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Poverty Reduction Potential of Increasing Smallholder Access to Land

by

Munguzwe Hichaambwa and T. S. Jayne

Working Paper 83

March 2014

Indaba Agricultural Policy Research Institute (IAPRI)
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EXECUTIVE SUMMARY

Background

Economists have long held that broad-based agricultural growth is the most powerful source of poverty reduction in developing countries where most of the rural population is engaged in agriculture (Johnston and Mellor 1961; Mellor 1974; Lipton 2006). However, in Zambia's case, despite sustained and fairly robust agricultural growth since 2000, rural poverty levels have remained at about 80% over the past 15 years. This indicates that productivity in the agricultural sector needs to be increased, especially considering that no country, apart from the island economies of Singapore and Hong Kong, has been able to sustain rapid transition out of poverty without raising the productivity in its agricultural sector. Over 70% of Zambia's agricultural households are small-scale farmers cultivating less than two hectares of land. A form of agricultural growth in which this group effective participates in the growth process is likely to be one of the only effective ways of achieving rapid reductions in rural poverty in Zambia.

Agricultural development and poverty reduction strategies in Zambia, and Sub-Saharan Africa more generally, are typically founded on a handful of common elements: scaling up the use of modern inputs and other appropriate technologies through government input promotion programs, extension services, and market development efforts; enhancing land tenure security and access to land through land markets for rentals and sales; lifting pervasive financial constraints through microfinance programs, reshaping financial services for smallholders; improving farmers' access to markets through producer organizations, marketing boards, and broader value chain development. Most of these programs are featured in Zambia's Comprehensive African Agriculture Development Program (CAADP) and Sixth National Development Program (SNDP) programs (Government of the Republic of Zambia (GRZ) 2011a; GRZ 2011b). However, conspicuously silent in most agricultural development and poverty reduction programs are addressing land constraints and rural population pressures in many customary lands. In many areas where the majority of the rural population live, unallocated land appears to be unavailable, particularly in areas close to urban areas and district centers, and along major highways. Many smallholder farming areas have become enclaves that cannot expand because of claims and titles on adjacent lands. Steady rural population growth therefore results in more rural households over time, subdivision of land, and smaller farm sizes without much expansion in the amount of land under cultivation. Actually less than half of Zambia's rural populations perceive some unallocated arable land to be available for allocation in their villages.

Analysis of nationwide representative data shows that smallholders in Zambia largely own and cultivate small pieces of land of land. According to the Rural Agricultural Livelihoods Survey (RALS) of 2012, 64% of the smallholder farmers own less than two hectares while about 70% cultivate less than two hectares of land. Smallholders who cultivate less than two hectares of land account for only about 31% of all agricultural output in the country, although they are the majority, which means that these farmers participated marginally in the agricultural growth through maize bumper harvests of recent years. These farmers received relatively little subsidised fertiliser and sold very little maize, hence they were unable to benefit from the Government supported producer price. The farmers benefiting the most from the government's expenditures on supporting maize prices were clearly those selling the most maize.

Conventional wisdom would expect these smallholders to earn more of their livelihood through off-farm income sources. Evidence shows that while the income share of off-farm employment for these farmers (39%) is indeed higher than those cultivating 10 to 20 hectares (16%) the amount earned in absolute terms is more than 5 times higher among the latter group. Off-farm employment opportunities have not been sufficient vibrant to date to provide a pathway out of poverty for land-constrained farm households in Zambia. It is no wonder that poverty rates (per capita income of less than U.S. Dollar (US$)1.25 per day) are much higher among these farmers (83% compared to 15%). The fact that agricultural growth has not been broadly based contributes to this outcome, because the employment multipliers from agricultural growth restricted to a relatively narrow segment of larger farmers inhibit the strength of the employment multipliers generated.

Study Objectives

This study determines the relationship between household farm size and agricultural commercialization. In so doing, we aim to explore the curious weak link between Zambia's agricultural growth and rural poverty reduction trends over the 2000-2012 period. Using various nationally representative data sets, we determine how broadly based Zambia's agricultural growth has been over the past decade, disaggregating growth and commercialization trends by farm size category. We then relate our findings to broader international literature (e.g., Timmer 1988; Ravallion and Datt 2002) suggesting that the contribution of agricultural growth to rural poverty reduction is neither deterministic nor assured; the initial distribution of productive assets (of which land is likely to be the most important in primarily agrarian societies) influences how inclusive the process of agricultural growth can be.

