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Crop Budgets for Maize Production Costs and Returns: Zambia, 2010/11 to 2013/14

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U.S. GLOBAL DEVELOPMENT LAB Powered by USAID
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Acronyms and Abbreviations

AEZ	Agro-ecological zone
AFRE	(Department of) Agricultural, Food, and Resource Economics at MSU
CFS	Crop Forecast Survey (Zambia)
CRM	Climate Resilient Maize
FISP	Farm Input Subsidy Programme (Zambia)
FRA	Food Reserve Agency (Zambia)
GCFSI	Global Center for Food Systems Innovation
GM	Gross Margin
HH	Household
MRI	MRI Seed Company
MSU	Michigan State University
MV	Missing variable
OPV	Open-pollinated Variety
SCCI	Seed Control and Certification Institute (Zambia)
US	United States
USAID	United States Agency for International Development
ZARI	Zambia Agricultural Research Institute
ZMW	Zambia Kwacha, new series
ZNFU	Zambia National Farmers Union

I. Introduction

Climate Resilient Maize is one of the Solution Sets chosen by the Global Development Lab of USAID. It is being implemented in conjunction with the Bureau for Food Security. As part of its support for CRM, GCFSI was asked to undertake analysis that would help estimate the likely adoption path of CRM varieties and their economic impact, using data available through other USAID-funded projects. This report presents the analysis of maize production costs and returns for Zambia, with a special focus on improved types of maize relevant to the CRM program, based on the 2010-11, 2011-12, 2012-13, and 2013-14 Zambia Crop Forecast Survey (CFS) data sets.[1] Three tables (1.1, 1.2, 1.3) display gross margins (excluding and including the cost of land), and three tables (2.1, 2.2, 2.3) display returns (to labor and land, and to labor only). Results are disaggregated by year (1.1, 2.1), by province (1.2, 2.2), and by seed variety (1.3, 2.3). The results are discussed in more detail below.

II. Gross Margin Tables

The standard definition of gross margin (GM) is value of output minus variable costs of production. In the gross margins reported in this paper, some opportunity costs are also included. In Tables 1.1, 1.2, and 1.3, two forms of gross margins are calculated. One excludes the estimated opportunity cost of land and the other includes it. Both forms of GM include labor cost, including an estimate of household as well as hired labor costs. Household labor costs, valued at the local market wage rate, are included only when no hired labor or rented animal or machine time is reported for a particular cropping activity. For details on the definition and calculation of costs, see Annex A.

On the revenue side, maize output was valued at the price at which households reported their largest maize sale (for 2010/11 and 2011/12). For households not reporting a sale, and for 2012/13 and 2013/14, median local (district) market prices were used. For details on the definition and estimation of returns, see Annex B.

Section IV discusses issues that may explain the prevalence of negative gross margins.

Specific notes regarding the figures in the tables:

- All costs and prices are in ZMW (Zambia Kwacha, new series)
- All weights in kg
- All budgets are expressed in ZMW per hectare
- Field, not household (HH), was the unit of analysis used
- Unless otherwise noted, all figures are averages

Results vary by year for two main reasons:

1. The characteristics of the data sets varied slightly from year to year. Year 2010-11 differed in that it contained data on <u>amounts</u> of labor and hired animal and machine power. Relevant comments on how this affected computations are included below.
2. In terms of maize production conditions, years 2011/12 and 2013/14 were good years and years 2010/11 and 2012/13 were bad years.

[1] For information about the content of these surveys, see http://fsg.afre.msu.edu/zambia/CFS0506_SynQuest.pdf

Table 1.1 Mean margins (ZMW/hectare) by year & seed type (early or late maturing)

	2010/11		2011/12		2012/13		2013/14		All years
Seed Type:	**early a/**	**late b/**	**early**	**late**	**early**	**late**	**early**	**late**	**All seeds**
Observations	*13,540*	*1,129*	*14,199*	*1,081*	*14,353*	*961*	*14,764*	*989*	*61,016*
yield (kg/ha)	2,260	2,438	2,282	2,298	1,996	1,929	2,360	2,287	2,226
maize price (ZMW/kg)	1.08	1.067	1.1	1.094	1.13	1.13	1.13	1.13	1.11
Gross Revenue (ZMW/ha)	**2,461**	**2,622**	**2,514**	**2,517**	**2,255**	**2,180**	**2,667**	**2,584**	**2,477**
Costs (ZMW/ha)									
basal fertilizer	301.6	347.9	354.4	367.6	344	415	421.5	419.4	358.6
top-dress fertilizer	300.9	348.8	350	366	371.5	422.9	427.9	439.3	365.9
fertilizer transport	26.03	27.26	21.05	18.44	29.02	32.69	41.3	32.34	29.36
herbicide	3.169	2.536	4.661	4.285	34.28	20.82	9.972	7.957	12.84
seed	141.7	238.6	32.28	28.64	143.2	204.7	146.1	204.7	119.4
maize transport to market	14.24	22.67	14.52	18.01	5.535	6.091	6.562	7.253	10.38
total power input c/	2,121	1,773	1,332	1,201	1,496	1,493	1,612	1,389	1,623
total household labor	1,422	1,055	874.9	654.9	852.2	696	672.8	490.6	932.4
total hired labor	698.6	717.7	456.9	546.1	643.6	797.2	939.7	898.1	690.2
Total Variable Cost	**2,908**	**2,760**	**2,109**	**2,004**	**2,423**	**2,595**	**2,666**	**2,500**	**2,519**
Gross Margins (excl. land)	**-447**	**-138**	**405**	**513**	**-168**	**-415**	**1**	**84**	**-42**
opportunity cost of land d/	224.8	227.7	244.5	254.6	287.5	301.1	313.6	326.3	269.1
Total Cost	**3,133**	**2,988**	**2,353**	**2,259**	**2,711**	**2,896**	**2,979**	**2,826**	**2,788**
Gross Margins (incl. land)	**-672**	**-366**	**161**	**258**	**-456**	**-716**	**-312**	**-242**	**-311**

a/ "early" refers to early maturing maize varieties of the 400 and 500 categories identified by Dr. Mwansa (See Annex C)
b/ "late" refers to later maturing maize varieties of the remaining categories
c/ Household and hired labor, animal draft and machine power
d/ Median district land rental value per ha

When the opportunity cost of land is included, the above results show the lowest gross margins for the two years where the weather was considered to be unfavorable for maize (2010/11 and 2012/13), and the highest gross margins for the two years considered to be favorable (2011/12) and (2013/14), though margins are still negative in 2013/14.

Table 1.2 shows GMs by province and seed type (early versus late-maturing).

