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**Impacts of Subsidized Hybrid Seed on Indicators of Economic Well-Being
among Smallholder Maize Growers in Zambia**

Nicole M. Mason*

Michigan State University
Department of Agricultural, Food, and Resource Economics
and the Indaba Agricultural Policy Research Institute
446 W. Circle Dr. Rm. 207
East Lansing, MI 48824
masonn@msu.edu

Melinda Smale

Michigan State University
Department of Agricultural, Food, and Resource Economics
446 W. Circle Dr. Rm. 207
East Lansing, MI 48824
msmale@msu.edu

**No senior authorship assigned*

***Selected Poster prepared for presentation at the Agricultural & Applied Economics Association's
2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013.***

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Impacts of subsidized hybrid seed on indicators of economic well-being among smallholder maize growers in Zambia

Nicole M. Mason (masonn@msu.edu) & Melinda Smale (msmale@msu.edu)

Department of Agricultural, Food, and Resource Economics, Michigan State University

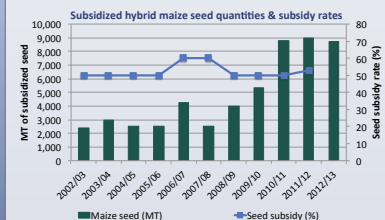
1. INTRODUCTION

Spurred by current debates about beneficiary bias in the new generation of input subsidies implemented across Sub-Saharan Africa, we test the hypotheses that subsidies on hybrid seed change maize production, total household income, the severity of poverty, and relative deprivation among smallholder maize growers in Zambia. The analysis contributes to the literature by measuring the quantitative effects of seed (as compared to fertilizer) subsidies on indicators of household well-being rather than input demand.



2. SEED SUBSIDIES IN ZAMBIA

The Zambian government has dramatically **scaled up** its input subsidy program over the last decade, from 2,400 MT of hybrid maize seed in 2002/03 to 8,730 MT in 2012/13. The seed subsidy rate has ranged from 50% to 60%. An average of **40% of total government agricultural sector spending** is devoted to agricultural input subsidies each year.



The objectives of the input subsidy program include "improving household and national food security, incomes, [and] accessibility to agricultural inputs by small-scale farmers through a subsidy and building the capacity of the private sector to participate in the supply of agricultural inputs" (MACO, 2008).

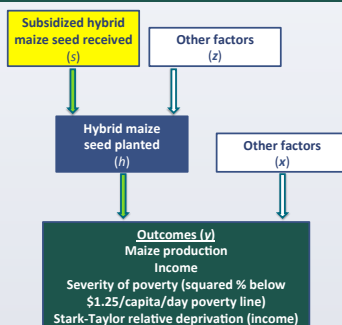
Poverty reduction is an implicit objective as the input subsidy program (the Farmer Input Support Programme) is considered a **Poverty Reduction Programme (PRP)** by the Zambian government, and accounts for an average of **47% of agricultural sector PRP spending**.

3. HYPOTHESES

We hypothesize that an additional kilogram of subsidized hybrid maize seed (s) allocated to a smallholder farm household raises its use of hybrid maize seed (h), which in turn:

- Raises its maize production and total household income
- Reduces its severity of poverty and relative deprivation (income inequality) compared to other households

4. CONCEPTUAL FRAMEWORK & OUTCOMES



$$Eq. 1. y = y[h(s, z), x]$$

$$Eq. 2. \frac{\partial y}{\partial s} = \frac{\partial y}{\partial h(s, z)} \cdot \frac{\partial h(s, z)}{\partial s}$$

A non-separable agricultural household model motivates our conceptual framework. Demand for hybrid maize (h) and household outcomes (y) are affected by **endogenous prices** (household characteristics) and **observed prices** as well as **market and agro-ecological conditions** (x, z).

Subsidized seed (s) is treated as a **quasi-fixed factor** because households cannot freely choose the quantity that they receive.

Income inequality for household i is measured as the Stark-Taylor (1989) index of **relative deprivation (RD)**:

$$RD_i = AD_i \cdot P_i$$

where AD_i is the average income of households with income greater than household i , and P_i is the proportion of households with income greater than household i .

5. DATA

The data are from the second and third waves of the **Supplemental Survey (SS)**, a **nationally-representative panel** survey of smallholder farm households in Zambia. The SS was conducted by the **Zambian Central Statistical Office (CSO)** and **Ministry of Agriculture and Cooperatives (MACO)** in conjunction with **MSU's Food Security Research Project (FSRP)**.