Data and Methods

The study uses a data set with 22,239 observations developed by pooling three nationally representative surveys of the 2004 and 2008 Supplemental Surveys and the 2012 RALS. These surveys collected information of smallholder rural livelihood in addition to agricultural production and marketing with respect to the 2002/3, 2006/7 and 2010/11 seasons.

It employed the lognormal double hurdle model in which Equation 1 formed the probit part and Equation 2 the lognormal regression part of the model. The double hurdle model is popular in analyzing smallholder market participation as it allows for two separate stochastic processes of market participation and the extent of level of market participation in its respective equations.

Findings and Policy Implications

Results show that there is a significant positive relationship between farm size and smallholder agricultural sales. Increasing smallholder farm size by 1%, other factors held constant, is associated with a 0.13 percentage point increase in the probability that a farmer will participate in agricultural output markets. To put these findings in perspective, a percentage increase in farm size would on average increase smallholder agricultural sales by only 0.38% among all smallholders and by 0.84% among selling smallholders all other factors held constant.

To demonstrate the poverty reduction potential of increasing smallholder farm size, we use the partial effect of each observation in the data set to estimate the expected new agricultural sales, total household income and ultimately poverty rates by: 1) leaving the farm sizes as they are; 2) increasing farm size by 1 Ha; and 3) increasing farm size by 2 Ha.

Increasing farm size by 1 hectare (Ha) is associated with an increase in agricultural sales sufficient to reduce the poverty rate from 86% to 53% among households starting out with less than 1 hectare. A one-hectare increase in farm size reduces poverty rates for the other farm size categories by 44 to 50% range. Among the entire sample, a one-hectare increase in farm size is associated with a reduction in rural headcount poverty rates from 84% to 48%. Not only are the poverty rates drastically reduced but household incomes become more equitably distributed as well.

This analysis has shown that small farm size is a very important factor constraining smallholder agricultural commercialization and poverty reduction among the 70% of farms less than two hectares in Zambia. Promoting access to land among this large group constitutes an important means (but certain not the only means) for promoting broad-based smallholder commercialization and structural transformation processes.

Therefore, current efforts for increasing smallholder technology adoption and productivity can be effectively complemented with those aimed at increasing the average farm size from prevailing levels to the 3-5 Ha range from which significant agricultural sales can be achieved. The target, resources permitting, should be to reach 10-12 Ha as the average smallholder farm size that can both produce significant crop surpluses as well as provide the means for subdivision to support rural livelihoods among the next generation, which would then buy another 20-30 years for demographic and economic transitions to take place that would eventually shift the majority of the labor force into non-farm employment. A policy that supports migration to areas of land abundance would entail basic public goods investments in fertile regions suitable for agricultural commercialization. Such investments would include trunk highways, health care facilities, schools, electrification, irrigation etc. to open up more land for cultivation in agro-ecologically suitable areas that are currently under-utilized.

This approach is likely to provide a more equitable pattern of agricultural growth and poverty reduction than the current emphasis on farm block development program, for two main reasons. First the smallest sizes in these farm blocks (30 - 50 Ha) are too big for the majority of the smallholders and as result the farm blocks can each only accommodate very few. Second, the majority of the smallholders lack the necessary resources and knowledge to effectively participate in the farm block allocation process. Therefore, in its current form, the farm block development program cannot increase access to land except for small proportion of farmers, very few of which are likely to be land-constrained smallholder farmers. We hope that this analysis will stimulate broader discussions in Zambia about how to achieve sustainable and equitable patterns of rural development over the coming several decades, how to make agricultural growth more inclusive, and the role of land allocation policies in achieving these important goals.

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ACRONYMS

APE	Average Partial Effect
CAADP	Comprehensive African Agriculture Development Program
CFS	Crop Forecast Survey
CSO	Central Statistical Office
FAO	Food and Agriculture Organization
FISP	Farmer Input Support Programme
FRA	Food Reserve Agency
FSRP	Food Security Research project
GDP	Gross Domestic Product
GRZ	Government of the Republic of Zambia
Ha	Hectare
IAPRI	Indaba Agricultural Policy Research Institute
IFPRI	International Food Policy Research Institute
MAL	Ministry of Agriculture and Livestock
OLS	Ordinary Least Squares
PHS	Post-Harvest Survey
RALS	Rural Agricultural Livelihoods Survey
SE	Standard Error
SEA	Standard Enumeration Area
SNDP	Sixth National Development Plan
SSA	Sub-Saharan Africa
US$	United States Dollars
ZMW	Zambian Kwacha rebased in January 2013

1. INTRODUCTION

Zambia's economy is generally growing and the country has been classified as a middle-income country by the World Bank. According to the World Bank Development Indicators Database[1], the country's current Gross Domestic Product (GDP) increased from US$19.2 billion in 2011 to US$20.7 billion in 2012, while its annual growth rate increased from 6.8% to 7.3% between the two years. Agriculture's contribution to the GDP stood at 20%, that of industry at 37% and services at 43% during the same period.