Table 1.2 Mean margins (ZMW/hectare) by province & seed type (early or late maturing)

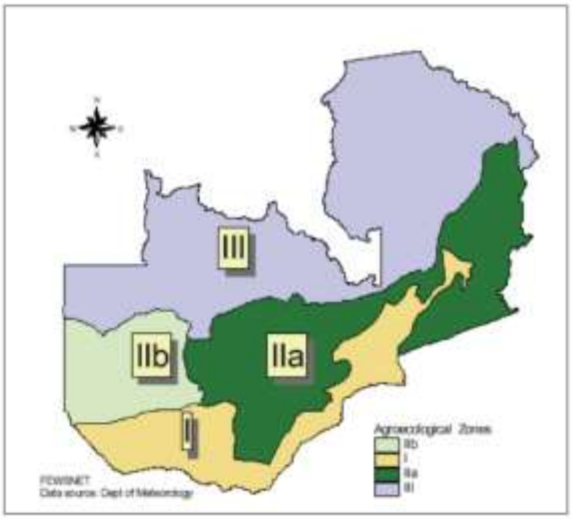
Province:	**Central**		**Copperbelt**		**Eastern**		**Luapula**		**Lusaka**		**Muchinga**		**Northern**		**Northwestern**		**Southern**		**Western**		**All prov**
Seed Type:	**early a/**	**late b/**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**all seeds**
Observations	*5,545*	*586*	*5,123*	*179*	*10,663*	*360*	*3,819*	*99*	*2,972*	*167*	*3,256*	*78*	*6,100*	*210*	*4,268*	*59*	*9,371*	*2,168*	*5,739*	*254*	*61,016*
yield (kg/ha)	2,542	2,708	2,550	2,736	2,144	2,595	2,599	2,891	2,057	2,047	3,174	3,764	2,996	4,088	2,346	2,827	1,727	1,899	980	1,091	2,226
maize price (ZMW/kg)	1.079	1.091	1.096	1.091	1.113	1.112	1.132	1.131	1.125	1.119	1.126	1.127	1.123	1.111	1.119	1.104	1.105	1.102	1.11	1.104	1.11
Gross Revenue (ZMW/ha)	2,758	2,981	2,810	2,989	2,389	2,891	2,935	3,252	2,316	2,285	3,579	4,235	3,366	4,510	2,632	3,153	1,908	2,093	1,083	1,199	2,477
Costs (ZMW/ha)																					
basal fertilizer	442.5	480.6	526.2	621.2	288.4	435.4	407.9	552	414.6	458.2	593.5	709	562.1	645.3	248.3	328	255.6	313.8	77.43	127.9	358.6
top-dress fertilizer	442.5	483.2	562.2	642.1	317	484.5	411.4	554.2	420.3	475.4	563.2	686	527.7	613.1	272	372.8	266.7	317.2	77.85	124.8	365.9
fertilizer transport	28.55	34.04	42.67	42.69	26.23	37.71	33.5	48.28	43.08	45.63	41.88	56.96	48.32	48.3	32.81	45.62	16.73	19.17	6.459	6.727	29.36
herbicide	10.56	10.3	100.8	92.25	3.821	4.098	1.004	0	12.08	17.82	1.191	0.897	1.367	1.194	1.865	1.186	5.514	3.254	3.686	3.655	12.84
seed	132.1	172.3	162.9	211	96.74	177.4	91.95	130.3	147.7	195.4	142	166.6	118.6	159.5	100.1	155.8	126	163.4	70.75	163.7	119.4
maize transport to market	14.06	21.95	9.97	9.63	7.962	10.75	9.71	7.956	5.741	9.066	15.49	16.68	15.87	21.13	8.177	7.011	11.42	14	3.136	3.237	10.38
total power input c/	1,343	1,519	2,373	2,430	1,368	1,789	1,583	1,664	2,288	2,252	1,441	1,542	1,584	1,767	2,840	2,507	1,142	1,168	1,513	1,680	1,623
total household labor	765	879.6	1,501	1,520	759	1,133	896.7	891.9	1,158	1,062	984.5	862.7	976	1,071	1,934	1,821	463.4	456.4	905.3	797.5	932.4
total hired labor	578.1	639.1	872.6	909.9	609.4	655.7	686.5	771.9	1,130	1,190	456.3	679.8	607.5	696	905.8	686.1	678.6	711.5	607.6	882.9	690.2
Total Variable Cost	**2,413**	**2,721**	**3,778**	**4,049**	**2,109**	**2,939**	**2,539**	**2,957**	**3,332**	**3,454**	**2,798**	**3,179**	**2,858**	**3,256**	**3,503**	**3,417**	**1,824**	**1,999**	**1,752**	**2,110**	**2,519**
Gross Margins (excl. land)	**345**	**260**	**-968**	**-1060**	**280**	**-48**	**396**	**295**	**-1016**	**-1169**	**781**	**1056**	**508**	**1254**	**-871**	**-264**	**84**	**94**	**-669**	**-911**	**-42**
opportunity cost of land d/	248.2	260.9	309.3	325.6	220.4	217.2	216.8	217.7	402.7	401.2	277.6	287.4	230	222.9	234.8	233.2	272.8	268.7	361	397	269.1
Total Cost	**2,662**	**2,982**	**4,087**	**4,375**	**2,329**	**3,156**	**2,755**	**3,174**	**3,734**	**3,855**	**3,076**	**3,466**	**3,088**	**3,479**	**3,738**	**3,650**	**2,097**	**2,267**	**2,113**	**2,507**	**2,788**
Gross Margins (incl. land)	**96**	**-1**	**-1277**	**-1386**	**60**	**-265**	**180**	**78**	**-1418**	**-1570**	**503**	**769**	**278**	**1031**	**-1106**	**-497**	**-189**	**-174**	**-1030**	**-1308**	**-311**

a/ "early" refers to early maturing maize varieties of the 400 and 500 categories identified by Dr. Mwansa (See Annex C)
b/ "late" refers to later maturing maize varieties of the remaining categories
c/ Household and hired labor, animal draft and machine power
d/ Median district land rental value per ha

Results vary by province partly as a function of agroecological zone (AEZ). Figure 1 shows a simplified map of Zambia's AEZs, drawn from Davies, Greenberg and Swanepoel (2015).

1. The most suitable zone for maize is AEZ IIa. This zone includes most of Central, Eastern and Lusaka Provinces. (See Figure 2 for a map of Zambia's provinces.)
2. AEZ III is moderately suitable for maize, characterized by higher rainfall but lower fertility and sometimes acid soils. This zone includes Northwest, Copperbelt, Luapula, and Northern Provinces (now divided into Northern and Muchinga Provinces).
3. AEZ I is marginally suitable for maize, being generally hot and dry. This includes part of Western Province, Southern Province and low-lying parts of Lusaka and Eastern Provinces.

Figure 1: Zambia Agro-ecological Zones



Source:http://img.static.reliefweb.int/sites/reliefweb.int/files/resources/A0B0FD1315C56BDF49256F40001CD840_0.gif.

Figure 2: Zambia's Provinces

Source: http://www.zambian.com/zambia/directory/travel-tourism/maps-locations/html/zambia-maps-pta_5.html

Averaging the GMs excluding land by AEZ gives the following:

1. Marginally suitable (AEZ I and AEZ IIb) = Southern: 84 (early) and 94 (late), Lusaka: -1016 (early) and -1169 (late), Central: 345 (early) and 260 (late), Western: -669 (early) and -911 (late). This gives an average of -314 (early) and -432 (late).
2. Moderately suitable (AEZ III) = Northwest: -871 (early) and -264 (late), Copperbelt: -968 (early) and -1060 (late), Luapula: 396 (early) and 295 (late), Northern: 508 (early) and 1254 (late), Muchinga: 781 (early) and 1056 (late). This gives an average of -31 (early) and 256 (late).
3. Suitable (AEZ IIa) = Eastern: 280 (early) and -48 (late).

These are rough estimates, since they do not adequately disaggregate provinces such as Central, Lusaka, and Eastern which have some area in the least suitable zone and some in the most suitable zone. Nonetheless, they do show a distinct difference between the marginal suitable zone (averages of -314 and -432 for early and late), versus the two more suitable zones (average of 125 for early and 232 for late).

