Poverty in maize growing rural communities of southern Africa

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(Received 13 November 2013; accepted 23 September 2014)

This study provides a detailed analysis of the extent and determinants of poverty in the maize-based rural economies of selected districts in southern African countries of Angola, Malawi, Mozambique, and Zambia. Poverty profiles showed that households that were absolutely poor had significantly smaller family sizes, fewer livestock, smaller farm sizes, smaller number of illiterate household members, and less number of important assets such as phones and radios. The study also details the extent and determinants of poverty in the study countries using quantile regression. The importance of maize technology use and resource allocation to the crop in determining the magnitude of poverty is an important finding as the sampled households were essentially semi-subsistent with limited market orientation. This finding also justifies the effort being exerted on the development and deployment of maize and maize-related technologies in rural communities of southern Africa.

Keywords: poverty; quantile regression; southern Africa

1. Introduction

There are different strands and variations in defining and analyzing poverty. Detailed expositions on the concepts related to poverty emphasize its multidimensionality and interdependence of the different perspectives (Alkire and Foster, 2009; Chambers 2008; Lehning, Vu, and Pintak 2007; Morazes and Pintak 2007; Scoones 2009). Scoones (2009) argues that the different perspectives and approaches have offered diverse insights into the way complex, rural livelihoods interact with political, economic and environmental processes from a wide range of disciplinary perspectives, drawing from both the natural and social sciences. Generally, poverty implies lack of entitlement for an adequate standard of living. It is multidimensional and assumes different dimensions of deprivation, which include consumption and food security, health, education, rights, voice, safety and security, dignity, and decent work (OECD 2001; UN 2005). A person living in poverty is denied equal opportunity and choice, which are fundamental virtues for human development. Very concisely, poverty can be defined as pronounced deprivation of well-being (Haughton and Khandker 2009).

In Africa, the poverty rate has been constant at 50% of the population compared to Asia where it has dropped by nearly 20% (Prabhakar 2008; World Bank 2008). Poverty is most concentrated in the southern and eastern parts of Africa where agriculture is the mainstay of the economies (IFAD 2013). The Southern Africa Development Community (SADC) is a subregional bloc which consists of Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Madagascar, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. The SADC region has a population of about 277 million people, with a 2.4% annual population growth rate. By 2030, the rural population should increase by 20% (SADC 2012). An estimated 61% of the subregion’s population depends on subsistence agriculture, income, and employment (SADC 2012). Agriculture accounts for about 8% of the subregion’s Gross Domestic Product (GDP). However, agricultural growth rate has remained subdued at about 2.6% per annum over the past decades.

About two-thirds of the subregion’s population live below the international poverty line of US$1.25/person per day and 45% of the population lives in abject poverty (SADC 2008). Poverty rates have remained high in the subregion because of low capital investment in agriculture (the largest employment sector). Only three (Malawi, Zambia, and Zimbabwe) of the SADC states have so far adhered to the 10% budgetary support to agriculture made under the Maputo Declaration (Benin and Yu 2013).

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Not unexpectedly, therefore, rural poverty continues to haunt southern African countries, especially because the rural poor depend on rain-fed agriculture that usually experiences perpetual crop failure mainly as a result of droughts and floods. The HIV pandemic has also affected the rural work force. Poor governance and administration of resources have also contributed to the slow infrastructure and institutional development necessary for meaningful and incessant economic growth (SADC 2008).

The importance of understanding the causes and extent of poverty in this region cannot be overemphasized. In analyzing individual-level poverty, social scientists still find it useful to focus largely on poverty as a lack of money measured either as low income or as inadequate expenditures (Deaton 1997). One reason for focusing on money is practical: inadequate income is clear, measurable, and of immediate concern for individuals. Another reason is that low incomes tend to correlate strongly with other concerns that are important but harder to measure. Income is universally an important element, even while most agree that money metrics are too narrow to capture all relevant aspects of poverty. Still, the challenges of measuring poverty narrowly defined by a lack of money are substantial in themselves (Jenkins et al. 2011). In fact, the expenditure measure is strongly recommended for statistical reasons (Deaton 1997; Haughton and Khandker 2009).

This study used reported total income and reported total expenditure to measure the well-being of the households in the rural districts of Angola, Malawi, Mozambique, and Zambia. The analysis depends entirely on reported income and expenditure data, and results were presented using both measures for comparison and cross-checking purposes.

The study focuses on districts where maize production is the most important means of livelihood. This is essentially because the reported research is part of a larger initiative that aims at developing and disseminating drought-tolerant maize varieties through a continent-wide project called Drought Tolerant Maize for Africa (DTMA). This study covers four of the 13 sub-Saharan African (SSA) countries where the project is being implemented. It is envisaged that the technologies of the project will increase the average productivity of maize under smallholder farmer conditions by 20–30% on adopting farms, reach 30–40 million people in SSA, and add an annual average of US$160–200 million of additional grain (LaRovere et al. 2010). The rest of the paper is structured as follows: the next section presents the sampling and data collection procedures of the study. Then follows the analytical framework employed in the paper. We then present the results and the detailed discussion of the main findings of the study. Finally, we conclude by highlighting the key results.

2. Sampling and data collection

The four countries of study are Angola, Malawi, Mozambique, and Zambia. Angola has a surface area of 1.25 million km² and had an estimated human population of 18 million in 2008 (UNdata 2010; World Bank 2010). More than 43% of the population lives in the rural areas depending mainly on subsistence agriculture. Agriculture contributed 6.6% of the GDP in 2008, while the oil and mineral based industry sector contributed the grand share (World Bank 2010). About 93% of the crop farming is conducted by smallholder farmers and maize is the major staple food crop in the country. In Angola, the survey was conducted in Cacuaco and Lobito Municipalities in Central West of the country. Cacuaco Municipality is a suburb of Luanda situated at 8°50′00″ latitude and 13°30′00″ longitude. It has an average altitude of 7 meters above sea level (masl), a daily temperature of 24.3°C, and an annual rainfall of 575 millimeters (mm). In 2008, the population density of the municipality was computed to be 46 people per km². Lobito municipality of Benguela province is located at 12°20′53″ latitude and 13°32′44″ longitude at an average altitude of 14 masl. It has an average daily temperature of 23.7°C and an annual rainfall of 356 mm. Lobito Municipality had a population density of 221 persons/km².

