

Fertilizer Promotion in Zambia:

Implications for Strategies to Raise Smallholder Productivity



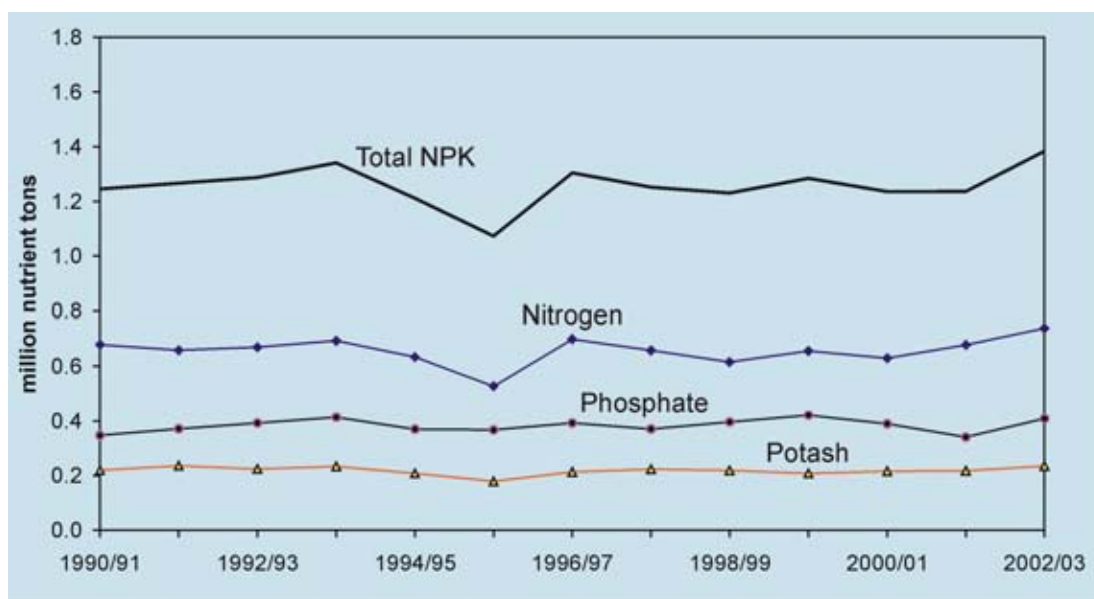
T.S Jayne, J. Govereh, X. Zu

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November 7, 2007

Current thinking on “strategy”

- Strong consensus about need for greater investment in public goods (infrastructure, crop science) and certain policy reforms
- Major debate with regard to what constitutes the right “enabling environment”
 - Input subsidies
 - food price support/stabilization
 - the role of regional trade

Sub-Saharan Africa: Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1990/91 - 2002/03



Source: Bumb, 2003, Derived from FAO data.

use intensity	% growth in fertilizer use intensity (kg/ha cultivated) (mean 1996-2002 / mean 1990-95)	
	< +30%	> +30%
<25 kg/ha	DRC (0.5, -47%)	Uganda (0.6, +237%)
	Angola (0.7, -69%)	Rwanda (1.8, +89%)
	Niger (0.9, +5%)	Mozambique (3.2, +142%)
	Guinea (2.0, -4%)	Ghana (3.6, +68%)
	Burundi (2.3, -6%)	Chad (4.3, +93%)
	Madagascar (2.9, -8%)	Cameroon (5.9, +77%)
	Mauritania (4.0, -64%)	Togo (7.0, +30%)
	Tanzania (4.8, -47%)	Cote d'Ivoire (11.8, +53%)
	Gambia (5.2, +15%)	Botswana (11.8, +294%)
	Nigeria (5.6, -73%)	Senegal (13.2, +67%)
	Burkina Faso (5.9, -28%)	Ethiopia (14.4, +71%)
	Zambia (8.4, -34%)	Benin (17.6, +76%)
	Mali (9.0, +7%)	Lesotho (23.2, +35%)
	>25 kg/ha	Swaziland (30.5, -40%)
Malawi (30.8, +9%)		Kenya (31.8, +33%)
Zimbabwe (48.3, +9%)		

Objectives:

1. To consider the range of potential impacts of fertilizer promotion programs
2. To specifically assess impacts of Fertilizer Support Program (FSP) impacts on maize production
3. To identify implementation modalities and complementary investments that would raise FSP effectiveness

Various impacts of fertilizer subsidy programs:

1. Contribution of fertilizer to crop production: crop-fertilizer response rate
2. Displacement effect: Δ total fert use / Δ program fert
3. Labor market effects: increased food yields raises demand for agricultural wage labor
4. Food price effect: Increased food production reduces food prices \rightarrow benefits food purchasing households
5. Dynamic effects: Lower food prices in year t may depress area cultivated and demand for fertilizer in year $t+1$
6. Substitution in production: fertilizer subsidy programs may raise area cultivated of some crops at expense of others

In short: Complex effects that are difficult to measure

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- We focus on Points 1 and 2, but discuss potential effects of Points 3 - 6.