Table 1.3 below shows GMs for five categories of seed type: early hybrid, early OPV (open-pollinated variety), other hybrid, other OPV, and local maize. Looking at the GMs excluding land cost, all improved seed types show a positive GM, averaging 53, compared to a negative GM of -218 for local maize. Looking at the GMs including land cost, the GMs for improved seed types are negative but less so than for local maize (-209 versus -487, respectively). Compared to local seed types, the improved seed types provide a net gain but generate a higher gross revenue per hectare, although costs per hectare are also higher—by about (2,443 minus 1862 = 581 per hectare, which represents a 31% increase relative to the costs associated with local maize.

Annex C shows characteristics of maize varieties that might be regarded as "climate-resilient" in some sense. Dr. B. N. Verma, maize seed breeder for ZAMSEED, noted that "earliness" in a maize variety provides "drought escape/avoidance" and not necessarily "drought tolerance," which requires breeding for performance under drought stress. A similar point is made by Dr. Kabamba Mwansa, maize breeder at the Zambia Agricultural Research Institute (ZARI). Tables C.1 through C.4 shows the maturity periods (early, medium, late) for varieties marketed by four major seed companies in Zambia. Table C.5 shows the characteristics of the drought-tolerant maize varieties released in Zambia during the period 2007 – 2014. Of the total of 27 varieties listed, 17 were hybrid and 10 were open-pollinated varieties. Annex D shows the frequency distribution of maize varieties reported as planted by farmers interviewed in the four CFS samples. Table D.1 shows that a third of the varieties were reported as "local maize." The nine varieties that were planted on at least 1,000 fields made up another 36% of the total. Variety ZMS 606, a medium-maturity variety reported by Dr. Verma as ZAMSEED's most popular variety, is relatively high on the list (frequency = 454), along with MM 606 which has a slightly higher frequency (583). Table D.2 shows that the most commonly planted early-maturing maize variety (Seed Co variety SC 513) was planted on 1,363 fields. The next most common early-maturing variety (Seed Co variety SC 403) was planted only 264 fields.

Table 1.3 Mean margins (ZMW/hectare) by seed type (detailed categories)

Seed Type:	Early hybrid a/	Early OPV b/	Other hybrid c/	Other OPV d/	Local maize e/	All seeds
Observations	*3,975*	*185*	*35,365*	*179*	*21,312*	*61,016*
yield (kg/ha)	2,248	2,245	2,671	1,826	1,488	2,226
maize price (ZMW/kg)	1.103	1.104	1.114	1.11	1.106	1.11
Gross Revenue (ZMW/ha)	**2,483**	**2,489**	**2,980**	**2,034**	**1,644**	**2,477**
Costs (ZMW/ha)						
basal fertilizer	386.3	367.8	500.2	227.1	119.5	358.6
top-dress fertilizer	393	368.4	504.9	232.8	131.2	365.9
fertilizer transport	27.18	32.84	41.11	18.42	10.33	29.36
herbicide	8.317	12.52	15.93	11.29	8.588	12.84
seed	169.4	140.7	169.4	144.5	26.78	119.4
maize transport to market	14.17	9.534	13.43	5.065	4.66	10.38
total power input f/	1,467	1,494	1,680	1,318	1,561	1,623
total household labor	728.1	858.1	885.5	737.6	1,051	932.4
total hired labor	739	635.7	794.1	580.2	510.2	690.2
Total Variable Cost	**2,465**	**2,426**	**2,925**	**1,957**	**1,862**	**2,519**
Gross Margins (excl. land)	**18**	**63**	**55**	**77**	**-218**	**-42**
opportunity cost of land g/	276.3	248	268.5	254.4	269	269.1
Total Cost	**2,742**	**2,674**	**3,193**	**2,211**	**2,131**	**2,788**
Gross Margins (incl. land)	**-259**	**-185**	**-213**	**-177**	**-487**	**-311**

a/ "Early hybrid" refers to early maturing hybrid maize varieties of the 400 and 500 categories (see Annex C)
b/ "Early OPV" refers to early maturing OPV maize varieties of the 400 and 500 categories
c/ "Other hybrid" refers to other hybrid maize varieties
d/ "Other OPV" refers to other hybrid maize varieties
e/ "Local maize" refers to remaining maize varieties identified as local maize in the CFS survey
f/ Household and hired labor, animal draft and machine power
g/ Median district land rental value per ha

III. Tables of Returns to Land and Labor

The gross margin tables include estimates of the opportunity cost of household labor and land. Margin measures that deduct these opportunity costs can result in negative net returns. An alternative is to calculate net revenue without deducting these opportunity costs, and then compare that to the quantity of land and (especially) household labor invested in farming. Table 2.1 therefore shows a calculation of net revenue which, when divided by the estimate of household labor days invested, gives the returns to labor and land. These figures are positive for all years and seed types. Note that for the calculations in this section, because of the lack of data for all four years on the quantity of household labor inputs, it was assumed that the farm household's own labor input was 180 days per year for all maize activities (from planting to processing) for all seed types.

Adjusting the calculation of net revenue by deducting the opportunity cost of land, and then dividing that by the number of household labor days, gives the returns to labor. This figure can be compared to an estimate of the opportunity cost of household labor to determine whether the particular farming activity provides a return to labor equivalent to or greater to the assumed opportunity cost. Table 2.1 below shows that the returns to labor are positive in every case, except for late-maturing maize in 2012/13 in which case they are marginally negative.

Table 2.1 Returns (ZMW/hectare) by year & seed type (early or late maturing)

	2010/11		2011/12		2012/13		2013/14		All years
Seed Type:	**early a/**	**late b/**	**early**	**late**	**early**	**late**	**early**	**late**	**All seeds**
Observations	*13,540*	*1,129*	*14,199*	*1,081*	*14,353*	*961*	*14,764*	*989*	*61,016*
yield (kg/ha)	2,260	2,438	2,282	2,298	1,996	1,929	2,360	2,287	2,226
maize price (ZMW/kg)	1.08	1.067	1.1	1.094	1.13	1.13	1.13	1.13	1.11
Gross Revenue (ZMW/ha)	2,461	2,622	2,514	2,517	2,255	2,180	2,667	2,584	2,477
Costs (ZMW/ha)									
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herbicide	3.169	2.536	4.661	4.285	34.28	20.82	9.972	7.957	12.84
seed	141.7	238.6	32.28	28.64	143.2	204.7	146.1	204.7	119.4
maize transport to market	14.24	22.67	14.52	18.01	5.535	6.091	6.562	7.253	10.38
Total hired labor	698.6	717.7	456.9	546.1	643.6	797.2	939.7	898.1	690.2
Total Variable Cost (no HH labor)	1,486	1,705	1,234	1,349	1,571	1,899	1,993	2,009	1,587
Net Revenue 1	975.2	916.9	1,281	1,168	684.2	280.8	674.2	574.7	889.9
HH labor days	180	180	180	180	180	180	180	180	180
Returns to labor & land/ha/day	5.418	5.094	7.114	6.49	3.801	1.56	3.745	3.193	4.944
oppportunity cost of land c/	224.8	227.7	244.5	254.6	287.5	301.1	313.6	326.3	269.1
Total Cost (excl. HH labor)	1,711	1,933	1,478	1,604	1,859	2,200	2,307	2,335	1,856
Net Revenue 2	750.4	689.2	1,036	913.6	396.7	-20.28	360.6	248.3	620.8
Returns to labor per ha per day	4.169	3.829	5.756	5.076	2.204	-0.113	2.003	1.38	3.449

a/ "early" refers to early maturing maize varieties of the 400 and 500 categories identified by Dr. Mwansa (See Annex C)
b/ "late" refers to later maturing maize varieties of the remaining categories
c/ Median district land rental value per ha

Table 2.2 shows the mean returns by province and seed type. Negative returns to labor occur only for Lusaka and Western Provinces. This result is consistent with the fact that Table 1.2 shows these two provinces as having the lowest gross margins when land and labor costs are both deducted. For Lusaka, these GMs are -1,418 and -1,570 for early and late varieties; for Western, they are -1,030 and -1,308, respectively.

