

# Rural Zambian Smallholders' Cost of Maize Production

**FSRP/ACF and MACO/Policy and Planning Dept.**  
Invited Presentation to the Ministry of Finance and National Planning  
17 February, 2011

## Introduction

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In 2009/2010, the Crop Forecast Survey was modified to include specific questions relating to the smallholder's land, labor and capital costs associated with producing and marketing maize

This was in response to the demand for this information from stakeholders following the rise in world food prices

## **Maize production costs in Zambia**

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Costs for which data are available include:

- Hired animal/tractor/labour
- Fertilizer (Basal and Top dressing)
- Fertilizer transportation
- Herbicides
- Seeds
- Maize transport to sale location
- Family labour
- Family asset use (animals/tractors/machines)
- Land

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## **Data and Methods**

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- The CFS targets 13,600 small & medium scale households country-wide.
- Among them 82% of households planted maize and 81% harvested maize
- The remaining 18% represents households that are either livestock only or did not grow field crops but may have grown garden crops.

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## Three stages of cost buildup;

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1. Compute cash expenditures for inputs such as;  
hired animals or labourers  
fertilizer, seed, herbicides and  
transportation of inputs and outputs

This is used to measure gross returns to household inputs (such as labour, land and other assets) at a given unit and selling price (e.g. gross returns per 50kg bag at the FRA buying price)

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## Three stages of cost buildup;

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2. After assigning some value to household labour, animal draught power and tractor use, we compute these household costs in addition to cash expenditures

- Household-owned animals, equipment and household labour were counted at the field level and are valued at opportunity cost rates.
- Information gathered from households that actually hired inputs was used to establish a local market rate for equipment and labour.

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## Three stages of cost buildup;

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3. We assign a value to the land under cultivation and compute the total cost of production at the household level.

These calculations have been used to evaluate the productivity of Zambian smallholders and the extent of variability in the cost of producing maize within the smallholder farm sector

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## Key Results

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1. Costs vary widely across households (no two are alike)
2. More than 80% (2.1 million MT) of Zambia's total maize output was produced at a total cost lower than the 65,000 ZMK FRA buying price
3. 1.8m MT was produced at a cost below 50,000 ZMK
4. The mean cost of production per bag in 2010 was ZMK 40,739 (38,278 among expected sellers)