Malawi is a landlocked country with a surface area of 118,484 km² and had a human population of 14.8 million in 2008 (UNdata 2010; World Bank 2010). The majority of Malawi’s population (~80%) live in the rural areas. Agriculture is a very important sector contributing about 34.3% of the GDP in 2008 (World Bank 2010). The government’s initiative to broaden seed and fertilizer subsidy programs has seen Malawi registering food surpluses over the last five years. Maize is the most important food crop in Malawi and availability equates to food security. The districts surveyed in Malawi are Balaka and Mangochi of the Central region. Balaka is located at 15°25′40″ latitude and 35°3′32″ longitude with an average altitude of 625 masl. It has an average daily temperature of 23°C and an annual rainfall of 800 mm. In 2008, the district had a human population density of 148 persons/km². Mangochi is a district to the north of Balaka situated at 14°23′34″ latitude and 35°20′47″ longitude. Mangochi has an average altitude of 492 masl, a daily temperature of 24°C, and an annual rainfall of 983 mm.

Mozambique has a surface area of about 0.8 million km² and had a human population of 22.4 million in 2008 (UNdata 2010). More than 63% of Mozambicans live in the rural areas eking a living out of traditional and subsistence agriculture. Agriculture contributed 28.6% of the GDP in 2008 (World Bank 2010). Maize accounts for about 75% of the total value of smallholder crop production in Mozambique and is by far the most important staple food crop in the country. Mossurize and Sussundenga districts of Manica Province were surveyed in this study. Mossurize is
located at 21°12′45″ latitude and 33°22′48″ longitude with an average altitude of 600 masl. It has an average daily temperature of 20°C and an annual rainfall of 1500 mm. In 2007, the district’s human population density was computed to be 38 persons/km². Sussundenga is a neighboring district situated at 19°24′14″ latitude and 33°17′25″ longitude, and an elevation of 500 masl. It has an average daily temperature of 21°C and annual precipitation of 1155 mm. The human population density of the district in 2007 was 18 persons/km².

Zambia is also a landlocked country with a surface area of about 0.75 million km² and had a human population of 13.3 million in mid-2010 (MCTI 2010). About 65% of Zambians live in the rural areas depending mainly on agriculture, which contributed 21.2% of the GDP in 2010. In Zambia, maize is the major staple food crop and accounts for about 80% of the total value of smallholder crop production. Zambia’s current economic plan ‘Enhancing Growth through Competitiveness and Diversification’ singles out agriculture as one of the sectors of focus for its strong forward and backward linkages with regard to employment creation and income generation. Agriculture is, therefore, being given due emphasis as Zambia is shifting from its heavy dependence on metallic exports (MCTI 2010). The districts surveyed were Monze and Kalomo in central south of the country. Monze is situated at 16°0′0″ latitude and 27°15′0″ longitude with an average elevation of 1012 masl. The average daily temperature and annual rainfall in the district are 20°C and 650 mm, respectively. The population density in 2007 was computed to be 28 persons/km². Kalomo district is located at 17°2′6″ latitude and 26°29′6″ longitude and at an average elevation of 1300 masl. It has an average annual rainfall of 350 mm and a daily temperature of 22°C. The district has a human population density of 10 persons/km².

The two districts in each of the countries were randomly selected provided that the districts fall in predetermined categories (20–40%) of probability of failed season (PFS). PFS implies the probability of growing season failure as a result of insufficient soil water availability (either too-short growing season, or too-severe level of water stress within the growing period) (Thornton et al. 2006) and was considered here to homogenize exposure to drought that results in crop failures. A total sample of 1005 households was randomly drawn with sample sizes varying from country to country (Table 1).

The sample households were approached with a structured and detailed questionnaire to generate data on different variables. The surveys were accomplished in English (Malawi and Zambia) and Portuguese (Angola and Mozambique). The variables of interest broadly included household characteristics, resource endowment, availability and access to institutional services, enterprise choice and resource allocation, maize variety selection, adoption and preferences, production and marketing risks, and perceived trends in the different aspects of maize production. The surveys were administered by senior researchers from the national agricultural research systems of the countries with need-based and tailored technical backstopping from the socioeconomics program of the International Maize and Wheat Improvement Center.

### 3. Analytical framework

The dependent variable was generated by dividing the total reported income (Ψ) and total reported expenditure (Γ) per adult equivalent by the poverty line (z) and then taking the natural logarithm of the values {i.e. ln(Ψ_i/z) and ln(Γ_i/z)}. We refer to ln of per adult equivalent income divided by poverty line as Ψ* and to ln of per adult equivalent expenditure divided by poverty line as Γ*. The regression diagnostics conducted showed that multicollinearity was not at all a problem in all cases, whereas heteroscedasticity was found to be a problem in Mozambique and Zambia model formulations.

According to Haughton and Khandker (2009), a typical multiple regression equation as applied to poverty analysis would look like ln(Ψ_i/z) = x_iβ_i, where z is the poverty line and Ψ_i is the per capita income (Ψ) or expenditure (Γ) of individual i, x_i is the explanatory variables, and the β is the coefficients to be estimated. Such formulation, however, has two problems in this particular context.

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**Table 1. Sample districts and sample size.**

| Country   | Districts    | District sample size | Sample | Household head respondent (%) | Gender of respondent (%) |
|-----------|--------------|----------------------|--------|-------------------------------|--------------------------|
|           |              |                      |        |                               | Male   | Female  |
| Angola    | Cacuaco      | 82                   | 150    | 79.9                          | 65.3   | 34.7    |
|           | Lobito       | 68                   |        |                               |        |         |
| Malawi    | Balaka       | 68                   | 155    | 62.3                          | 29.3   | 70.7    |
|           | Mangochi     | 87                   |        |                               |        |         |
| Mozambique| Mossurize    | 207                  | 350    | 67.5                          | 59.9   | 40.1    |
|           | Sussundenga  | 143                  |        |                               |        |         |
| Zambia    | Monze        | 204                  | 350    | 89.1                          | 71.7   | 28.3    |
|           | Kalomo       | 146                  |        |                               |        |         |
First, it only summarizes the average relationship between the well-being measure and the set of explanatory variables, based on the conditional mean function \( E(\ln(Y_i/z)|x) \). Second, when the random terms are heteroscedastic, the parameter estimates will be inefficient despite remaining unbiased. We therefore require a more complete formulation that provides information about the relationship between the outcome \( \ln(Y_i/z) \) and the regressors \( (x) \) at different points in the conditional distribution of \( y \) with inbuilt corrections for heteroscedasticity.