Table 2.2 Mean returns (ZMW/hectare) by province & seed type (early or late maturing)

Province:	**Central**		**Copperbelt**		**Eastern**		**Luapula**		**Lusaka**		**Muchinga**		**Northern**		**Northwestern**		**Southern**		**Western**		**All prov**
Seed Type:	**early a/**	**late b/**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**early**	**late**	**all seeds**
Observations	*5,545*	*586*	*5,123*	*179*	*10,663*	*360*	*3,819*	*99*	*2,972*	*167*	*3,256*	*78*	*6,100*	*210*	*4,268*	*59*	*9,371*	*2,168*	*5,739*	*254*	*61,016*
yield (kg/ha)	2,542	2,708	2,550	2,736	2,144	2,595	2,599	2,891	2,057	2,047	3,174	3,764	2,996	4,088	2,346	2,827	1,727	1,899	980	1,091	2,226
maize price (ZMW/kg)	1.079	1.091	1.096	1.091	1.113	1.112	1.132	1.131	1.125	1.119	1.126	1.127	1.123	1.111	1.119	1.104	1.105	1.102	1.11	1.104	1.11
Gross Revenue (ZMW/ha)	2,758	2,981	2,810	2,989	2,389	2,891	2,935	3,252	2,316	2,285	3,579	4,235	3,366	4,510	2,632	3,153	1,908	2,093	1,083	1,199	2,477
Costs (ZMW/ha)																					
basal fertilizer	442.5	480.6	526.2	621.2	288.4	435.4	407.9	552	414.6	458.2	593.5	709	562.1	645.3	248.3	328	255.6	313.8	77.43	127.9	358.6
top-dress fertilizer	442.5	483.2	562.2	642.1	317	484.5	411.4	554.2	420.3	475.4	563.2	686	527.7	613.1	272	372.8	266.7	317.2	77.85	124.8	365.9
fertilizer transport	28.55	34.04	42.67	42.69	26.23	37.71	33.5	48.28	43.08	45.63	41.88	56.96	48.32	48.3	32.81	45.62	16.73	19.17	6.459	6.727	29.36
herbicide	10.56	10.3	100.8	92.25	3.821	4.098	1.004	0	12.08	17.82	1.191	0.897	1.367	1.194	1.865	1.186	5.514	3.254	3.686	3.655	12.84
seed	132.1	172.3	162.9	211	96.74	177.4	91.95	130.3	147.7	195.4	142	166.6	118.6	159.5	100.1	155.8	126	163.4	70.75	163.7	119.4
maize transport to market	14.06	21.95	9.97	9.63	7.962	10.75	9.71	7.956	5.741	9.066	15.49	16.68	15.87	21.13	8.177	7.011	11.42	14	3.136	3.237	10.38
Total hired labor	578.1	639.1	872.6	909.9	609.4	655.7	686.5	771.9	1,130	1,190	456.3	679.8	607.5	696	905.8	686.1	678.6	711.5	607.6	882.9	690.2
Total Variable Cost (no HH labor)	1,648	1,842	2,277	2,529	1,350	1,806	1,642	2,065	2,174	2,391	1,814	2,316	1,881	2,184	1,569	1,596	1,361	1,542	846.9	1,313	1,587
Net Revenue 1	1,110	1,139	533.2	459.7	1,040	1,085	1,293	1,188	142.2	-106.1	1,765	1,920	1,485	2,325	1,063	1,556	547.6	551.2	236.4	-114.2	889.9
HH labor days	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
Returns to labor & land/ha/day	6.165	6.328	2.962	2.554	5.777	6.028	7.182	6.599	0.79	-0.59	9.807	10.66	8.25	12.92	5.905	8.647	3.042	3.062	1.313	-0.634	4.944
oppportunity cost of land c/	248.2	260.9	309.3	325.6	220.4	217.2	216.8	217.7	402.7	401.2	277.6	287.4	230	222.9	234.8	233.2	272.8	268.7	361	397	269.1
Total Cost (excl. HH labor)	1,897	2,102	2,587	2,854	1,570	2,023	1,859	2,282	2,577	2,793	2,091	2,603	2,112	2,407	1,804	1,830	1,633	1,811	1,208	1,710	1,856
Net Revenue 2	861.5	878.2	223.9	134.1	819.4	868	1,076	970	-260.5	-507.3	1,488	1,632	1,255	2,103	828	1,323	274.7	282.5	-124.6	-511.2	620.8
Returns to labor per ha per day	4.786	4.879	1.244	0.745	4.552	4.822	5.977	5.389	-1.447	-2.819	8.265	9.067	6.972	11.68	4.6	7.351	1.526	1.569	-0.692	-2.84	3.449

a/ "early" refers to early maturing maize varieties of the 400 and 500 categories identified by Dr. Mwansa (See Annex C)

b/ "late" refers to later maturing maize varieties of the remaining categories

c/ Median district land rental value per ha

Table 2.3 shows mean returns for five seed type categories. As noted above, it was assumed that the farm household's own labor input was 180 days per year for all maize activities for all seed types. This assumption leads to a different "ranking" of seed types than that shown in Table 1.3, where all improved seed types had better net returns than the local maize type. In Table 2.3, returns to labor in local maize were higher than for early hybrid seed, and slightly higher than for other OPV seed. One possible explanation is that the average HH using earlier varieties might employ less HH labor than those using other varieties. While such HH labor costs are accounted for in the gross margins table, they are not accounted for here and furthermore a uniform assumption of HH labor days is used across seed varieties. For example, a 15% decrease in the assumed number of HH labor days (e.g., 153 instead of 180) for early hybrids would yield a returns to labor and land of approximately 4.90.

Table 2.3 Mean returns (ZMW/hectare) by seed type (detailed categories)