# Results (1)

**Table 1: Maize Production Costs (ZMK/50kg bag) by Quintile**

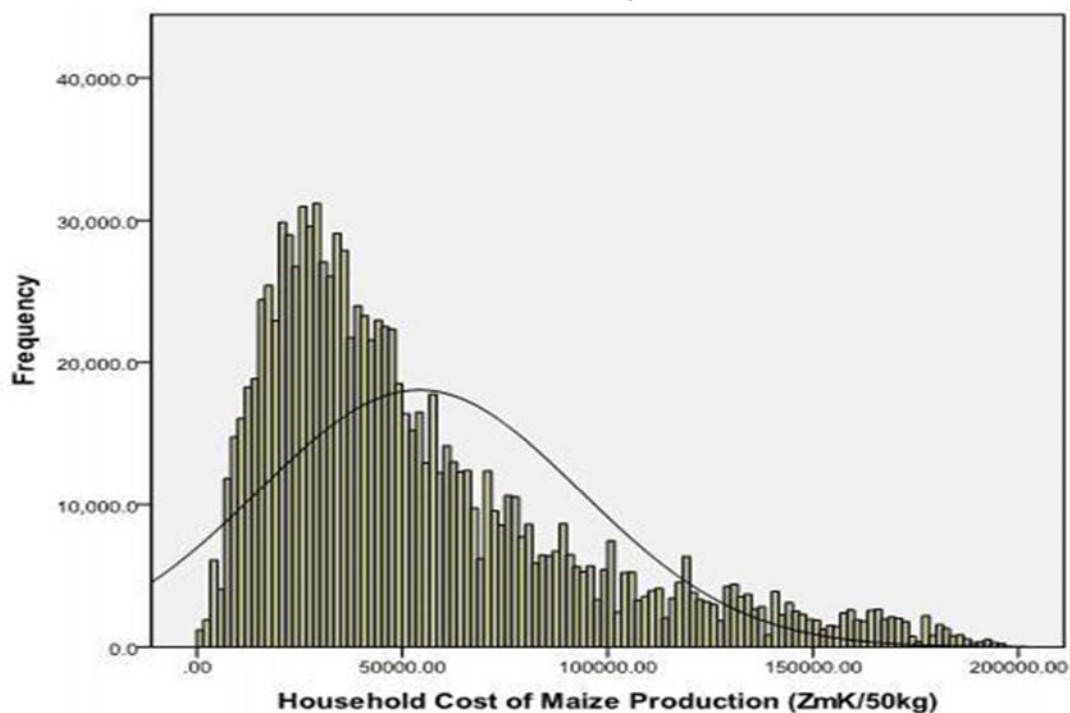
Share of total maize production (%)	Total Cost Quintile (ZMK/50 maize kg)					farmer mean	per 50 kg bag mean
	1	2	3	4	5		
	31.4%	27.1%	20.1%	12.8%	8.7%		
<i>Costs of production (ZMK/50kg)</i>							
	-----Mean-----						
Hired animal use	283	516	829	1,163	1,763	911	536
Hired machine/tractor use	22	57	49	153	103	77	97
Hired labor	1,493	2,662	3,340	4,825	6,619	3,788	3,438
Basal dressing <sup>a</sup>	1,314	2,479	2,897	3,549	4,419	2,932	3,487
Top dressing <sup>a</sup>	1,290	2,585	2,964	3,863	4,627	3,066	3,576
Fertilizer transport to homestead	39	108	143	184	223	139	193
Transport cost to FRA depot	349	606	407	296	208	373	763
Transport cost to private buyer	189	365	543	544	997	528	2,044
Herbicides	15	24	63	17	46	33	62
Seeds <sup>a</sup>	1,417	2,838	3,734	4,853	8,478	4,265	4,434
<b>Total cash expenditures</b>	<b>6,411</b>	<b>12,239</b>	<b>14,969</b>	<b>19,449</b>	<b>27,482</b>	<b>16,111</b>	<b>18,630</b>
Family labor	8,274	15,379	25,585	41,810	87,103	35,638	19,745
Own animal use	873	1,431	2,179	3,071	4,287	2,368	2,304
Own machine use	9	29	43	12	82	35	61
<b>Expenditures plus household labor and assets (excl. land)</b>	<b>15,567</b>	<b>29,078</b>	<b>42,776</b>	<b>64,341</b>	<b>118,953</b>	<b>54,152</b>	<b>40,739</b>
Land annual rental	3,364	4,835	6,633	9,152	15,102	7,818	4,720
<b>Total Cost (incl. land cost)</b>	<b>18,931</b>	<b>33,914</b>	<b>49,409</b>	<b>73,493</b>	<b>134,055</b>	<b>61,970</b>	<b>45,459</b>

Source: MACO/CSO Crop Forecast Survey, 2010.

Note: a) Fertilizer and seed costs include both subsidized and commercially acquired inputs.

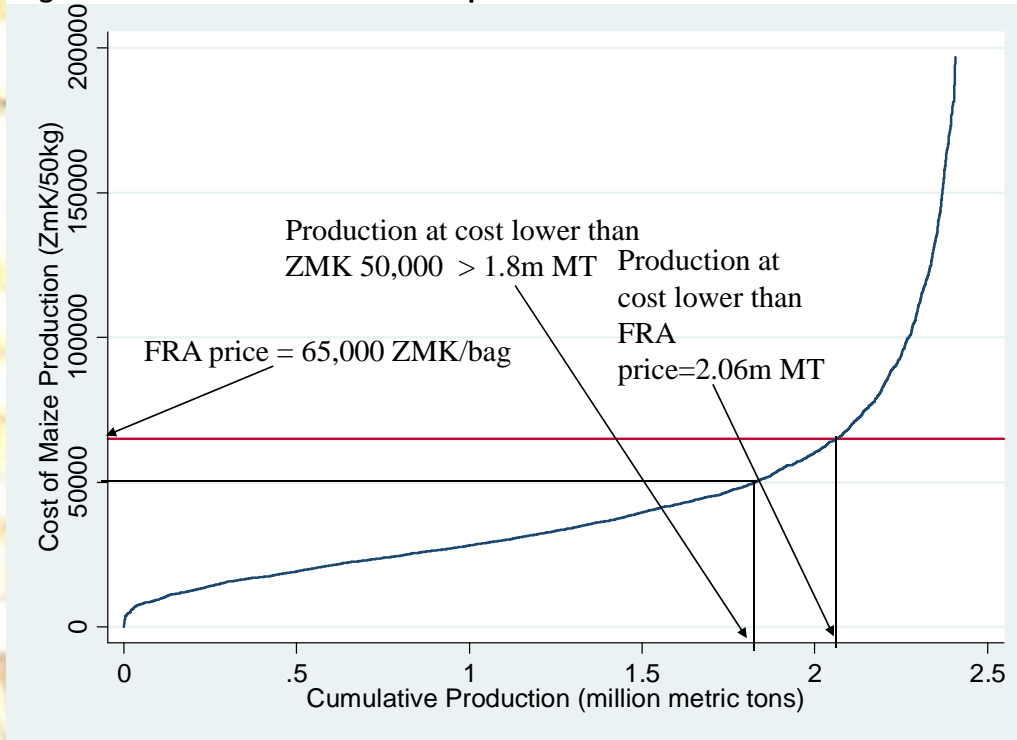
# Results (2)