Quantile regression (QR), and specifically median regression, a special case of QR that is more robust to outliers than mean regression, is recommended under such circumstances (Cameron and Trivedi 2005, 2009). QR permits us to study the impact of regressors on both the well-being measure and the set of explanatory variables \((x)\), thereby allowing a richer understanding of the data. In addition, the approach is semiparametric in the sense that it avoids assumptions about parametric distribution of regression errors. These features make QR especially suitable for heteroscedastic data (Cameron and Trivedi 2005).

The quantile \( q, q \in (0, 1) \), is defined as the value of \( y \) that splits the data into the proportion \( q \) below and \( 1 - q \) above, that is, \( F(y_q) = q \) and \( y_q = F^{-1}(q) \). This concept extends to the conditional QR. The conditional quantiles denoted by \( Q_q(x|\beta) \) are the inverse of the conditional cumulative distribution function of the response variable, \( F^{-1}_y(q|x) \), where \( q \in [0, 1] \) denotes the quantiles (Cade, Terrell, and Schroeder 1999; Koenker and Machado 1999). Here, we consider functions of \( X \) that are linear in the parameters; for example, \( Q_q(x|\beta) = \beta_0(q)X_0 + \beta_1(q)X_1 + \beta_2(q)X_2 + \ldots + \beta p(q)X_p \), where the \( (q) \) notation indicates that the parameters are for a specified \( q \) quantile. The parameters vary with \( q \) due to effects of the \( q \)th quantile of the unknown error distribution \( \varepsilon \).

The computational implementation of the QR is different from ordinary least squares and maximum likelihood as its optimization uses linear programming methods.

The \( q \)th QR estimator \( \hat{\beta}_q \) minimizes over \( \beta_q \) and the objective function is given by

\[
Q(\beta_q) = \sum_{i: q\geq q_i} q|y_i - x'_ib_q| + \sum_{i: q< q_i} (1-q)|y_i - x'_ib_q|,
\]

where \( 0 < q < 1 \), and \( \beta_q \) is used instead of \( \beta \) to underline the fact that different choices of \( q \) estimate different values of \( \beta \). Apparently, when \( q > 0.5 \), higher weight is attached to the positive errors of prediction and when \( q < 0.5 \), higher weight is attached to the negative errors of prediction model prediction. Often, estimation sets \( q = 0.5 \) (median), giving the least absolute deviations estimator that minimizes \( \sum |y_i - x'_ib_{0.5}| \).

The objective function (1) is not differentiable, and hence the usual gradient optimization methods cannot be applied. The classic solution is the simplex method of linear programming that is guaranteed to yield a solution in a finite number of simplex iterations.

The estimating equations in (1) are solved by a modification of the Barroda and Roberts (1974) simplex linear program for any specified value of \( q \) (Koenker and Bassett 1978). With little additional computation, the entire regression quantile function for all distinct values of \( q \) can be estimated (Koenker and Bassett 1978; Koenker, Ng, and Portnoy 1994). The estimator that minimizes \( Q(\beta_q) \) is a maximum likelihood-like (m) estimator (Greene 2003; Huber 1981) with well-established asymptotic properties. The QR estimator is asymptotically normal under general conditions and it can be shown that:

\[
\hat{\beta}_q \sim \mathcal{N}(\beta_q, A^{-1}BA^{-1}),
\]

where \( A = \sum_i q(1-q)x_ix'_i \), \( B = \sum_i fu_q(0|x_i)x'_i \), and \( fu_q(0|x_i) \) is the conditional density of the error term \( u_q = y_i - x'_ib_q \) evaluated at \( u_q = 0 \).

Parameter estimates in linear QR models have the same interpretation as those in any other linear model. They are rates of change conditional on adjusting for the effects of the other variables in the model, but now are defined for some specified quantile. The marginal effects (MEs) for the \( j \)th (continuous) regressor after QR can be given as

\[
\frac{\partial Q_q(y|x)}{\partial x_j} = \beta_{qj}.
\]

Regression quantiles, like the usual 1-sample quantiles with no predictor variables, retain their statistical properties under any linear or nonlinear monotonic transformation of \( y \) as a consequence of this ordering property; that is, they are equivariant under monotonic transformation of \( y \) (Koenker and Machado 1999). Thus, it is possible to use a nonlinear transformation (e.g. logarithmic) of \( y \) to estimate linear regression quantiles and then back-transform the estimates to the original scale (a nonlinear function) without any loss of information. Our dependent variable is \( \ln(y/z) \); therefore, in order to compute the MEs for the \( y/z \), the equivariance property of QR is important. Following Cameron and Trivedi (2005), given \( Q_q(\ln(y|x)) = x'_b \), we have \( Q_q(y|x) = \exp(\ln(y|x)) = \exp(x'_b \) and \( (\beta_q) \). The ME on \( y \) in levels, given QR model \( x'_b \) in logs, is computed as

\[
\frac{\partial Q_q(y|x)}{\partial x_j} = \exp(x'_b \beta_{qj}).
\]
4. Results and discussion

4.1. Poverty line determination

The international absolute poverty line of $1/day per capita was initially determined in 1985 and revised to 1.08 in 1993 and then to $1.25\(^3\) in 2005 prices (Chen and Ravallion 2008). The first step in determining the absolute poverty line is, therefore, to calculate the local currency equivalent of $1.25/day per capita at current prices. Accordingly, the absolute poverty lines in local currency were calculated in 2007 prices for Mozambique and Zambia and in 2008 prices for Angola and Malawi. The calculation is a simple adjustment of the $1.25 in 2005 prices for accumulated price inflation since 2005. The data required, that is, purchasing power parity (PPP) for 2005, consumer price indices (CPI) for 2007 and 2008, and inflation rates for 2007 and 2008, were generated mainly from World Bank, UN, and IMF web portals and other reliable sources\(^4\).