Seed Type:	**Early hybrid a/**	**Early OPV b/**	**Other hybrid c/**	**Other OPV d/**	**Local maize e/**	**All seeds**
Observations	*3,975*	*185*	*35,365*	*179*	*21,312*	*61,016*
yield (kg/ha)	2,248	2,245	2,671	1,826	1,488	2,226
maize price (ZMW/kg)	1.103	1.104	1.114	1.11	1.106	1.11
Gross Revenue (ZMW/ha)	2,483	2,489	2,980	2,034	1,644	2,477
Costs (ZMW/ha)						
basal fertilizer	386.3	367.8	500.2	227.1	119.5	358.6
top-dress fertilizer	393	368.4	504.9	232.8	131.2	365.9
fertilizer transport	27.18	32.84	41.11	18.42	10.33	29.36
herbicide	8.317	12.52	15.93	11.29	8.588	12.84
seed	169.4	140.7	169.4	144.5	26.78	119.4
maize transport to market	14.17	9.534	13.43	5.065	4.66	10.38
Total hired labor	739	635.7	794.1	580.2	510.2	690.2
Total Variable Cost (no HH labor)	1,737	1,567	2,039	1,219	811.2	1,587
Net Revenue 1	746.1	922	940.6	814.8	832.9	889.9
HH labor days	180	180	180	180	180	180
Returns to labor & land per ha per day	4.145	5.122	5.226	4.527	4.627	4.944
oppportunity cost of land f/	276.3	248	268.5	254.4	269	269.1
Total Cost (excl. HH labor)	2,014	1,816	2,308	1,474	1,080	1,856
Net Revenue 2	469.7	673.9	672.1	560.4	564	620.8
Returns to labor per ha per day	2.61	3.744	3.734	3.113	3.133	3.449

a/ "Early hybrid" refers to early maturing hybrid maize varieties of the 400 and 500 categories (see Annex C)
b/ "Early OPV" refers to early maturing OPV maize varieties of the 400 and 500 categories
c/ "Other hybrid" refers to other hybrid maize varieties
d/ "Other OPV" refers to other hybrid maize varieties
e/ "Local maize" refers to remaining maize varieties identified as local maize in the CFS survey
f/ Median district land rental value per ha

IV. Other Observations on Results

The fact that the margin and returns figures presented above are relatively low may raise questions. For example, many of the margins are negative, which may seem inconsistent with the widespread cultivation of maize in Zambia. In addition, the margins are lower on average than those reported in Burke et al. (2011).[2] Three general factors account, or may account, for the relatively low figures: (1) because the purpose of the calculations reported here was to contribute to a cost-benefit analysis of the CRM program, unsubsidized input and output prices were generally used rather than subsidized ones; (2) certain cost components may be overstated, given the data available; and (3) prices used to value maize output in the budgets are likely to have understated value to farmers who are deficit producers, i.e., they produce less maize than the household consumes. These points are elaborated below.

1. **Use of unsubsidized fertilizer costs.** Local market prices were used to calculate fertilizer costs, not the price charged to farmers under the government's Farm Input Subsidy Programme (FISP). Since most farmers use subsidized fertilizer, their actual costs are lower than those shown in the budgets. That is one reason why the gross margins reported in Burke et al. (2011) are higher.

2. **Possibly overstated costs.**
    a. <u>Hired labor and power costs</u>. Unfortunately the degree of detail for these costs was not high for most years, and varied between years. Quantities of labor inputs were available only for 2010/11 (the year used by Burke et al. (2011)). Also, while information was collected in all years on the prevailing village-level costs per hectare for hired labor, animal draught power, and machine power, in cases where multiple sources of power were used there was no indication of the proportion of total power provided from each source. The conservative assumption was thus made that each cultivation activity was carried out with the most costly power source that a HH reported for that activity. This inevitably tended to overstate the labor and animal/machine power costs. Partly or largely for this reason, power costs used in the above budgets were somewhat higher than those reported in Burke et al. (2011).
    b. <u>HH labor costs</u>. HH labor was valued at local market wage rates. This valuation likely overstates the actual opportunity costs of production, since it makes the strong assumption that 100% of HH labor hours could otherwise be redeployed to employment at the given wage rate. However, in the absence of other data, this valuation was again the most conservative approach.
    c. <u>Land costs</u>. Because formal land markets do not exist, rental values are based on reported market prices, which could be inflated.

3. **Possibly understated maize values.**
    a. <u>Year, province, and seed variety</u>. Average margins/returns are brought down by certain years (2010-11, 2012-13), certain provinces, and by farms using local maize seeds. In particular, the geographical and seed variety effect could be very important. The latter is explained further in (c) below.

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[2] Table 1.2 shows that the gross margin (excluding land costs) for all provinces and all seed types was -42 ZMK/ha. In Burke et al. (2011), the average GM was 1,109, ranging from -1,348 for the lowest quintile of gross margins to 4,048 for the highest quintile.

b. Use of unsubsidized maize prices. Maize was valued at the local market price reported by farmers. In the many cases where no price was reported, values were imputed based on the village-, district-, or province-level average price, calculated across all sales outlets. Although many farmers who sell receive the government-support price paid by the Food Reserve Agency (FRA), most of the prices used to calculate the average price were lower than that. An unknown but probably significant percentage of farmers whose maize was valued at this price actually sold their output at the higher FRA price. Use of market rather than government maize prices therefore probably understated the value received by farmers selling at the higher FRA price, although (by design) the estimated market price represented more accurately the "economic" (i.e., unsubsidized) price.

c. Value of maize for deficit producers. Output by farmers using local maize seed was valued at the sale price, yet many local maize producers are deficit producers whose output really substitutes for purchased maize. However, the value of maize for deficit producer households would be better reflected by a (higher) purchase-equivalent price (market price plus cost of transport from market to farm) than by a sale-equivalent price (market price minus the cost of transport from farm to market).

On the other hand, and looking on the bright side, the results show that:

- 2011-12 and 2013-14 were relatively good years, with positive gross margins (excluding land).
- Maize production is generally more profitable in Central, Luapula, Muchinga, Northern, and Southern provinces, which have positive gross margins (excluding land).
- All improved varieties show positive average gross margins (excluding land) for all years and provinces. Only farms using "local maize seeds" show negative gross margins.
- When assumptions about the opportunity cost of HH labor and land are not made, all varieties show positive returns to labor across years and provinces.

References

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food Policy*, *33*(4), 299-317.

Burke, W. J., Hichaambwa, M., Banda, D., & Jayne, T. S. (2011). The cost of maize production by smallholder farmers in Zambia. Working Paper No. 50, Food Security Research Project, Lusaka, Zambia. March. http://fsg.afre.msu.edu/zambia/wp50.pdf

Davies, F., Greenberg, S., and Swanepoel, S. (2015). Which way forward for Zambia's smallholder farmers: Green Revolution input subsidies or agro-ecology? Johannesburg: African Centre for Biodiversity. http://acbio.org.za/wp-content/uploads/2015/11/Zambia-report-2015.pdf

Siegel, P. B., & Alwang, J. (2005). *Poverty Reducing Potential of Smallholder Agriculture in Zambia* (No. 85). Africa Region Working Paper Series. Washington, D.C.: The World Bank.

Wineman, Ayala. (2014). Climate change and crop choice in Zambia; A math programming approach. Working paper draft, Department of Agricultural, Food, and Resource Economics, Michigan State University. February 27. http://fsg.afre.msu.edu/climate_change/Climate_change_and_crop_choice_in_Zambia_DRAFT_Feb_27_March_10,_2014.pdf

ZNFU Enterprise Budgets.

Annex A. Definition and Computation of Cost Elements

This Annex explains how the cost variables were defined and calculated. Notes on the specific variables give the abbreviated variable names contained in the data files, as well as a more complete variable description. The Stata DO files used for the calculations are available from the authors.

yield_field – yield (kg) per ha per field

maizeprice – marketed maize price per kg

- For 2010/11 and 2011/12, we used the price at which HHs reported their *largest* maize sale. So some prices may, but do not necessarily, reflect the price accorded by the Zambian government purchase program implemented by the Food Reserve Agency (FRA).
- For HHs not reporting a sale, we imputed median local (district) market prices.
- Marketing data were not available for 2012/13 and 2013/14 so we imputed median data from first 2 years.