To derive benefit-cost ratio for Fertilizer Support Programme (considering only points 1 and 2):

- Key parameters of interest:
 1. Cost of imported fertilizer + admin costs
 2. Additional fertilizer use from additional ton of fertilizer distributed under FSP
 3. Maize-fertilizer response rates
 4. Was program fertilizer delivered on time
 5. Price / opportunity cost of maize
 6. Probability of different states of nature

Modeling Approach and Data:

1. Maize response function based on Guan (AJAE, 2006)
2. Chamberlain random-effects estimation
3. Data drawn from survey data of 2,660 smallholder farm households
4. 1999/00 and 2002/03 seasons
5. Using estimated response rates and displacement from model results, we then conduct simulations to examine benefit/cost ratios under range of different assumptions
6. Papers available on request: jayne@msu.edu

Variable	1999/00	2002/03
	Mean	Mean
<i>Maize yield, kgs per hectare</i>	1781.67	1776.92
<i>Nitrogen nutrient kgs per hectare</i>	21.38	28.75
<i>% of basal to total fertilizer application</i>	47.73	49.02
<i>mm of rainfall in growing season</i>	838.45	1034.25
<i>=1 if used hybrid</i>	0.19	0.28
<i>=1 if fertilizer available on time</i>	0.69	0.72
<i>=1 if used animal draft power</i>	0.519	0.475
<i>maize area</i>	1.6	1.21
<i>family labor units</i>	3.06	4.43
<i>=1 if extension contact</i>	0.221	0.594
<i>=1 if hh used FSP fertilizer</i>	0.157	0.153
<i>age of hh head</i>	44.6	47.4
<i>education of hh head</i>	4.69	4.64
<i>=1 if female-headed hh)</i>	0.178	0.178
<i>=1 if PAM in past 3 years)</i>	0.083	0.137
<i>=1 if 2002/03 season)</i>	0	1

Parameter values:

1. Cost of imported fertilizer + admin costs

US\$ 450 landed at provincial depots + US\$ 75 for program admin and logistical costs to satellite depots

Actual costs of administration not yet released but thought to be higher than \$75 per ton.

Actual landed cost of fertilizer most likely higher than \$450

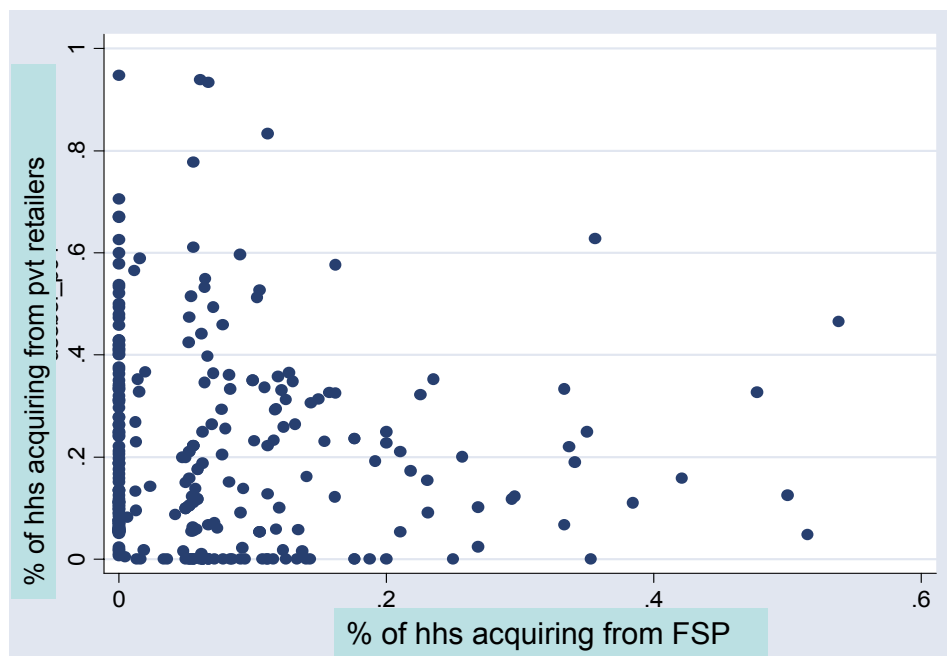
Thus, \$525/mt most likely under-estimates true social cost of fertilizer use.