**Distribution of Households by Production Costs**



## Results (3)

Figure 1: Cumulative distribution of production cost



## Results (4)

Table 2: Production Costs by 2009 Market Position and Expected 2010 Market Position

	Production Costs		
	Cash expenditures	All non-land costs	Total Cost
<i>Market Position 2009</i>			
	Production weighted (per bag) average cost (ZMK/50kg)		
Did not sell	14,315	42,949	48,862
Sold to FRA only	22,172	35,767	38,954
Sold to private buyer only	21,101	41,474	45,853
Sold to FRA and Private buyer	22,894	35,629	38,712
<i>Expected Market Position 2010</i>			
Do not expect to sell	13,751	49,912	57,326
Expect to Sell	20,061	38,278	42,247

Source: MACO/CSO Crop Forecast Survey, 2010

## Disparities within smallholder agriculture, Zambia - 2008

	N=	Farm size (ha)	Asset values (US\$)	Gross rev., maize sales (US\$)	Gross rev., crop sales (US\$)	Total hh income (US\$)
Top 50% of maize sales	30,150 (2%)	7.2	3,703	3,199	3,354	7,624
Rest of maize sellers	467,320 (30%)	1.9	257	172	252	1,272
Households not selling maize	1,010,014 (67%)	1.1	129	0	57	756

Source: CSO Supplemental surveys, 2008

Note: More than 2/3 of Non-sellers are maize *buyers*.

## Results (5)

Table 3: Cost and Share of Total Production by Province and AEZ

Province	Share of Total Production	Total Cash Expenditures	Expenditures plus household labor and assets (exl. land)	Total Cost of Production
		-----ZMK per 50 kg bag-----		
Central	0.21	23,237	43,958	47,785
Copperbelt	0.07	26,099	53,143	58,500
Eastern	0.22	13,925	34,096	38,569
Luapula	0.03	16,203	38,531	41,374
Lusaka	0.04	22,174	44,279	50,470
Northern	0.13	20,370	34,197	37,615
North Western	0.05	17,833	42,801	48,166
Southern	0.22	16,243	41,320	46,630
Western	0.03	12,654	53,018	63,688
All Zambia	1.00	18,630	40,739	45,459
<i>Agro-ecological Zone</i>				
I -Marginally Suitable	0.06	17,145	51,128	59,454
IIa -Suitable	0.64	17,893	39,305	43,682
IIb -Marginally Suitable	0.02	14,835	47,279	57,702
III -Moderately Suitable	0.28	20,956	41,129	45,357
All Zambia	1.00	18,630	40,739	45,459

Source: CSO/MACO Crop Forecast Survey, 2010

## Results (6)

**Table 4: Profit per Hectare of Maize Production by Province**

Province	Total maize profit (ZMK)	Hectares planted	Profit per hectare (ZMK/ha)
Central	215,897,973,871	187,019	1,154,417
Copperbelt	40,864,409,155	77,462	527,540
Eastern	326,853,442,781	284,183	1,150,151
Luapula	34,909,023,448	27,943	1,249,274
Lusaka	36,248,607,230	32,028	1,131,769
Northern	187,590,528,628	111,132	1,687,995
North Western	56,120,979,487	61,420	913,723
Southern	250,840,182,271	243,944	1,028,270
Western	19,194,798,374	62,549	306,877
<b>All Zambia</b>	<b>1,168,519,945,244</b>	<b>1,087,681</b>	<b>1,074,322</b>

Source: CSO/MACO Crop Forecast Survey 2010

Note: Profit is calculated as ZMK 65,000 less total expenditures including family labor and asset use.