Variable cost elements: material inputs

basalcosts_ha – basal fertilizer commercial costs per ha

- Subsidized and free prices were omitted. This is an important caveat, since most farmers do acquire fertilizer from the government input subsidy program (which included fertilizer and seed).
- Local values (district and province levels) were imputed on observations with missing variables (MV).

topcosts_ha – top-dressing fertilizer commercial costs per ha

- Subsidized and free prices were omitted. This is an important caveat, since most farmers do acquire fertilizer from the government input subsidy program.
- Local values (district and province levels) were imputed on observations with MVs.

ferttrancost_ha –fertilizer transportation costs (point of purchase to farm) per ha

- Based on HH's reported data for largest fertilizer purchase.
- Local values (district and province levels) imputed on observations with MVs.

herbcosts_ha – herbicide costs per ha

- Based on HH's reported total herbicide cost, divided per household ha planted of maize.
- Many of the reported values appear exceptionally high—up to 5000KMW— but the analysis reported here does not omit outliers.

seedcosts_ha – seed commercial costs per ha

- Average seed prices per kg were developed, then local values (district and province levels) were imputed on observations with missing variables.
- Subsidized and zero cost seeds were omitted; only those purchased from a commercial agent were used. Important assumption, since the Zambian government subsidized seeds for at least the 2012-13 and 2013-14 years.
- Consequently, recycled seeds have some estimated local commercial value.

mktcost_ha – maize transport to market costs per ha

- Based on HH's reported distance to point of sale for largest maize sale. A minority of farmers actually sold (or sold and actually reported a distance), so imputed local estimates (based on district or province level estimates) were used for the rest.
- We used the ZNFU enterprise budget's assumed maize transport cost of $.2/km/t, which was converted to ZMW at current rates.

<u>Variable cost elements: labor & power</u>

totpower_ha – combined household and hired labor, draught, and machine power

- First, if HH reported using mechanical power (own or hired) for a labor activity, we assumed that all of this activity was performed by machine for all fields for that HH. We used the local price/ha to rent a machine for that activity, as reported by the HH, or else imputed an estimated local value.
- Second, if no machines used for that activity, and if HH reported using animal draught power (own or hired) for an activity, we assumed that all of this activity was performed by draught for all fields for that HH. We used the local price/ha to rent draught power for that activity, as reported by the HH, or else imputed an estimated local value.
- Third, if no draught or machines are used for that activity, we assume that the activity is done by own or hired labor for all fields for that HH. We used the local price/ha to hire labor for that activity, as reported by the HH, or else imputed an estimated local value.
- Own and hired power is the largest cost component category. We have capped labor (both HH and hired) at about $300/ha, and draught and mechanical power at ($1000/ha). These rates should perhaps be capped further.

totHHL_ha – an estimate of **total HH own labor** per ha

- If a HH reported *not* hiring/renting power or labor for a particular activity, it was assumed that the activity was performed entirely by HH labor, valued at the local market rate.

tothired_ha – an estimate of hired/rented labor, animal, or machine power

- Derived by subtracting total HH labor from the total costs of power (totpower_ha - totHHL_ha).

<u>Fixed cost elements: land</u>

loclandrent_ha – the opportunity cost of a ha of land

- Estimated by taking by taking the median local (district) value of the price/ha at which HHs report being able to rent their land out.

<u>Total cost figures</u>

TVC – total variable costs

- All costs but land

TC – total costs

- All costs including land

TVC_noHHL – total variable costs excluding HH labor (but including hired labor and power)

TC_noHHL – total costs excluding HH labor (but including hired labor and power)

Annex B. Definition and Computation of Returns

Gross revenue – revenue from maize sales, before subtracting out any costs

Gross margins (excl. land) – profits from maize sales, after subtracting out TVC (but not land) from gross revenue

Gross margins (incl. land) – profits from maize sales, after subtracting out TC (including land) from gross revenue[3]

Returns to (household) labor & land (per hectare per day)– returns to a HH/ha for one day of deployment of land and HH labor

- Assumption: the farm HH's own labor input = 180 days/year for all maize activities (from planting to processing).
- Computed by taking gross margins minus *total variable costs* (including hired labor and power costs, but *excluding land and HH labor*), and dividing by 180

Returns to (household) labor (per hectare per day)

- Assumption: the farm HH's own labor input = 180 days/year for all maize activities (from planting to processing).
- Computed by taking gross margins minus *total costs* (including land, hired labor, and power costs, but *excluding hh labor*), and dividing by 180

[3] This could be referred to as "net margin" since at least one element of fixed cost (land) has been deducted.

Annex C. Characteristics of Maize Varieties in Zambia

Researchers and seed company personnel in Zambia were contacted for assistance in categorizing the seed variety codes in the CFS survey data in terms of early versus late maturing and drought tolerance or drought resistance characteristics.

Regarding these distinctions, Dr. B. N. Verma, maize seed breeder for Zamseed, stated in a September 1, 2015, e-mail:

> ". . . in my view earliness is drought escape/avoidance and not necessarily tolerance. Maize is general has poor drought tolerance. However some varieties perform better than others under stress. CIMMYT claims that their material is drought resistant and that could be true to some degree as they have been exposing their material across stress conditions including low fertility. But there are certainly some commercial company cultivars that are equally performing well under stress. Among my materials one such hybrid is ZMS 606 which is by far most popular hybrid from Zamseed. I believe other companies will also have some claims like this. OPVs and double-cross hybrids are generally more resilient than single-cross hybrids."

Dr. Verma notes that the Zamseed variety ZMS 606 performs well under drought and made up more than 50% of their seed production during 2015.

The distinction between "early" and "late" varieties shown in Tables 1.1, 1.2, and 1.3 is based on information from Kabamba Mwansa, maize breeder at the Zambia Agricultural Research Institute (ZARI). In an August 15, 2015, e-mail message, Dr. Mwansa stated:

> ". . . I could only indicate maturities for varieties that follow nomenclature as stipulated by SCCI release committee and these are from SEEDCO, ZAMSEED, MRI-SYGENTA, KAMANO, and ZARI. Codes used by Monsanto, Pannar and AFGRI are difficult to tell . . . .
>
> "Our stress breeding requires that a variety to be designated as drought tolerant needs to be screened under managed drought during off season in which moisture stress is applied prior to flowering. The important traits such as anthesis-silking interval, number of ears per plant, leaf senescence among them are determined. Any variety that has not be screened for such is an escape.
>
> "I have attached another sheet for drought tolerant varieties that known to have undergone such screening and have been released in Zambia.
>
> "Finally, I have also included variety release booklet for all crop varieties released in Zambia up to 2013 for your assistance in case any variety that was captured during survey does or does not exist."

The maturity ratings given by Dr. Mwansa are shown in the tables below.

Table C.1 Maize Maturities, ZAMSEED Varieties

	EARLY	MEDIUM	LATE
1 = Pool 16 (OP)	X		
19 = GV 61 Yellow		X	
6 = GV 408	X	X	
3 = GV 412	X		
5 = GV 470	X		
12 = GV 512	X		
13 = GV 607		X	
14 = GV 702			X
15 = GV 703			X
18 = GV 704			X
16 = GV 722			X
4 = MM 441	X		
7 = MM 501	X		
8 = MM 502	X		
9 = MM 601		X	
10 = MM 603		X	
11 = MM 604		X	
177=MM 606		X	
17 = MM 752			X
2 = MMV 400 (OP)	X		
178= MMV 600 (OP)	X		
141 = ZMS 402	X		
179= ZMS 510	X		
180= ZMS 528	X		
181= ZMS 602		X	
142 = ZMS 606		X	
143 = ZMS 607		X	
182= ZMS 616		X	
144 = ZMS 737			X
145 = ZMV 600			

Table C.2 Maize Maturities, MRI Varieties

	EARLY	MEDIUM	LATE
MRI			
194=MRI EP (OP)	X		
195=MRI MP (OP)		X	
196=MRI 404	X		
67 = MRI 455	X		
66 = MRI 514	X		
157 = MRI 534	X		
65 = MRI 594	X		
63 = MRI 611		X	
64 = MRI 614		X	
62 = MRI 624		X	
61 = MRI 634		X	
158 = MRI 644		X	
60 = MRI 651 (Y)		X	
159 = MRI 694		X	
197= MRI 704			X
161 = MRI 711 (Y)			X
160 = MRI 714			X
57 = MRI 724			X
59 = MRI 734			X
58 = MRI 744			X

Source: Kabamba Mwansa, ZARI.