Parameter values:

2. Additional fertilizer use from additional ton of fertilizer distributed under FSP

- *+0.7 to 1.0* in areas where private sector is not active; tends to be less productive areas
- *+0.3 to 0.4* in areas where private traders are active; tends to be productive areas where fertilizer use is profitable

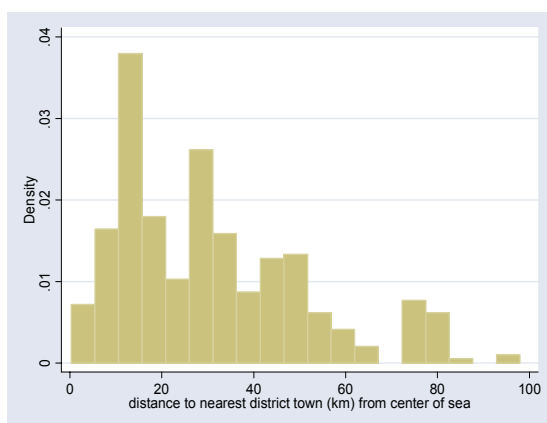
% of households acquiring fertilizer from FSP and from private traders, 2002/03



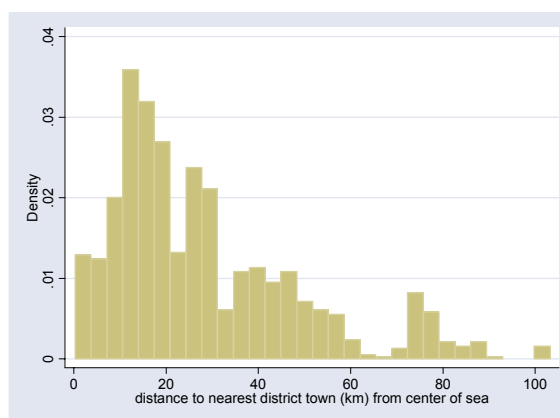
Note: each point is an SEA (Standard Enumeration Area in PHS survey)

Households acquiring fertilizer from FSP and private traders, by distance from district town

FSP recipients



Hhs purchasing from traders



Zambia	Total Income	Assets	Landholding size
	'000 kwacha per capita		ha per capita
Fertilizer source:			
<i>Households not acquiring fertilizer:</i>	266	173	.15

Source: Govereh et al, 2006

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<i>Households not acquiring fertilizer:</i>	266	173	.15
<i>Cash purchases from private retailers:</i>	774	342	.20

Source: Govereh et al, 2006

Zambia	Total Income	Assets	Landholding size
Fertilizer source:	'000 kwacha per capita		ha per capita
<i>Households not acquiring fertilizer:</i>	266	173	.15
<i>Cash purchases from private retailers:</i>	774	342	.20
<i>Government Fertilizer Support Program (50% subsidy)</i>	804	425	.23

Source: Govereh et al, 2006

Characteristics of smallholder farmers, Zambia 2003/04

	N=	Farm size (ha)	Asset values (US\$)	Gr. Rev., maize sales (US\$)	Gr. Rev., crop sales (US\$)	Total hh income (US\$)
Top 50% of maize sales	31,3280 (2%)	4.3	1,132	720	1163	2,932
Rest of maize sellers	328,561 (26%)	1.6	316	88	193	634
Households not selling maize	907,255 (72%)	0.9	231	0	97	415

Fertilizer use patterns, 2002/03

	% receiving FSP fertilizer	% purchasing fertilizer from retailers	-- kgs per hh (users only)	
			Received from FSP	private retailers
Top 50% of maize sales	38%	54%	1,011	815
Rest of maize sellers	21%	30%	248	225
Households not selling maize	9%	13%	173	157

Parameter values:

3. Response rates (kgs maize per kg fertilizer applied):

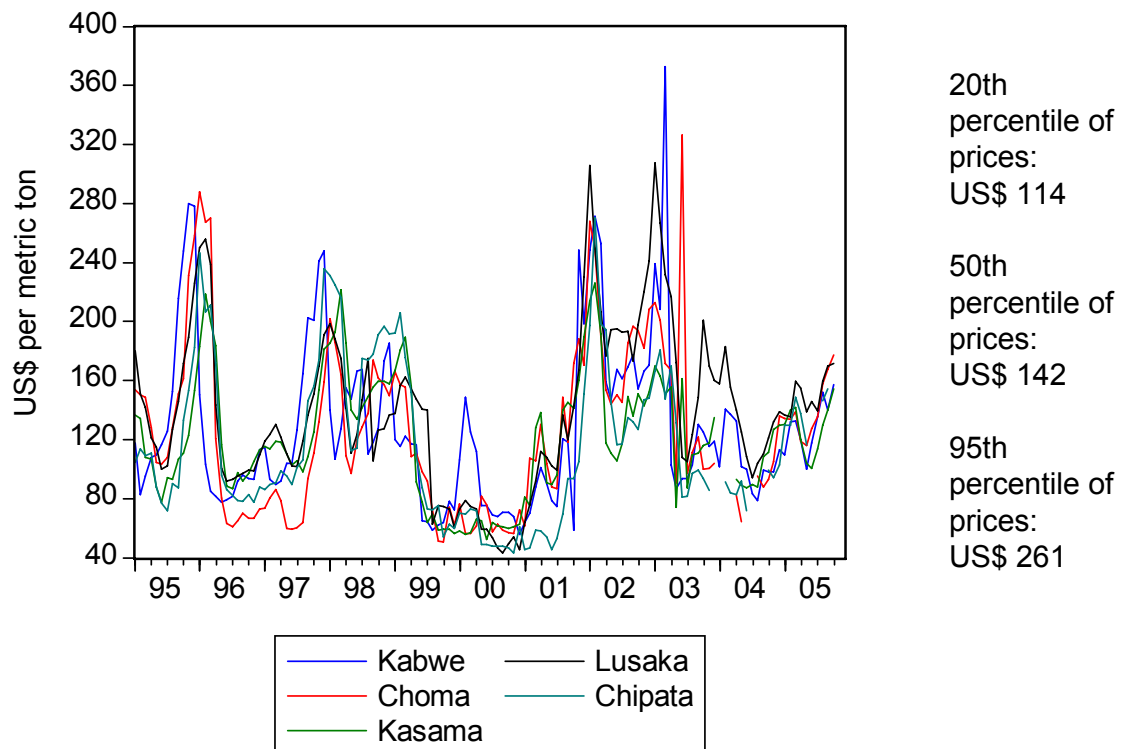
- If used on-time and in correct proportions basal/top dressing, estimated response rates:
 - 7.42
 - 5.58
 - 3.88

Parameter values:

4. Was program fertilizer delivered on time:

- About 70% of FSP users indicated that fertilizer was available on time
- If not, deduct roughly 35% off maize-fertilizer response rates
- Also, if proportion of basal to top dressing deviated far from equal proportion, deduct again

5. Price of maize:



Parameter values:

6. Probability of different states of nature

- Not all outcomes are equally likely:
 - e.g., low maize-fertilizer response rates more likely to occur in drought year when maize price is high

Cost of fertilizer	$\Delta F_{tot} / \Delta FSP$	$\Delta Q_m / \Delta F$	P_{mz}	B/C ratio
525	0.7	5.58	142	1.06
525	0.7	7.50	120	1.20
525	0.7	4.00	260	1.39
525	0.4	5.58	142	0.60
525	0.4	7.50	120	0.69
525	0.4	4.00	260	0.79

Cost of fertilizer	$\Delta F_{tot} / \Delta FSP$	$\Delta Q_m / \Delta F$	Pmz	B/C ratio
525	0.4	7.50	142	0.81
525	0.6	7.50	142	1.22
525	0.7	7.50	142	1.42