## Results (7)

**Table 5: Distribution of gross margins for maize production (ZMK/ha)**

	Gross Margin Percentiles					Mean
	1	2	3	4	5	
Yield (kg/ha planted)	1,607	1,179	1,675	2,493	4,421	2,275
Price (ZMK/kg)	1,300	1,300	1,300	1,300	1,300	1,300
<b>Gross Revenue (ZMK/ha)</b>	<b>2,088,454</b>	<b>1,532,097</b>	<b>2,177,930</b>	<b>3,241,058</b>	<b>5,746,974</b>	<b>2,957,341</b>
<i>Costs (ZMK/ha)</i>						
Hired animal use	107,787	97,186	88,822	79,808	73,801	89,482
Hired machine use	6,705	3,107	3,100	3,402	7,246	4,712
Hired labor	200,150	117,093	100,705	156,141	198,715	154,568
Basal	172,599	86,033	92,777	150,319	233,677	147,088
Top dressing	180,470	92,968	97,821	156,085	225,662	150,608
Fertilizer transport	9,579	4,277	4,080	7,479	9,545	6,993
Transport to FRA	13,349	6,934	13,949	28,454	67,175	25,973
Transport to other buyer	56,652	13,882	17,570	28,969	36,507	30,719
Herbicides	1,523	579	1,606	1,559	2,996	1,653
Seed	275,545	117,949	117,387	166,048	230,332	181,466
Family labor	2,559,361	949,405	930,752	815,579	776,116	1,206,384
Own animal use	74,089	70,904	59,362	56,068	50,354	62,156
Own machine use	1,774	450	1,755	777	2,346	1,421
<b>Total costs excl' land</b>	<b>3,436,075</b>	<b>1,351,404</b>	<b>1,312,816</b>	<b>1,444,282</b>	<b>1,698,510</b>	<b>1,848,799</b>
<b>Gross margins (ZMK/ha)</b>	<b>-1,347,620</b>	<b>180,692</b>	<b>865,113</b>	<b>1,796,776</b>	<b>4,048,464</b>	<b>1,108,542</b>

Source: MACO/CSO Crop Forecast Survey, 2010.

## Results (8)

### Factors driving Cost Variation

- I. Ecological conditions
  - a. Zones IIa and III are the lowest cost producers
  - b. Rainfall is significant
  
- II. More educated households earn more from their land

## Results (9)

### Factors driving Cost Variation

- III. Tillage Matters
  - a. **Plowing, Ripping, Zero Tillage, Basin Planting, and Ridging** methods show signs driving up gross margins and/or decreasing cost per bag.
  - b. **Pre-rain planting** (less than a third of all fields) does not show signs of being economically advantageous *if labor is valued at market wages*.

## Results (10)

### Factors driving Cost Variation

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#### IV. Proper fertilizer use increases returns

- a. When used properly, fertilizer use puts *upward* pressure on gross margins and the returns to labor
- b. At average application rates and FRA buying price gross margins are roughly ZMK 230,000 per hectare greater on fertilized fields

#### V. Herbicides lower costs

- a. Labor saving/productivity enhancing
- b. Cost of production is roughly ZMK 5,000 lower per bag and gross margins per hectare (at the FRA buying price) are ZMK 375,000 greater when herbicides are used

## Conclusions

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- The cost of production is different for each farmer
- Most farmers costs of production range from ZMK 29,078 - 64,341
- Variation in costs are driven by:
  - Geography & Weather
  - Household characteristics
  - Management practices
- Selling is highly concentrated and is done by more efficient, wealthier producers
- High cost production is associated with high family labor costs
- Many Zambians produce maize at competitive costs

# Thank You

**Table 4: Distribution of adult equivalent family labor hours per activity per hectare**

Production Activity	Percentile					Mean
	10	25	50	75	90	
	-----Family Labor Hours-----					
Land preparation	0	11	90	301	650	247
Planting	10	24	52	103	219	94
Basal dressing application	0	0	0	32	79	28
Top dressing application	0	0	0	32	80	30
First weeding	0	47	143	298	531	231
Second weeding	0	0	0	103	277	93
Third weeding	0	0	0	0	0	17
Harvesting	10	42	102	203	375	167
Transport (field to homestead)	0	13	46	124	260	106
Shelling and Packing	0	31	91	216	417	175