Table C.3 Maize Maturities, ZARI Varieties

	EARLY	MEDIUM	LATE
ZARI- MAL			
146 = ZM 421	X		
147 = ZM 521 (OP)	X		
148 = ZM 621		X	
OTHERS			
MMV409 (OPV)	X		
MMV607 (OPV)		X	
GV613		X	
GV628		X	
GV635		X	
GV637		X	
GV638		X	
GV640		X	
GV655		X	
GV659		X	

Table C.4 Maize Maturities, SEEDCO Varieties

	EARLY	MEDIUM	LATE
56 = SC 206 (Y)			
47 = SC 401	X		
48 = SC 403	X		
49 = SC 405	X		
50 = SC 407	X		
198=SC 411	X		
42 = SC 501	X		
55 = SC 506 (Y)	X		
44 = SC 513	X		
43 = SC 515	X		
45 = SC 517	X		
46 = SC 521	X		
199=SC 525	X		
40 = SC 601		X	
53 = SC 602 (Y)		X	
54 = SC 604 (Y)		X	
41 = SC 621		X	
39 = SC 625		X	
38 = SC 627		X	
155 = SC 633		X	
200=SC 637		X	
36 = SC 701			X
51 = SC 704 (Y)			X
52 = SC 706 (Y)			X
37 = SC 707			X
32 = SC 709			X
35 = SC 711			X
33 = SC 713			X
34 = SC 715			X
201=SC 719			X

Source: Kabamba Mwansa, ZARI.

The drought-tolerant maize variety release booklet provided by Dr. Mwansa is contained in Table C.5 below.

Table C.5 Drought-tolerant Maize Varieties Released in Zambia, 2007-2014

Release name	Release year	Hybrid/OPV	Maturity range	Kernel Colour	Released by (Company)	Suitable agro-ecologies	On-farm yield range (MT/ha)	Additional traits/remarks
PGS53	2007	Hybrid	Intermediate	White	Progene	Drier mid-altitudes	3.0-6.0	MSV resistant
PGS71*	2007	Hybrid	Intermediate	White	Progene	Drier mid-altitudes	3.0-6.0	MSV resistant
KAM601*	2008	Hybrid	Intermediate	White	Kamano	Drier mid-altitudes	4.0-6.0	GLS and MSV resistant
KAM602*	2008	Hybrid	Intermediate	White	Kamano	Drier mid-altitudes	4.0-6.0	GLS & MSV resistant
SC721	2008	Hybrid	Very late	White	SeedCo	Drier mid-altitudes	6.0-8.0	GLS and MSV resistant
CAP9001	2010	Hybrid	Intermediate	White	Capstone	Drier mid-altitudes	4.0-6.0	MSV& GLS resistant
SC727	2010	Hybrid	Late	White	SeedCo	Drier mid-altitudes	4.0-6.0	MSV & GLS resistant
ZMS606	2010	Hybrid	Intermediate	White	ZamSeed	Drier mid-altitudes	4.0-6.0	MSV & GLS resistant
ZMS623	2012	Hybrid	Intermediate	White	ZamSeed	Drier mid-altitudes	3.0-5.0	MSV & GLS resistant
GV 635*	2013	Hybrid	Intermediate	White	ZARI	Drier mid-altitudes	4.0-6.0	Semi-flint, MSV & GLS resistant
GV 638*	2013	Hybrid	Intermediate	White	ZARI	Drier mid-altitudes	4.0-6.0	Semi-flint, MSV & GLS resistant
GV 628*	2013	Hybrid	Early	White	ZARI	Drier mid-altitudes	4.0-6.0	Semi-flint, MSV & GLS resistant
GV613*	2014	Hybrid	Intermediate	White	ZARI	Drier mid-altitudes	4.0-6.0	Semi-flint, MSV & GLS resistant
GV637*	2014	Hybrid	Intermediate	White	ZARI	Drier mid-altitudes	4.0-6.0	Semi-flint, MSV & GLS resistant
GV655*	2014	Hybrid	Intermediate	White	ZARI	Drier mid-altitudes	4.0-6.0	Semi-flint, MSV & GLS resistant
ZM423	2007	OPV	Early	White	Kamano	Drier mid-altitudes	3.0-4.0	MSV resistant
ZM523	2008	OPV	Early	White	Kamano	Drier mid-altitudes	3.0-4.0	MSV resistant
ZM625	2008	OPV	Intermediate	White	Kamano	Drier mid-altitudes	3.0-5.0	MSV resistant
ZM721	2008	OPV	Late	White	Kamano	Drier mid-altitudes	3.0-5.0	Flint, MSV & GLS resistant
Nelson's Choice	2010	OPV	Intermediate	White	Capstone	Drier mid-altitudes	3.0-4.0	GLS, MSV & rust resistant
MMV409	2011	OPV	Very early	White	ZARI	Drier mid-altitudes	2.0-3.0	Flint, MSV resistant
MMV607	2014	OPV	Intermediate	White	ZARI	Transition & drier mid-alt.	3.0-4.0	Semi-flint, MSV & GLS resistant
ZM421	2004	OPV	Early	White	ZARI	Drier mid-altitudes	2.0-3.0	Flint, MSV, GLS
ZM521	2004	OPV	Early	White	ZARI	Drier mid-altitudes	2.0-3.0	Flint, MSV, GLS
ZM621	2004	OPV	Intermediate	White	ZARI	Drier mid-altitudes	2.0-3.0	Flint, MSV, GLS
GV640	2004	Hybrid	Intermediate	White	ZARI	Drier mid-altitudes	3.0-4.0	Flint, GLS
GV659	2004	Hybrid	Intermediate	White	ZARI	Drier mid-altitudes	3.0-4.0	Flint, GLS

Source: Kabamba Mwansa, ZARI.

Annex D. Frequency Distribution of Fields by Maize Variety Grown, from Zambia Crop Forecast Survey Data,* 2010/11 to 2013/14.

