

POLICY SYNTHESIS

FOOD SECURITY RESEARCH PROJECT - ZAMBIA

Ministry of Agriculture & Cooperatives, Agricultural Consultative Forum, Michigan State University – Lusaka, Zambia
No. 49 (Downloadable at <http://www.waec.msu.edu/agecon/fs2/zambia/index.htm>) December 2011

ZAMBIAN SMALLHOLDER BEHAVIORAL RESPONSES TO FOOD RESERVE AGENCY ACTIVITIES

Nicole M. Mason, T. S. Jayne, and Robert J. Myers

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. Increases in FRA farmgate maize prices and FRA maize purchase volumes influence smallholder behavior by increasing the farmgate maize price that smallholders expect to receive at the next harvest.
3. Smallholders respond to increases in these FRA policies by expanding total and maize area planted without reducing the area planted to other crops. However, maize yields are lower on the additional area brought under maize. The net effect is no significant change in maize quantity harvested or total crop output in response to the FRA's activities.
4. Part of the FRA's strategic mission is to ensure national food security and incomes. The finding of no statistically significant FRA effects on smallholder maize or total crop output during the 1999/2000 to 2006/07 study period does not support the conclusion of improvement in food security or incomes.
5. Between 2004 and 2011, an average of 25% of Zambia's annual Poverty Reduction Programmes budget was allocated to the FRA. The failure of FRA policies to increase smallholder maize and total crop output, and the concentration of maize sales to the FRA in the hands of a small, relatively well-off group of smallholders call 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 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 synthesis 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 synthesis 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: intensity of fertilizer use on maize (kg/ha) as well as area planted, output per hectare, 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 synthesis, please refer to the forthcoming FSRP

Working Paper No. 59 of the same title, available at <http://aec.msu.edu/fs2/zambia/research.htm>.

FINDINGS: The empirical results point to four 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 volume of maize purchased by the FRA in a household's district in previous years or an increase in the FRA farmgate maize price faced by the household at the previous harvest has a positive effect on the household's expected maize price at the next harvest. As shown in Table 2, a 1% increase in past FRA maize purchases increases households' expected maize price in 2006/07 by 0.10%. 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.

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 Five Years' FRA District-level Maize Purchases

Population	Percentage change in a household's expected maize price given a 1% increase in:			
	FRA farmgate maize price (previous 1 year)		FRA district-level purchases (previous 5 years)	
	Estimate	p-value	Estimate	p-value
All households	0.121	0.160	0.103	0.060
<i>Farm size category:</i>				
Less than 2 ha cultivated	0.0962	0.353	0.0796	0.064
2+ ha cultivated	0.191	0.002	0.170	0.070
<i>Suitability of area for low input management, rainfed maize:</i>				
High/moderate	0.130	0.004	0.128	0.070
Marginal/unsuitable	0.109	0.532	0.0710	0.068

Source: Authors' calculations

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

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.

For these farmers, an increase in the previous year's FRA farmgate price is also associated with an increase in the maize price they expect to receive at the next harvest (Table 2). For example, among smallholders cultivating more than two hectares, their expected maize price increases by 0.19% for each 1% increase in the previous year's FRA farmgate maize price.

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 smallholder total and maize area planted and a negative effect on maize yields. However, other

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
Intensity of fertilizer use on maize	Not stat. sig.	0.817
<i>Area planted:</i>		
Total	0.843	0.063
Maize	0.639	0.063
Other crops	Not. stat. sig.	0.260
<i>Crop output per hectare:</i>		
Total	Not. stat. sig.	0.897
Maize	-0.866	0.007
Other crops	Not. stat. sig.	0.327
<i>Crop output:</i>		
Total	Not. stat. sig.	0.134
Maize	Not. stat. sig.	0.715
Other crops	Not. stat. sig.	0.386

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.

factors constant, when the expected maize price increases, smallholders do not alter their rate of fertilizer application to maize nor do they change how much area they plant to other crops, their output per hectare in total or for non-maize crops, nor their output levels of maize and other crops. There is no significant change in maize output levels in response to an increase in the expected maize price because the positive maize area planted effect and the negative maize yield effect offset each other. The regression results do not suggest that the additional area planted to maize in response to a higher expected maize price comes at the expense of area planted to other crops; rather, both total cropped area and maize area expand.