The steps we followed are as follows: first, we calculated the current (2007 and 2008) PPP exchange rate by adjusting the 2005 PPP for cumulative inflation since 2005. Second, we multiplied the poverty line by the current PPP exchange rate to find the local currency equivalent in 2005 prices of the $1.25. Third, we updated the poverty line in local currency using the inflation rates in 2007 and 2008. Finally, the poverty lines were computed to be 18.34 Meticais for Mozambique and 3979 Zambian Kwacha for Zambia in 2007 prices and 98.27 Kwanza for Angola and 72.53 Malawian Kwacha for Malawi in 2008 prices.

In addition to absolute poverty lines which are essential for international comparison of intensity of poverty, relative poverty lines are equally important when targeting of program or interventions is the purpose (Haughton and Khandker 2009). The data generation process in this study aimed at understanding the structure of poverty and inequality in areas where the DTMA would be implemented and hence the relative poverty measures are deemed relevant. Three relative poverty indicators – 40%, 50%, and 60% – of the median value of the reported total income and total expenditure were computed. Table 2 presents the relative poverty lines for all study countries based on data collected from sample households. The comparison with the absolute poverty lines shows that in all four countries, the absolute poverty line is higher than the 50% median of the total reported income and expenditure per day per adult equivalent.

The absolute poverty lines of all countries, but Zambia, are less than all relative poverty lines that were computed based on total reported income and expenditure. Despite the need to correct for measurement error – which we have reported later in the paper, the absolute poverty line based computation shows that Zambian sample households are more deprived than samples in other countries. The relative poverty lines also reveal that Angolan and Zambian sample households are the poorest.

4.2. Measuring poverty

A common phenomenon in household-level rural surveys (to collect data on income and expenditure) is measurement

| Country | Measure | Total income | Total expenditure | Poverty line | % of households below poverty line |
|---------|---------|--------------|------------------|--------------|-----------------------------------|
| Angola (KW) | Absolute | 98.27 | 98.27 | 21.95 | 22.92 |
|         | Relative (% of median) 40 | 170.40 | 244.41 | 28.05 | 31.25 |
|         |                  50 | 213.00 | 305.51 | 34.15 | 31.25 |
|         |                  60 | 255.59 | 366.62 | 41.46 | 39.58 |
| Malawi (MK) | Absolute | 72.53 | 72.53 | 14.47 | 13.55 |
|         | Relative (% of median) 40 | 115.01 | 120.59 | 22.37 | 21.94 |
|         |                  50 | 143.76 | 150.74 | 25 | 27.74 |
|         |                  60 | 172.52 | 180.88 | 29.61 | 30.97 |
| Mozambique (MC) | Absolute | 18.34 | 18.34 | 25.22 | 11.75 |
|         | Relative (% of median) 40 | 21.27 | 29.70 | 27.60 | 20.34 |
|         |                  50 | 26.58 | 37.13 | 32.64 | 27.22 |
|         |                  60 | 31.90 | 44.55 | 36.80 | 33.81 |
| Zambia (ZK) | Absolute | 3979.00 | 3979.00 | 33.95 | 34.01 |
|         | Relative (% of median) 40 | 2968.23 | 2890.28 | 26.43 | 24.13 |
|         |                  50 | 3710.28 | 3612.85 | 32.43 | 30.52 |
|         |                  60 | 4452.34 | 4335.42 | 36.94 | 36.92 |
error due primarily to underreporting and non-reporting of income and expenditure. This usually occurs for two reasons. One, due to the natural tendency of human beings in rural areas to underreport their incomes merely because of lack of confidence in the confidentiality and ultimate use of the data being collected, and two, due to the lack of records of expenses made on different items. The irregularity in income and expenditure flow and the inherent spontaneous and conspicuous consumption patterns can also be reasons why rural communities tend to report less than what they earn and/or spend.

Accordingly, we adjusted the welfare measures for measurement error. Following Haughton and Khandker (2009), the study assumed that the measurement error is a random normal variable with a standard error as big as one-tenth of the standard error of total reported income or expenditure. This study also assumed that the measurement error is additive to the reported values of income and expenditure. This error is, by design, independent of reported income/expenditure and of any other household or community characteristics. The poverty measures presented and discussed in Tables 3 and 4 are calculated based on the measurement error adjusted values (50% of median) of total reported income \[\Psi\] – Welfare Measure 1 (WM1) and total reported expenditure \[\Gamma\] – Welfare Measure 2 (WM2).

Using both the absolute and measurement error-corrected half-median income poverty lines, it was clear that sample households in Mozambique and Zambia were poorer than the sample households in Angola and Malawi (Table 3). The poverty measures computed based on the corrected poverty line were rather comparable than those computed based on the absolute poverty line. Nearly 33% of sample Mozambicans were in absolute poverty, while about 27% of sample Angolans lived below the absolute poverty line. Sen, Thon, and Takayama indices show that Mozambique is by far the poorest of the countries, whereas the Watts index – distribution sensitive and theoretically sound poverty measure – identifies Angolan sample households to be the poorest.

The poverty measures computed based on WM2 show a slightly different pattern in levels of poverty despite the fact that the two poorest countries are still the same (Table 4). These computations show that the sample households in Zambia are the poorest. Taking the poverty gap index, for example, the minimum cost of eliminating poverty (relative to the poverty line) is much higher in Zambia compared to that in all other countries. The Watts index, differently from the other measures, identified sample households in Mozambique to be the poorest.

