with landholdings smaller than 1 ha make up 37.6% of the smallholder population but account for just 1.4% of smallholder maize sales to the FRA. The direct benefits of the high price the FRA pays for maize therefore accrue disproportionately to households with more land (and presumably higher incomes). These relatively better-off households also benefit more from increases in the FRA price through a larger supply response, i.e., a larger increase in maize kg harvested in response to an increase in the lagged FRA price.

CONCLUSIONS AND POLICY IMPLICATIONS: Empirical evidence based on nationally-representative household-level panel survey data collected by GRZ indicates that only a relatively small percentage of well-capitalized smallholders are able to sell maize to the FRA and

take advantage of the maize price support. For example, in the 2007/08 marketing year, just 10% of smallholder households sold maize to the FRA despite the Agency's purchasing more than 50% of smallholders' marketed maize.

Furthermore, econometric results based on these data suggest that an increase in the FRA farmgate maize price raises smallholder maize production by inducing farmers to apply more fertilizer to their maize and to plant more area to maize. Empirical results do not support the claim that the increase in maize production stimulated by FRA policies comes at the expense of other crops. FRA policies have no statistically significant effect on the yields of maize or other crops. Relatively better off farmers with more land are more responsive to changes in the FRA price and are more likely to sell to the FRA.

Although results indicate that FRA policies have indeed increased maize production in Zambia, additional research is needed to assess the cost-effectiveness of these policies, especially given the high level of public resources devoted to the FRA. For example, in the 2010/11 marketing season, spending on the FRA amounted to approximately 2% of the nation's GDP (IMF 2011). Between 2004 and 2011, GRZ allocated an average of 25% of its annual agricultural sector Poverty Reduction Programmes budget to the FRA. Despite these large expenditures on FRA activities, rural poverty rates have remained stubbornly high at roughly 80% since the early 2000s, and there has been no substantive reduction in rural poverty since the FRA was established in 1996 (CSO 2010). This calls into question whether the FRA has accomplished its "strategic mission" of ensuring national food security and income (FRA n.d.). Results presented here also cast doubt on the effectiveness of FRA policies as poverty reduction strategies. In particular, we show that although poorer households with relatively small landholdings make up the vast majority of the smallholder population, these households sell very little maize to the FRA. They also have a much smaller maize supply response to changes in the FRA price than larger, relatively better-off smallholders.

GRZ and donor funds devoted to the FRA come at a high opportunity cost. Limiting FRA involvement in the maize market to securing the national strategic food reserve, its original mandate, would free up resources that could be invested in the known drivers of pro-poor agricultural growth such as agricultural research, development and extension, rural infrastructure, and education (Fan, Gulati, and Thorat 2008; World Bank 2008).

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