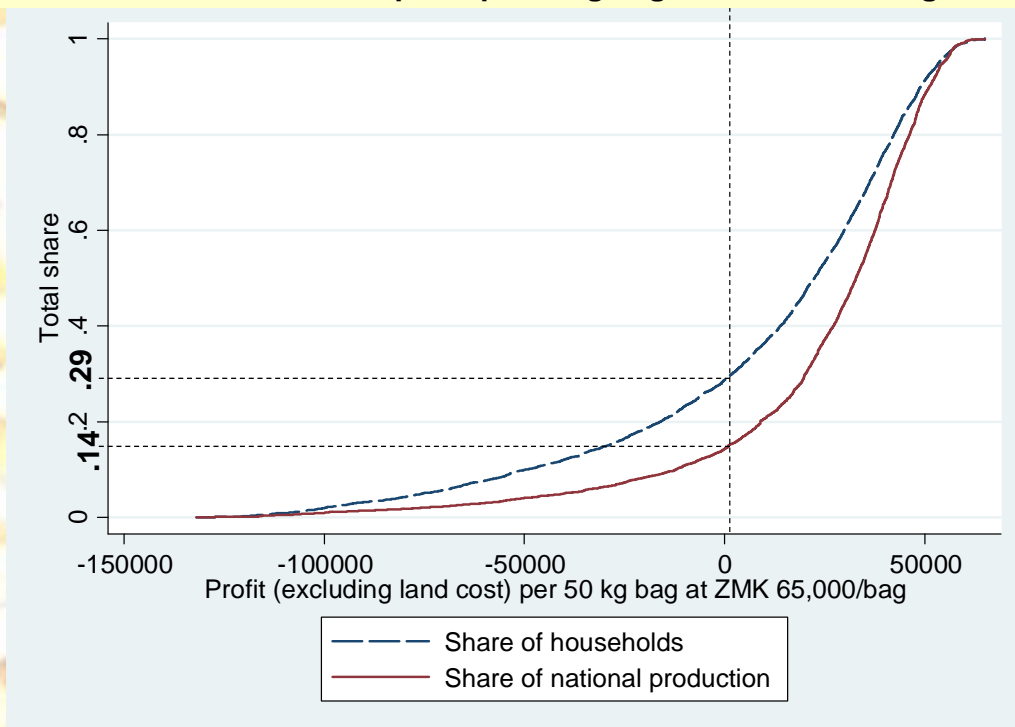
Source: CSO/MACO Crop Forecast Survey, 2010

**Table 5: Distribution of returns to labor days per hectare planted**

Revenue	Returns to Labor Quintiles					Mean
	1	2	3	4	5	
Yield (kg/ha planted)	1,282	1,720	2,112	2,618	3,573	2,261
Price (ZMK/kg)	1,300	1,300	1,300	1,300	1,300	1,300
Gross Revenue (ZMK/ha)	1,666,998	2,235,686	2,746,225	3,403,496	4,645,496	2,939,637
<b>Costs (ZMK/ha)</b>						
Hired animal use	111,541	70,919	81,838	89,496	96,437	90,045
Hired machine use	7,434	1,986	3,014	3,129	7,656	4,644
Hired labor	211,777	81,440	92,753	124,204	201,691	142,370
Basal	172,725	94,266	121,997	141,511	191,926	144,483
Top dressing	174,741	106,863	124,130	145,070	190,268	148,213
Fertilizer transport	9,706	4,218	5,148	6,285	8,935	6,858
Transport to FRA	13,584	12,301	18,940	32,758	47,669	25,051
Transport to other buyer	52,898	11,288	17,975	24,216	44,194	30,113
Herbicides	1,570	346	1,720	1,226	3,059	1,584
Seed	262,520	123,309	147,688	161,964	199,423	178,977
Own animal use	76,710	50,061	56,232	61,976	68,726	62,740
Own machine use	1,742	204	1,659	715	2,764	1,417
Costs excl' land/hh labor	1,096,947	557,199	673,093	792,549	1,062,748	836,494
Net revenue (ZMK/ha)	570,051	1,678,487	2,073,132	2,610,947	3,582,748	2,103,143
HH labor days (days/ha)	394	348	229	156	79	241
Return: labor & land (ZMK/day)	-875	4,966	9,216	17,206	75,560	21,217
Land cost (ZMK/ha/year)	221,908	218,356	215,410	211,929	203,514	214,223
Costs excl' hh labor	1,318,854	775,555	888,503	1,004,479	1,266,262	1,050,717
Net Revenue (ZMK/ha)	348,143	1,460,131	1,857,722	2,399,018	3,379,234	1,888,920
Return : labor (ZMK/ day)	-2,666	3,850	7,683	15,198	70,146	18,844

Source: MACO/CSO Crop Forecast Survey, 2010.