A total of **6,922 households** were interviewed in the first wave of the survey, which covered the **1999/2000** agricultural year. Maize seed details were not recorded, so the first wave of the survey is not used here. The second wave of the survey covered the **2002/03** agricultural year and **5,358 households** were successfully re-interviewed. Of these, **4,286** were re-interviewed in the third wave of the survey, which covered the **2006/07** agricultural year. The **balanced panel of 3,231 households** that grew maize in the latter two survey waves is used in the econometric analysis.



6. ESTIMATION STRATEGY

The two terms in Eq. 2 are estimated separately and then multiplied to obtain the average partial effect of subsidized seed on an outcome.

Panel data methods (the **fixed effects estimator**, FE, or the **correlated random effects** approach, CRE) are used to control for **time invariant heterogeneity**.

Dependent variable	Distribution	Estimator
Hybrid seed demand	Cornet solution	CRE truncated normal hurdle
Maize production	Continuous	FE
Income	Continuous	FE
Severity of poverty	Proportion	CRE fractional response
Relative deprivation	Continuous	FE

Control function (CF) methods are used to test and control for **endogeneity**. Test results suggest that **subsidized seed is endogenous to hybrid maize seed demand** but that **hybrid seed is exogenous** to all of the outcome variables ($p > 0.10$).

Instrumental variables:

- **Subsidized seed**: =1 if HH head is related to the village headman/chief
- **Hybrid seed**: district-level cumulative adoption of F1 hybrids (% of total maize area)

7. DESCRIPTIVE RESULTS

	Planted hybrid		Did not plant hybrid
	No subsidy	Subsidy	
(i) % of HHs: 2002/03	26.4	11.0	62.6
(ii) % of HHs: 2006/07	31.9	9.8	58.3
(iii) Hybrid seed planted (kg)	38.4	26.6	0
(iv) Maize production (kg)	3,736	2,194	990
(v) Income ('000 ZMK)	8,870	5,815	2,860
	(\$2,217)	(\$1,454)	(\$715)
(vi) Income < \$1.25/day pov line (=1)	0.81	0.87	0.95
(vii) Poverty severity (%)	37.0	45.2	57.3
(viii) Relative deprivation ('000 ZMK)	3,656	3,852	4,315
	(\$914)	(\$963)	(\$1,008)

Note: All differences are statistically significant at the 1% level.

Rows (i) & (ii): In the two study years, roughly **40%** of Zambian smallholder maize growers **planted maize hybrids**, and about **1%** of those **planting hybrids received seed** through the subsidy program.

Rows (iv) to (viii): Comparing **unconditional mean outcomes** across the three groups of households (columns):

- Subsidy recipients were **worse off** than non-subsidy recipients who planted maize hybrids
- Households that **did not plant maize hybrids** were **destitute**!

8. ECONOMETRIC RESULTS

$\frac{\partial h(s, z)}{\partial s}$ An additional kg of subsidized seed (s) raises hybrid seed use (h) by **0.42 kg** on average, *ceteris paribus*.
• This effect is **less than 1 kg** due to crowding out: subsidized seed displaces some commercial hybrid seed purchases (Mason & Ricker-Gilbert, 2013).

$$\frac{\partial y}{\partial s} = \frac{\partial y}{\partial h(s, z)} \cdot \frac{\partial h(s, z)}{\partial s}$$

Outcome variable	Estimated change per 10-kg increase in subsidized seed
Maize production	+106 kg
Income	+1.1%
Poverty severity	-0.7 percentage points
Relative deprivation (income)	-0.4%

Note: Estimates are statistically significant at the 10% level or lower.

Other factors constant, an increase in **subsidized hybrid maize seed** leads to **modest improvements in all household outcomes** examined.

9. CONCLUSIONS & POLICY IMPLICATIONS

Empirical evidence suggests that the **hybrid maize seed component of Zambia's input subsidy program** led to **modest increases in maize production and incomes among smallholder maize growers**, reducing their severity of poverty and relative deprivation (income inequality).

Simple calculations suggest that the **benefits** (increased household income) of the **seed subsidy outweigh the costs**.

- The **private benefit-cost ratio (BCR)** ranges from **2.73 to 5.46** depending on if the farmer opts for the most or least expensive seed available through the program.
- The **social BCR** ranges from **1.09 to 2.18** excluding unobserved administrative costs.

Efforts to **improve targeting and reduce displacement** of commercial hybrid maize seed purchases by subsidized seed could **increase the impacts of the seed component of Zambia's input subsidy program** on smallholder farmers' economic well-being.

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ACKNOWLEDGEMENTS



The authors acknowledge financial support from the United States Agency for International Development Mission in Zambia. Any views expressed or remaining errors are solely the responsibility of the authors.