### Table 3. Poverty measures based on measurement error adjusted total reported income.

| Poverty measure          | Total reported income |          | Total reported income |          |
|--------------------------|-----------------------|----------|-----------------------|----------|
|                          | Angola | Malawi | Mozambique | Zambia | Angola | Malawi | Mozambique | Zambia |
| Headcount ratio (%)      | 13.42 | 14.47 | 27         | 35.7   | 26.83 | 27.63 | 32.64       | 32.43  |
| Poverty gap ratio (%)    | 13.3  | 23.25 | 46.3       | 31.36  | 16.44 | 22.42 | 39.74       | 35.55  |
| Income gap ratio (%)     | 99.1  | 160.6 | 171.5      | 111.05 | 61.29 | 81.15 | 121.75      | 109.61 |
| Watts index (%)          | 11.87 | 7.93  | 10.1       | 15.15  | 22.83 | 16.97 | 15.8        | 15.8   |
| Sen index *100           | 18.13 | 31.73 | 64.7       | 49.3   | 23.07 | 31.87 | 55.11       | 48.9   |
| Thon index *100          | 25.36 | 44.3  | 85         | 64.24  | 30.17 | 41.2  | 71.48       | 63.85  |
| Takayama index *100      | 14.1  | 27.58 | 72.3       | 44.53  | 16.62 | 24.36 | 52.82       | 44.04  |

### Table 4. Poverty measures based on measurement error adjusted total reported expenditure.

| Poverty measure          | Total reported expenditure |          | Total reported expenditure |          |
|--------------------------|-----------------------------|----------|-----------------------------|----------|
|                          | Angola | Malawi | Mozambique | Zambia | Angola | Malawi | Mozambique | Zambia |
| Headcount ratio (%)      | 14.58 | 9.03   | 12.61      | 32.56  | 27.1  | 27.74 | 27.2        | 35.47  |
| Poverty gap ratio (%)    | 25.24 | 10.94  | 9.5        | 59.43  | 23.9  | 15     | 14.83       | 54.46  |
| Income gap ratio (%)     | 173.1 | 121.12 | 74.94      | 182.52 | 88.23 | 54.1  | 54.5        | 153.55 |
| Watts index (%)          | 0.1  | 5.03   | 9.4        | 9.32   | 10.94 | 14.92 | 21.23       | 12.06  |
| Sen index *100           | 32.4 | 14.32  | 13.1       | 85.4   | 30.6  | 21.52 | 20.48       | 77.78  |
| Thon index *100          | 47.5 | 21.15  | 18.15      | 107.9  | 42.9  | 27.6  | 27.15       | 97.82  |
| Takayama index *100      | 30.44 | 11.54  | 9.64       | 119.81 | 25.47 | 14.9  | 14.5        | 95.48  |
4.3. Poverty profiling

Poverty groups (poor and nonpoor) were formed using both welfare measures, implying that those who earn/spend below the absolute poverty line are poor. Mean comparison of owned quantities of important assets and access to social services (education and extension services) has shown important tendencies in the sample communities. Comparing the poor and nonpoor groups based on WM1, the Angolan sample did not show much difference between poor and nonpoor groups (Table 5). Only household size – which is significantly higher in nonpoor households – and proportion of land allocated to maize – which is significantly higher for the poor households – were found to be statistically different in the two groups.

In the case of Malawi, household size, number of illiterate family members, farm size, and number of bicycles owned were significantly higher in the nonpoor group compared to that in the poor group. In Mozambique the poor were characterized by significantly less household size, less number of illiterate household members, less education of the household head (in years), less number of household members engaged in off-farm activities, less number of ploughing animals, less farm size, and less livestock wealth than the nonpoor group. In Zambia, the nonpoor households are characterized by significantly higher farm size; higher number of illiterate household members; higher number of household members engaged in off-farm activities; higher number of ploughing animals; higher number of radios, phones, and bicycles owned; and higher livestock wealth.

The profiling of poor and nonpoor groups done using WM2 showed more elaborate differences in Malawi,

| Table 5. Poverty profiles of sample households based on daily income per adult equivalent. |
|---------------------------------------------------------------|
| Daily income per AE | Angola n = 82 | Malawi n = 152 | Moz. n = 337 | Zambia n = 333 |
|---------------------|---------------|----------------|--------------|----------------|
| Household size      | 1.57          | 3.35           | 2.31         | 4.01           |
|                     | -0.02         | -0.06          | 0.47         | 1.30           |
| Number of illiterate household members | 0.02 | 0.08 | 0.81 | 2.61 |
| Number of household members in off-farm activities | -0.09 | -0.35 | 0.41 | 1.34 |
| Number radio owned  | 0.06          | 0.39           | 0.35         | 1.91           |
| Number of credit types received | 0.12 | 1.04 | 0.12 | 1.63 |
| Number of extension contacts in last 12 months | 0.55 | 0.87 | 0.27 | 0.18 |
| Farm size (ha)      | 1.48          | 1.02           | 0.39         | 1.78           |
| Land allocated to maize (% of total land) | -10.41 | -1.92 | -0.10 | -1.22 |
| Livestock wealth in TLU | 0.31 | 1.45 | 0.21 | 0.64 |
| Number of phones owned | 0.00 | 0.01 | 0.27 | 1.87 |
| Average education of the household (years) | 0.64 | 0.73 | -0.38 | -0.91 |
| Number of farm plots | 0.12 | 0.42 | 0.00 | 0.03 |
| Number of bicycles owned | 0.39 | 2.36 | 0.03 | 0.23 |

Note: Mean diff. = mean(nonpoor) - mean(poor).

| Table 6. Poverty profiles of sample households based on daily expenditure per adult equivalent. |
|---------------------------------------------------------------|
| Daily expenditure per AE | Malawi n = 155 | Mozambique n = 349 | Zambia n = 344 |
|--------------------------|----------------|-------------------|----------------|
| Household size           | 2.47           | 4.23              | 4.24           |
| Dependency ratio         | 0.48           | 1.31              | 0.47           |
| Number of illiterate household members | 0.53 | 1.68 | 2.14 | 4.67 |
| Number of household members engaged in off-farm activities | 0.35 | 1.13 | 0.63 | 3.45 |
| Number radio owned       | 0.26           | 1.41              | 0.17           |
| Number of credit types received | 0.01 | 0.12 | 0.01 | 0.63 |
| Number of extension contacts in the last 12 months | 0.86 | 0.56 | 0.27 | 0.82 |
| Farm size (ha)           | 0.55           | 2.48              | 3.26           |
| Land allocated to maize (% of total land owned) | -0.19 | -3.11 | 0.02 | 0.42 |
| Livestock wealth in TLU  | 0.22           | 0.69              | 0.79           |
| Number of phones owned   | 0.31           | 2.15              | 0.06           |
| Average education of household in years | 0.55 | 1.29 | 0.39 | 1.09 |
| Number of farm plots     | 0.48           | 1.64              | 0.18           |
| Number of bicycles owned | 0.44           | 2.60              | 0.02           |
Mozambique, and Zambia (Table 6). The poor in Malawi possess significantly less household size, and have less number of illiterate household members, lower average education of household in years, less farm size, and less number of phones and bicycles compared to the nonpoor. However, the poor allocate a significantly higher proportion of their land to maize. In Mozambique, the nonpoor group has significantly higher family size, higher dependency ratio, higher number of illiterate household members, higher education of household head (in years), higher number of household members engaged in off-farm activities, larger farm size, and higher livestock wealth. In Zambia, except for the proportion of land allocated to maize, the poor own less of all assets and have less household head education as compared to nonpoor households. In fact, poor households do have a significantly less number of illiterate household members.