What could explain the positive maize area effect but negative maize yield effect? The increase in the expected farmgate maize price encourages a maize area expansion but the additional land brought under maize may be of poorer quality and/or in areas less agro-ecologically suitable for maize production. In other words, the maize area expansion may be onto marginal land. As a result, maize yields are lower. Maize yields may also be lower due to other constraints faced by the

household. For example, the household may not have the necessary cash or credit to buy improved seed for the additional maize area; family time or financial resources to hire in labor to successfully weed and otherwise manage the additional acreage of maize could be lacking, etc. That is, households may expand their maize area planted beyond a level they can effectively manage.

Fourth, together, the first- and second-stage results indicate that for 2006/07, increases in past FRA district-level maize purchases, and in the lagged FRA farmgate price are associated with household-level increases in total and maize area planted and a decrease in maize yield. These results are summarized in Table 4. The p-values are quite large because of the two-stage estimation procedure and the use of bootstrapping to obtain valid standard errors. However, most of the p-values are in the range of 0.20 or less, indicating some evidence of statistically significant FRA effects. The negative effects of changes in FRA policies on maize yields are concentrated among households cultivating less than two hectares of land and/or in areas that are only marginally suitable or unsuitable for rainfed maize production. The latter finding is consistent with the hypothesis

Table 4. Estimated Percentage Changes in Dimensions of Smallholder Behavior in 2006/07 Given a 1% Increase in the Previous Year's FRA Farmgate Maize Price or the Previous Five Years' FRA District-level Maize Purchases

Dimension of smallholder behavior	Percentage change in smallholder behavior given a 1% increase in:			
	FRA farmgate maize price (previous 1 year)		FRA district-level purchases (previous 5 years)	
	Estimate	p-value	Estimate	p-value
Total area planted:				
All households	0.104	0.213	0.0805	0.182
Maize area planted:				
All households	0.0865	0.117	0.0734	0.179
Maize yield:				
All households	-0.133	1.000	-0.139	0.894
Farm size category:				
Less than 2 ha cultivated	-0.110	0.102	-0.114	0.215
2+ ha cultivated	-0.189	1.000	-0.196	0.953
Suitability of area for low input management, rainfed maize:				
High/moderate	-0.132	1.000	-0.184	0.775
Marginal/unsuitable	-0.136	0.144	-0.0761	0.965

Source: Authors' calculations

Note: p-values based on 500 bootstrap replications. 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.

that an increase in the expected maize price (due in part to increases in past FRA purchases and farmgate prices) encourages the expansion of maize into areas that are not agro-ecologically suitable for it. Maize quantity harvested, total crop output, and the other dimensions of smallholder behavior examined are not responsive to changes in the expected maize price. Thus, FRA policies have no significant effect on these behaviors.

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 smallholder farm households respond to increases in FRA farmgate maize prices and FRA maize purchase volumes by expanding their maize area planted without reducing the area planted to other crops. However,

maize yields are lower on the additional area brought under maize in response to FRA policies. The positive maize area effect and negative maize yield effects offset each other, and as a result, there is no statistically significant change in maize quantity harvested in response to an increase in the FRA farmgate maize price or FRA maize purchases. The additional area brought under maize in response to FRA policies may be of poorer quality and/or ill-suited for maize production, hence the decline in maize yields even with the same intensity of fertilizer use. The negative effect on maize yields may also be the result of households expanding their maize area planted beyond a level that they can effectively manage. Increases in FRA activities have no statistically significant effect on total crop output at the household level.