Table D.1 Frequency Distribution for Maize Varieties Grown on 25 Fields or More

What main seed variety did you plant?	Freq.	Percent		What main seed variety did you plant?	Freq.	Percent
Local Maize (MRI)	15,671	33.77	|	PAN 6777 - Maize (Pannar)	94	0.20
PAN 53 - Maize (Pannar)	3,611	7.78	|	KAMANO - Seed companies	91	0.20
Hybrid Maize (MRI)	2,191	4.72	|	SC 625 - Maize (Seed Co)	83	0.18
SC 627 - Maize (Seed Co)	1,937	4.17	|	PAN 4M-19 - Maize (Pannar)	81	0.17
Recycled hybrid Maize (MRI)	1,855	4.00	|	MRI 455 - Maize (MRI)	80	0.17
PANNAR - Seed Companies	1,703	3.67	|	MRI 724 - Maize (MRI)	78	0.17
SEED CO - Seed Companies	1,634	3.52	|	DKC 8073 - Maize (Monsanto)	78	0.17
MRI 624 - Maize (MRI)	1,425	3.07	|	PAN 6243 - Maize (Pannar)	77	0.17
SC 513 - Maize (Seed Co)	1,363	2.94	|	PAN 6363 - Chipolopolo (Pannar)	76	0.16
SC 621 - Maize (Seed Co)	1,069	2.30	|	ZMS 602 - Maize (Zamseed)	65	0.14
MRI - Seed Companies	754	1.62	|	MRI 404 - Maize (MRI)	65	0.14
MRI 634 - Maize (MRI)	747	1.61	|	Pool 16 - Maize (Zamseed)	63	0.14
PIONEER - Seed companies	720	1.55	|	SC 601 - Maize (Seed Co)	60	0.13
SC 719 - Maize (Seed Co)	714	1.54	|	PAN 69 - Maize (Pannar)	56	0.12
MM 606 - Maize (Zamseed)	583	1.26	|	SC 704 - Yellow Maize (Seed Co)	55	0.12
PAN 413 - Maize (Pannar)	576	1.24	|	SC 401 - Maize (Seed Co)	54	0.12
ZAMSEED - Seed Companies	555	1.20	|	PAN 77 - Maize (Pannar)	54	0.12
ZMS 606 - Maize (Zamseed)	454	0.98	|	MRI 704 - Maize (MRI)	54	0.12
DK 8031 - Maize (Monsanto)	362	0.78	|	DK 8071 - Maize (Monsanto)	53	0.11
MRI 614 - Maize (MRI)	358	0.77	|	SC 525 - Maize (Seed Co)	52	0.11
MRI 744 - Maize (MRI)	344	0.74	|	MRI 644 - Maize (MRI)	46	0.10
DKC 8053 - Maize (Monsanto)	302	0.65	|	PAN 6M-55 - Maize (Pannar)	46	0.10
MONSANTO - Seed companies	290	0.62	|	SC 521 - Maize (Seed Co)	45	0.10
DKC 8033 - Maize (Monsanto)	276	0.59	|	MRI 611 - Maize (MRI)	44	0.09
SC 403 - Maize (Seed Co)	264	0.57	|	SC 501 - Maize (Seed Co)	43	0.09
Do not know	262	0.56	|	SC 515 - Maize (Seed Co)	43	0.09
MM 604 - Maize (Zamseed)	231	0.50	|	ZMS 616 - Maize (Zamseed)	43	0.09
PAN 67 - African Queen (Pannar)	230	0.50	|	MRI EP (OP) - Maize (MRI)	42	0.09
SC 604 - Yellow Maize (Seed Co)	226	0.49	|	MM 752 - Maize (Zamseed)	41	0.09
GV 704 - Maize (Zamseed)	203	0.44	|	SC 407 - Maize (Seed Co)	40	0.09
MM 603 - Maize (Zamseed)	189	0.41	|	SC 706 - Yellow Maize (Seed Co)	38	0.08
PAN 64 - Maize (Pannar)	184	0.40	|	PAN 6017 - Maize (Pannar)	38	0.08
PAN 57 - Maize (Pannar)	173	0.37	|	PAN 61 - Maize (Pannar)	35	0.08
MRI 514 - Maize (MRI)	165	0.36	|	ZMS 528 - Maize (Zamseed)	34	0.07
SC 637 - Maize (Seed Co)	163	0.35	|	PAN 7M-97 - Maize (Pannar)	33	0.07
MRI 594 - Maize (MRI)	154	0.33	|	MMV 400 - Maize (Zamseed)	32	0.07
MRI 734 - Maize (MRI)	148	0.32	|	GV 607 - Maize (Zamseed)	31	0.07
OTHER SEED COMPANIES	138	0.30	|	GV 408 - Maize (Zamseed)	29	0.06
DK 8051 - Maize (Monsanto)	129	0.28	|	PAN 6479 - Maize (Pannar)	29	0.06
SC 701 - Maize (Seed Co)	128	0.28	|	ZM 621 - Maize (ZARI-MACO)	29	0.06
PAN 4M-17 - Maize (Pannar)	121	0.26	|	PAN 5503 - Maize (Pannar)	28	0.06
MM441 - Maize (Zamseed)	120	0.26	|	ZMS 607 - Maize (Zamseed)	27	0.06
SC 709 - Maize (Seed Co)	119	0.26	|	GV 702 - Maize (Zamseed)	26	0.06
SC 602 - Yellow Maize (Seed Co)	118	0.25	|	GV 722 - Maize (Zamseed)	26	0.06
OPV Maize (MRI)	114	0.25	|	PAN 6549 - Mr Reliable (Pannar)	26	0.06
MRI 534 - Maize (MRI)	113	0.24	|	SC 506 - Yellow Maize (Seed Co)	26	0.06
SC 633 - Maize (Seed Co)	109	0.23	|	MM 502 - Maize (Zamseed)	25	0.05
SC 206 - Yellow Maize (Seed Co)	99	0.21	|	ZMS 402 - Maize (Zamseed)	25	0.05
MRI 694 - Maize (MRI)	98	0.21	|			

Table D2. Frequency Distribution of Fields for Early-Maturing Maize Varieties Grown

What main seed variety did you plant?	Freq.	Percent
SC 513 - Maize (Seed Co)	1,363	2.94
SC 403 - Maize (Seed Co)	264	0.57
MRI 514 - Maize (MRI)	165	0.36
MRI 594 - Maize (MRI)	154	0.33
MM441 - Maize (Zamseed)	120	0.26
MRI 534 - Maize (MRI)	113	0.24
MRI 455 - Maize (MRI)	80	0.17
MRI 404 - Maize (MRI)	65	0.14
Pool 16 - Maize (Zamseed)	63	0.14
SC 401 - Maize (Seed Co)	54	0.12
SC 525 - Maize (Seed Co)	52	0.11
SC 521 - Maize (Seed Co)	45	0.10
SC 501 - Maize (Seed Co)	43	0.09
SC 515 - Maize (Seed Co)	43	0.09
MRI EP (OP) - Maize (MRI)	42	0.09
SC 407 - Maize (Seed Co)	40	0.09
ZMS 528 - Maize (Zamseed)	34	0.07
MMV 400 - Maize (Zamseed)	32	0.07
GV 408 - Maize (Zamseed)	29	0.06
SC 506 - Yellow Maize (Seed Co)	26	0.06
MM 502 - Maize (Zamseed)	25	0.05
ZMS 402 - Maize (Zamseed)	25	0.05
SC 411 - Maize (Seed Co)	24	0.05
GV 512 - Maize (Zamseed)	20	0.04
MM 501 - Maize (Zamseed)	19	0.04
SC 517 - Maize (Seed Co)	17	0.04
SC 405 - Maize (Seed Co)	17	0.04
GV 412 - Maize (Zamseed)	15	0.03
ZM 521 - Maize (ZARI-MACO)	15	0.03
ZM 421 - Maize (ZARI-MACO)	10	0.02
ZMS 510 - Maize (Zamseed)	10	0.02
MMV 600 (OP) - Maize (Zamseed)	7	0.02
GV 470 - Maize (Zamseed)	6	0.01

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