**Figure 4: National distribution of profit per 50kg bag at ZMK 65,000/bag sale price**



**Table 7: Profit per hectare of maize production by province**

Province	Total maize profit (ZMK)	Hectares planted	Profit per hectare (ZMK/ha)
Central	215,897,973,871	187,019	1,154,417
Copperbelt	40,864,409,155	77,462	527,540
Eastern	326,853,442,781	284,183	1,150,151
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<b>All Zambia</b>	<b>1,168,519,945,244</b>	<b>1,087,681</b>	<b>1,074,322</b>

Source: CSO/MACO Crop Forecast Survey 2010

Note: Profit is calculated as ZMK 65,000 less total expenditures including family labor and asset use.

**Table A1: Median hourly wage by province for maize related production activities**

	Province								
	Central	Copperbelt	Eastern	Luapula	Lusaka	Northern	N. Western	Southern	Western
Land preparation	1,500	1,389	1,375	1,195	1,333	823	677	3,000	1,667
Planting	1,771	1,615	972	781	2,000	833	1,042	2,500	945
Basal Dressing	1,615	1,458	690	1,000	1,833	833	1,486	1,949	408
Top Dressing	1,615	1,339	714	1,000	2,083	817	1,417	1,667	333
1st Weeding	863	952	866	762	1,042	578	583	732	722
2nd Weeding	967	774	625	732	955	500	521	950	528
3rd Weeding	476	476	862	694	1,042	440	419	536	323
Harvesting	938	714	690	586	938	670	732	458	833
Transporting to homestead	2,500	1,667	2,241	741	1,333	625	833	2,232	2,500
Shelling and Packing	804	833	525	567	670	469	760	1,000	600

Source MACO/CSO Crop Forecast Survey, 2010

### Gross Margins by Geography and Fertilizer Use

	Do not use fertilizer		Use fertilizer	
	Gross margins (ZMK/ha)			
	Median	Mean	Median	Mean
Central	506,157	745,974	1,208,387	1,349,719
Copperbelt	248,933	482,098	226,667	703,013
Eastern	737,180	947,913	1,126,100	1,547,810
Luapula	807,961	768,189	1,715,615	1,638,932
Lusaka	349,666	394,590	1,101,934	1,247,308
Northern	1,189,934	1,372,624	2,238,054	2,143,883
North Western	725,217	878,397	1,155,001	1,269,177
Southern	464,813	736,449	720,234	1,038,664
Western	149,939	173,962	265,432	832,002
<i>Agro-zones</i>				
AEZ 1	280,679	232,286	679,203	903,701
AEZ 2a	671,920	907,897	1,117,396	1,377,295
AEZ 2b	330,699	309,676	265,432	831,609
AEZ 3	820,177	967,189	1,561,330	1,588,823
<b>All Zambia</b>	<b>624,503</b>	<b>796,890</b>	<b>1,208,387</b>	<b>1,425,744</b>

**Table A3: Sensitivity analysis of Family labor wage rates**

Province	Opportunity cost of family labor valued at:		
	Zero	Local wage rate	ZMK 8500/day
	Mean Gross Margin (ZMK/ha)		
Central	2,515,364	1,174,405	618,297
Copperbelt	2,457,816	624,710	-532,059
Eastern	2,095,651	1,209,806	367,329
Luapula	2,536,805	1,060,497	-588,944
Lusaka	2,516,662	1,066,892	375,222
Northern	2,916,749	1,824,673	322,174
North Western	2,258,916	1,028,417	-442,387
Southern	2,011,335	887,101	606,121
Western	1,668,617	238,925	-601,771
<b>All Zambia</b>	<b>2,314,926</b>	<b>1,108,542</b>	<b>166,495</b>

Source MACO/CSO Crop Forecast Survey, 2010

**Table A2: Sensitivity analysis of fertilizer pricing**

Province	All fertilizer valued at:		
	Actual price paid by		
	FISP price	household	Commercial price
	Mean Gross Margin (ZMK/ha)		
Central	1,301,851	1,174,405	1,073,966
Copperbelt	751,595	624,710	543,293
Eastern	1,265,839	1,209,806	1,160,080
Luapula	1,103,493	1,060,497	883,261
Lusaka	1,200,391	1,066,892	956,950
Northern	1,926,248	1,824,673	1,661,959
North Western	1,054,382	1,028,417	902,919
Southern	964,549	887,101	858,243
Western	248,426	238,925	224,096
All Zambia	1,185,272	1,108,542	1,022,061

Source MACO/CSO Crop Forecast Survey, 2010