Part of the FRA's strategic mission is to ensure national food security and income (FRA n.d.). Although we do not estimate the effects of FRA policies on food security or incomes *per se*, the finding of no statistically significant impact of FRA policies on maize or total crop output does not support the conclusion of improvement in food security or incomes.

A large proportion of Zambia's public resources are 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 Poverty Reduction Programmes budget to the FRA. The failure of FRA policies to increase smallholder maize and total crop output, and the fact that it is mainly relatively well-off smallholders who benefit from the high FRA purchase price, calls into question the efficacy of maize price supports as a poverty reduction tool in Zambia. Indeed, at approximately 80%, rural poverty rates remain stubbornly high and there has been no substantive reduction in rural poverty since the FRA was established in 1996 (CSO 2010).

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).

REFERENCES

- CSO/MACO/FSRP. 2004 and 2008. Supplemental Surveys. Lusaka: CSO.
- Central Statistical Office (CSO). 2010. *Poverty Trends Report: 1996-2006*. Lusaka, Zambia: CSO.
- Fan, Shenggen, Ashok Gulati, and Sudhadeo Thorat. 2008. Investment, Subsidies, and Pro-poor Growth in Rural India. *Agricultural Economics* 39: 163-170.
- Food Reserve Agency (FRA). n.d. FRA website. Available at <http://www.fra.org.zm/> (accessed December 2011).
- International Monetary Fund (IMF). 2011. *Zambia: Sixth Review Under the Three-year Arrangement under the Extended Credit Facility, Requests for Waiver of Nonobservance of Performance Criterion, and Financing Assurances Review*. IMF Country Report No. 11/196. Washington D.C.: IMF.
- Jayne, T. S., Antony Chapoto, and Jones Govereh. 2007. Grain Marketing Policy at the Crossroads: Challenges for Eastern and Southern Africa. Paper presented at the FAO workshop on Staple Food Trade and Market Policy Options for Promoting Development in Eastern and Southern Africa, 1-2 March. Rome, Italy. Available at http://www.fao.org/es/esc/common/ecg/17/en/JAYNE_et_al_paper_FAO_conference_V2.pdf (accessed December 2011).
- Mason, Nicole M., T.S. Jayne, and Robert J. Myers. forthcoming 2012. *Zambian Smallholder Behavioral Responses to Food Reserve Agency Activities*. FSRP Working Paper No. 59. Lusaka: FSRP.
- World Bank. 2008. *World Development Report 2008: Agriculture for Development*. Washington D.C.: The World Bank.

ACKNOWLEDGEMENTS: The Food Security Research Project is a collaborative program of research, outreach, and local capacity building, between the Agricultural Consultative Forum, the Ministry of Agriculture and Livestock, and Michigan State University's Department of Agricultural, Food, and Resource Economics. The authors are grateful to the Food Reserve Agency for releasing detailed data on its maize purchases and to Antony Chapoto, Masiliso Sooka, Stephen Kabwe, Solomon Tembo, Nick Sitko, and Kasweka Chinyama for liaising with the FRA to obtain these data. They also wish to thank Jeff Wooldridge, David Mather and Jake Ricker-Gilbert for feedback on the paper; Nick Sitko for helpful comments on the policy synthesis; Milu Muyanga for input on the maize price prediction model; Margaret Beaver for technical assistance with the survey data used in the study; and Patricia Johannes for formatting and editorial assistance. The authors acknowledge financial support from the United States Agency for International Development Zambia Mission and the Bill and Melinda Gates Foundation.

Nicole M. Mason and T. S. Jayne are, respectively, assistant professor and professor, International Development, in the Department of Agricultural, Food, and Resource Economics at Michigan State University (AFRE/MSU) and currently on long-term assignment with FSRP in Lusaka, Zambia. Robert J. Myers is university distinguished professor in AFRE/MSU.