An interesting observation in the poverty profiling is the fact that the poor households allocate a significantly higher proportion of their land to maize as compared to the better-offs. This implies the magnitude of the importance poor and vulnerable households attach to maize. It is therefore imperative to emphasize the contribution of interventions around maize technology development and deployment to alleviate poverty – and ultimately reduce the relative importance of maize in the household economy.

One outstanding issue in the profiling is the higher number of illiterate household members in the nonpoor group. Although there is no causality implied yet, it is important to put this into context. Given the theoretical and empirical arguments that education helps households improve their well-being, the most tempting argument in this case could be the failure of the implicit assumptions that resource use efficiency will be improved due to education and/or there is enough market to absorb skilled labor. In these countries, there is little or no evidence that educated household members stay on farm to influence resource efficiency and it is well documented that there is a very small market for skilled labor. We therefore argue that the uneducated members of the communities are taking agriculture – the mainstay of life in all study areas – seriously and hence enjoying a relatively better life, at least using financial yardsticks. Education’s not-so-straightforward relationship with poverty in the region has also been reported by, among others, Bruck (2001) and Datt et al. (2004).

### 4.4. Determinants of poverty

The quantile (median) regression model estimated to explain the household-level absolute poverty (measured in per capita reported daily income and expenditure) has shown that different factors influence poverty comparably across countries. The econometric results are reported only for Malawi, Mozambique, and Zambia.

#### 4.4.1. Malawi

Possession of assets such as farm land, livestock, bicycles, telephones (fixed and mobile); houses with modern

| Dependent Variable – Γ* | Coefficient | Std. Err. | t |
|-------------------------|-------------|-----------|---|
| Constant                | 2.041***    | 0.584     | 3.500 |
| Age of household head   | −0.004      | 0.006     | −0.700 |
| Household head is illiterate (1 = yes) | 0.162 | 0.234 | 0.690 |
| Female-headed household (1 = yes) | −0.117 | 0.247 | −0.480 |
| Dependency ratio        | −0.060      | 0.076     | −0.790 |
| Number of household members engaged in off-farm activities | 0.061 | 0.058 | 1.050 |
| Average education of the household in years | −0.088 | 0.062 | −1.420 |
| Number of bicycles owned | 0.188* | 0.105 | 1.790 |
| Household owns phones (1 = yes) | 0.850*** | 0.233 | 3.640 |
| Household owns radio (1 = yes) | −0.145 | 0.199 | −0.730 |
| Household has improved roofing (1 = yes) | 0.494** | 0.200 | 2.470 |
| Received any credit (1 = yes) | 0.450* | 0.233 | 1.930 |
| Number of farm plots    | −0.316***   | 0.090     | −3.500 |
| Farm size (ha)          | 0.623***    | 0.115     | 5.430 |
| Land allocated to maize (% of total land) | 0.341 | 0.420 | 0.810 |
| Livestock wealth (TLU)  | 0.046*      | 0.025     | 1.820 |
| Continuous user of improved maize (1 = yes) | −0.199 | 0.190 | −1.040 |
| District (1 = Balaka)   | −0.222      | 0.209     | −1.060 |

N = 92
Raw sum of deviations = 81.955
Min. sum of deviations = 51.935

***Significant at alpha < 0.01.
**Significant at alpha < 0.05.
*Significant at alpha < 0.1.
roofing; and access to credit were found to be positively related to the well-being of sample households in Malawi. Earlier studies have also reported similar results that better-off households are characterized by asset accumulation involving livestock and off-farm income sources (Benson, Chamberlin, and Rhinehart 2005; Ellis and Ade Freeman 2004; Mussa and Pauw 2011). On the other hand, the number of farm plots was found to be negatively related to the well-being of the households (Table 7).

Asset wealth is known to have a positive contribution on the well-being of households. In rural areas of Malawi, in particular, owning livestock means having a buffer for trying times. The propensity to keep livestock might arise from initial wealth and yet proves to be positively influencing the spending the household is able to make. Given the importance of crop farming, the positive relationship between farm size and household-level well-being is also expected. Nonetheless, the negative relationship between number of plots, which indicates land fragmentation probably more than anything else, and well-being implies the need for farm land consolidation. Consolidation of farmlands would apparently increase farmers’ financial performance as they will certainly reduce the cost of their crop production per unit of land.

More importantly, ownership of cell phones was found to be highly significant and positively influencing the well-being of the households. This implies the importance of access to information and better networking in terms of opening up opportunities and reducing uncertainties in making production and marketing decisions. Thus, it is imperative to highlight the importance of developing communication infrastructure and access to information in rural areas of Malawi to improve livelihoods. The importance of bicycles in Malawian rural areas cannot be overemphasized as it is serving as the main means of transportation to and from the market. Accordingly, the positive relationship between number of bicycles owned and well-being implies the direct and positive effect the asset has on the economic viability of a given household. In fact, one can easily see the role bicycles are playing by looking at the deftly arranged loads of fuel wood or grain along the main roads to and from rural Malawi. Households who own houses with improved roofing were also better off than those who live in thatched or other traditional roof houses. Clearly, this is related to the additional cost households have to incur in maintaining or attending to their ailments that happen due to exposure to harsh temperature levels or even flooding while living under poorly built roofs.