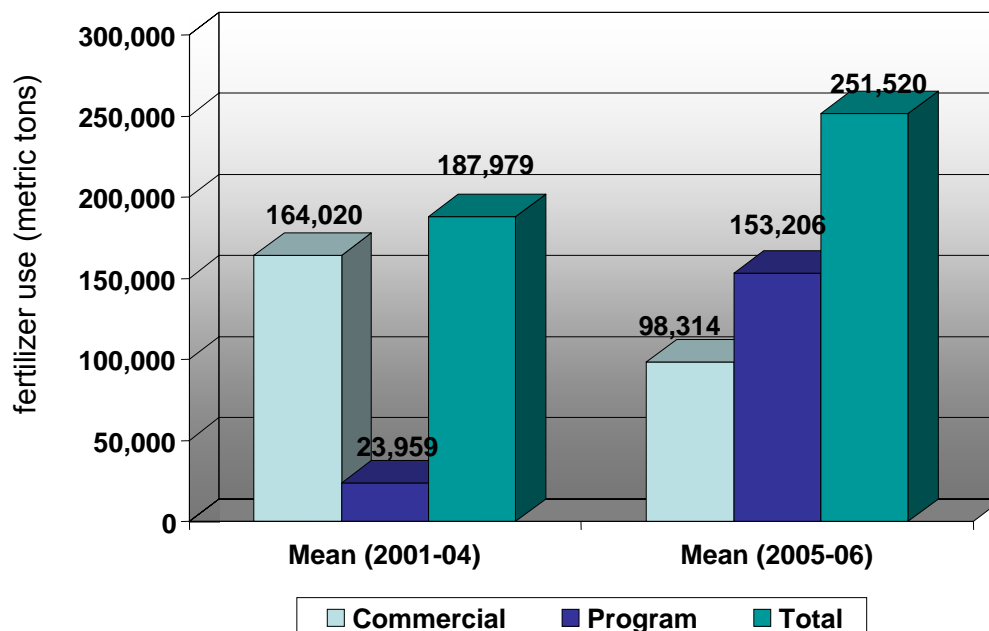
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- Average of all simulations, using alternative parameter estimates:
B/C ratio: 1.07
 - This average B/C estimate based on average of all scenarios assuming FSP fertilizer is delivered on time and used in correct proportions
 - Recall: many additional impacts of fertilizer subsidy programs which are not yet included in this B/C ratio

Three reasons for estimated low B/C ratio of FSP:

1. Relatively low maize-fertilizer response rates (much lower than Malawi)
2. Poor targeting
3. crowding out of commercial sales → limited overall additional fertilizer use

Malawi

* The additional 129,247 mt subsidized fertilizer only raised total use by 63,541 mt
note: numbers subject to updating



Factors that could improve the B/C ratio of FSP:

1. Target relatively poor farming households
 - This will minimize displacement and have the most direct effect on poverty reduction
2. Target FSP to areas where private traders are not already active (use PHS data to determine areas)
3. Reduce recommended fertilizer application levels – 200kg Compound D + 200kg Urea appears to be in stage 3 of production function
4. Prioritize R&D to generate improved fertilizer-responsive seeds (note Malawi appears to get significantly higher response to fertilizer than most areas of Zambia.
5. Open regional trade (especially in good harvest years) will raise and stabilize the price of maize → improve profitability of using fertilizer on maize

Additional Considerations:

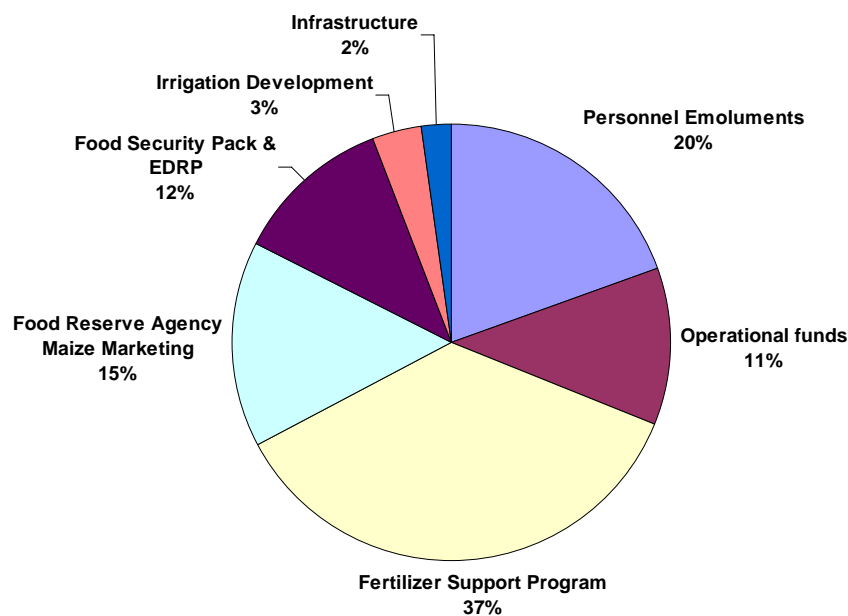
1. Labor market effects
2. Effect of lower maize prices on consumption and food security
3. Dynamic effects of lower maize price in year t on maize cultivation and demand for ag. labor in year $t+1$
4. Substitution effects, crop shifts

IFPRI review of rate of return studies:

	Returns
Subsidies	Negative – 12%
Investments	
- research & extension	35% to 70%
- roads	20% to 30%
- education	15% to 25%
- communications	10% to 15%
- irrigation	10% to 15%

If we believe these findings, they have major implications

Budget allocation to Agricultural Sector in Zambia: ZMK465 million in 2005





Thank you

<http://www.aec.msu.edu/fs2/>