In line with this, access to agricultural credit, as expected, positively influences the well-being of the households apparently through increasing their propensity to invest in productivity-enhancing inputs and probably postponing selling decisions when prices are not right.

### 4.4.2. Mozambique

Regression results for Mozambican households showed that engaging in off-farm activities, asset (such as bicycles, livestock, and farm size) ownership, and being in Mossurize district (as compared to Sussundega) are positively related to the well-being of the households. Previous

| Dependent Variable – Γ* | Coefficient | Std. Err. | t |
|--------------------------|-------------|-----------|---|
| Constant                 | 1.055***    | 0.331     | 3.180 |
| Age of household head    | 0.003       | 0.004     | 0.870 |
| Household head illiterate (1 = yes) | -0.244*      | 0.130     | -1.870 |
| Female-headed household (1 = yes) | -0.471*** | 0.163     | -2.880 |
| Dependency ratio         | -0.004      | 0.045     | -0.080 |
| Number of household members engaged in off-farm activities | 0.180*** | 0.048     | 3.710 |
| Average education of the household in years | 0.019       | 0.025     | 0.750 |
| Number of bicycles owned | 0.104**      | 0.052     | 1.990 |
| Number of cell phones owned | -0.183    | 0.117     | -1.560 |
| Received any credit (1 = yes) | -0.475*      | 0.254     | -1.870 |
| Number of farm plots     | -0.037      | 0.057     | -0.650 |
| Farm size (ha)           | 0.019**      | 0.008     | 2.390 |
| Land allocated to maize (% of total land owned) | -0.128 | 0.236     | -0.540 |
| Livestock wealth in TLU  | 0.111***     | 0.032     | 3.510 |
| Continuous user of improved maize (1 = yes) | 0.137       | 0.113     | 1.210 |
| District (1 = Mossurize)  | 0.225**      | 0.110     | 2.030 |

N = 264
Raw sum of deviations = 188.047
Min. sum of deviations = 153.021

***Significant at alpha < 0.01.
**Significant at alpha < 0.05.
*Significant at alpha < 0.1.
works have also shown the strong and positive impact of off-farm activities (Datt et al. 2004) and asset accumulation (Bruck 2001; Datt et al. 2004) on welfare in rural Mozambique. On the contrary, households who are headed by females or illiterates, and those who have exposure to rural credit were found to be worse off than otherwise (Table 8). Comparable results on the relationship female-headedness and education of household head have with likelihood of poverty have been reported by Bruck (2001) and Datt et al. (2004).

In line with the theory of diversification of income sources, the results show that as the number of household members engaged in off-farm activities increases, the well-being of the household improves. The importance of off-farm income sources in reinforcing rural livelihoods is a well-proven theory that applies to Mozambican farmers. It is interesting, nonetheless, that access to credit rather worsens household well-being. Poorly designed and implemented rural credit systems can aggravate poverty and hence vulnerability of rural households who rarely have buffer resources to lean on during difficult times. A recent national report on agricultural and rural finance has indicated that transaction costs as well as interest rates of agricultural credit are high in rural Mozambique. Most credit products in the market that could be used by those in rural areas with little income have effective annual interest rates of 40–120%. In addition, many households have to use credit products designed for other types of activities to satisfy their agricultural needs. While other business activities might be able to pay the high prices involved, agriculture typically has lower margins and is less able to do so (Hunguana et al. 2012). This finally leads to erosion of assets and hence poverty.

The importance of assets in the viability of the households’ economy is quite clear and verifies the arguments made by earlier researches (Hanlon 2007). Bicycles serve the same purpose as in Malawi, being essentially the main means of transportation for the rural households. Hence, owning a bicycle enables the smooth flow of production and marketing activities, thereby reducing the cost of life altogether. The bigger the farm size a household owns, the better its well-being. Being the most important asset for the farming community, this influence of farm land size is again expected. Livestock wealth is also important in the sample districts of Mozambique as a source of cash and security, and hence positively influencing the well-being of the household.

Households in Mossurize district were found to be better off compared to those in Sussundenga district. There can be so many reasons why this is so and yet it is clear that farming communities in Mossurize do have access to bigger markets such as Maputo.

Households headed by females and illiterates were found to have less and less spending per adult equivalent. The fact that women were structurally incapacitated over the years due to sociocultural and political-economic phenomena makes female-headed households poorer and less likely to fare as much as the male-headed ones. Similarly, households headed by illiterates can hardly deal efficiently with the challenges they face and/or exploit

| Dependent Variable – Γ* | Coefficient | Std. Err. | T    |
|-------------------------|-------------|-----------|------|
| Constant                | −1.423***   | 0.177     | −8.050 |
| Age of household head   | −0.005***   | 0.002     | −2.630 |
| Household head is illiterate (1 = yes) | −0.063 | 0.101 | −0.620 |
| Female-headed household (1 = yes) | −0.098 | 0.075 | −1.300 |
| Dependency ratio        | 0.126***    | 0.021     | 5.960 |
| Number of household members engaged in off-farm activities | 0.034** | 0.017 | 1.990 |
| Average education of the household in years | 0.083*** | 0.015 | 5.350 |
| Number of bicycles owned | 0.273*** | 0.041 | 6.730 |
| Number of cell phones owned | 0.718*** | 0.076 | 9.410 |
| Number of plowing animals owned | 0.029** | 0.013 | 2.270 |
| Received any credit (1 = yes) | 0.291*** | 0.077 | 3.790 |
| Number of farm plots    | 0.119***    | 0.024     | 4.900 |
| Farm size (ha)           | 0.005***    | 0.001     | 7.800 |
| Land allocated to maize (% of total land owned) | 0.286** | 0.118 | 2.430 |
| Livestock wealth in TLU  | 0.089***    | 0.007     | 11.830 |
| Continuous user of improved maize (1 = yes) | 0.394*** | 0.071 | 5.510 |
| District (1 = Monze)     | 0.299***    | 0.057     | 5.240 |

N = 323
Raw sum of deviations = 320.10
Min. sum of deviations = 244.20

***Significant at alpha < 0.01.
**Significant at alpha < 0.05.
*Significant at alpha < 0.1.

Pseudo $R^2 = 0.24$ (about 0.9)
opportunities. The knowledge and skills developed through education are paramount in enabling and empowering individuals. Heading a household under limited resources is a challenge and with limited personal capabilities, even worse.

4.4.3. Zambia

Only dependency ratio was found to be unexpectedly positively influencing well-being in Zambian sample households. Otherwise, all asset wealth-related variables, that is, number of bicycles, cell phones, and ploughing animals owned, number and size of farm plots, access to credit, number of household members engaged in off-farm activities, average education of the household members in years, proportion of total land allocated to maize, continuous use of improved maize varieties, and residing in Kalomo district were all found to be positively influencing the well-being of the sample households (Table 9). Earlier studies by Chapoto et al. (2011) and Kapungwe (2004) have also reported a positive and strong relationship between education, asset wealth, off-farm activities, and welfare of households.

The importance of assets in positively influencing well-being has already been discussed above in Malawian and Mozambican cases. In this case both number and size of farm plots are positively related to household well-being. This might have happened because the plots are close to each other and to the residence of the household with no significant bearing on costs of production and marketing. Access to credit and engagement of household members in off-farm activities are also positively related to the well-being of Zambian farming households. The average literacy – in years of education – of the household was, as expected, positively related to well-being as well. Households in Kalomo were also found to be better off than their counterparts in Monze. One possible explanation can be the distance of Monze from the urban areas such that their sources of income and hence spending are limited.

In the case of Zambia, we have also observed that the proportion of farm area allocated to maize and continuous use of improved maize varieties do positively influence well-being. This is an important finding in view of the fact that the sample population can be characterized as essentially semi-subsistent with limited market orientation. This finding also justifies the effort being exerted on development and deployment of maize and maize-related technologies in rural Zambia.

5. Conclusion

Measuring poverty based on reported income and expenditure is as informative as any other approach. The poverty and inequality measures we computed based on reported expenditure seem to be more reasonable than those generated based on reported income. This is in line with the experiences documented in Africa and elsewhere in the world (Haughton and Khandker 2009; UN 2005). Local currency equivalents of measurement error corrected for relative poverty lines were used along with absolute poverty line in the poverty analysis. Household-level determinants of poverty were identified using quintile regression with household size as an analytic weight.

This study has robustly revealed that livelihoods of poor households in the rural districts studied are heavily dependent on maize production. Particularly in Zambia, an increase in the proportion of farm area allocated to maize and continuous use of improved maize varieties were found to strongly and positively influence the well-being of these rural households. The findings justify the need for focused and pro-poor maize technology development for and dissemination into these communities. Despite the strong argument that in many rural areas poverty is essentially a result of heavy reliance on food crop agriculture and low commercialization of the economy (Ellis and Ade Freeman 2004), it is important to rural households that they achieve their primary objective, that is, producing enough food for the family.

Possession of assets such as farm land, livestock, bicycles, telephones (fixed and mobile), houses with modern roofing, and access to credit was found to be positively related to the well-being of sample households in Malawi. On the other hand, number of farm plots was found to be negatively related to the well-being of households.

For rural households in Mozambique, engagement in off-farm activities, asset – such as bicycles, livestock, and farm size – ownership, and being in Mossurize district (as compared to Sussundenga) are positively related to the well-being of households. On the other hand, households who are headed by females or illiterates and unexpectedly those with access to rural credit were found to be worse off than otherwise.

Only dependency ratio was found be unexpectedly positively influencing well-being in Zambian sample households. Otherwise, all asset wealth-related variables, that is, number of bicycles, cell phones, and ploughing animals owned, number and size of farm plots, access to credit, number of household members engaged in off-farm activities, average education of the household members in years, proportion of total land allocated to maize, continuous use of improved maize varieties, and residing in Monze district were all found to be positively
influencing the well-being of the sample households. Only age of the household head was found to be negatively related to household well-being.

The importance of asset wealth in positively enhancing the well-being of rural households has been reported by other studies in the region (Benson, Chamberlin, and Rhinehart 2005; Bokosi 2006; Ellis and Ade Freeman 2004; Mukherjee and Benson 2003; Mussa and Pauw 2011). Generally, education and asset accumulation are crucially important in determining the well-being of the households in the rural communities of the study countries. Accordingly, investment in rural education, rural financing, and market participation would have a profound impact in these rural communities. The impact will be enhanced if the investments are designed with due emphasis on the disadvantages of women and female-headed households.

We would like finally to emphasize the need for further study on the depth and determinants of poverty in the region. Future studies need to see the dynamics in poverty and inequality with longitudinal observations on resource generation and management, access and use of social services, and participation in labor markets (including remittances) with due consideration of gender and age heterogeneities within the household.

Acknowledgments
This research project was funded by the Bill & Melinda Gates Foundation (BMGF) and the Howard G. Buffett Foundation (HGBF). The project is part of a broad partnership, known as the Drought Tolerant Maize for Africa (DTMA) Initiative, that involves national agricultural research and extension systems, seed companies, nongovernmental organizations (NGOs), community-based organizations (CBOs), and advanced research institutes. Its activities build on longer term support by other donors, including the Swiss Agency for Development and Cooperation (SDC), the German Federal Ministry for Economic Cooperation and Development (BMZ), the International Fund for Agricultural Development (IFAD), the United States Agency for International Development (USAID), and the Eiselen Foundation.

Notes
1. Africa’s population stood at about 0.911 billion in 2005 (UNdata 2010).
2. Under the declaration in 2003 in Maputo Mozambique, all SADC countries signed to spend at least 10% of government expenditure on agriculture.
3. It is referred to in the literature as $1.00 absolute poverty line. Note that it is different from the $2.00 poverty line which is used as frequently as the $1.00 threshold.
4. PPP data were generated from http://unstats.un.org/unsd/mdg/ SeriesDetail.aspx?sr=699 and http://research.worldbank.org; CPI data were generated from http://www.imf.org/external/pubs/cat/longres.cfm?sk=17165.0; and inflation rate data were generated from http://www.economywatch.com/economic-statistics/economic-indicators/

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