The agricultural sector has only grown at an average rate of 3% in the past decade. However, there was significant growth of 12-13% between 2009 and 2011 which was largely attributed to larger maize harvests mostly arising from unusually favorable weather conditions and to government policies promoting maize production (Burke, Jayne, and Chapoto 2010). Despite this impressive agricultural growth in recent years, rural poverty levels according to the Central Statistical Office (CSO) have remained stubbornly high at about 80% in the last 15 years or so.

Economists have long held that broad-based agricultural growth is the most powerful source of poverty reduction in developing countries where most of the rural population is engaged in agriculture (Johnston and Mellor 1961; Mellor 1974; Lipton 2006). Many recent studies from the International Food Policy Research Institute (IFPRI) project a strong deterministic relationship between agricultural growth and poverty reduction (e.g., Thurlow and Wobst 2006). However, in Zambia's case, the sustained and fairly robust agricultural growth since 2000 has not had the anticipated favorable impact on rural poverty rates.

This scenario of agricultural growth accompanied by little change in rural poverty seems to be more widespread in Sub-Saharan African (SSA) than previously thought. Similar stories of rapid economic growth and urbanization with scarcely declining poverty rates and shares of agriculture in total employment has recently been reported in Mozambique by Cunguara et al. (2012), and in Tanzania by Pauw and Thurlow (2011).

It has been acknowledged before (Timmer 2009) that the agricultural sector declines in relation to total economic activity as countries become richer. Therefore, poor countries like Zambia, looking to learn from the structural transformation of the rich countries that has led to where they are, may tend to easily jump to the conclusion that *a world without agriculture* can start sooner rather than later. However, it has been demonstrated before that no country has been able to sustain rapid transition out of poverty without raising the productivity in its agricultural sector, save for the tiny island economies of Singapore and Hong Kong (Timmer 2009). Everywhere else, the process normally involves a successful transition involving rising and broadly-based agricultural productivity, rising rural incomes, increased demand for non-farm goods and services, the growth of non-farm employment, and subsequent demographic processes involving migration, urbanization, reduction in fertility rates, improved returns to education, and major changes in the structure of the economy. Agricultural growth may put downward pressure on food prices, benefitting consumers and promoting urbanization. Timmer (2009) adds that for the process to be triggered the

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[1] http://ddp-ext.worldbank.org/ext/ddpreports/ViewSharedReport?REPORT_ID=9147&REQUEST_TYPE=VIEWADVANCED&DIMENSIONS=226 accessed on 20 August 2013.

agricultural growth and commercialization process must be broad-based, so as to generate income broadly enough among the rural population to stimulate the demand for locally produced non-farm goods and services, and thereby build economic synergies between the urban and rural areas as each provide a market for the other.

Since Zambia's agricultural sector is predominantly composed of smallholder farmers mostly owning less than two hectares of land, a broadly based agricultural growth and commercialization strategy is likely to require a focus on households in this farm size category. The most recent nationally representative farm surveys in Zambia (and most of the region) show that over 70% of the smallholder farms in the country are less than two hectares. The availability of nationally representative farm surveys over the past decade provides the opportunity to disaggregate Zambia's recent impressive agricultural growth and examine the contribution to this growth from various farm size categories.

This study determines the relationship between household farm size and agricultural commercialization. In so doing, we aim to explore the curious weak link between Zambia's agricultural growth and rural poverty reduction trends over the 2000-2012 period. Using various nationally representative data sets, we determine how broadly based Zambia's agricultural growth has been over the past decade, disaggregating growth and commercialization trends by farm size category. We then relate our findings to broader international literature (e.g., Timmer 1988; Ravallion and Datt 2002) suggesting that the contribution of agricultural growth to rural poverty reduction is neither deterministic nor assured; the initial distribution of productive assets (of which land is likely to be the most important in primarily agrarian societies) influences how inclusive the process of agricultural growth can be.

The rest of the paper is arranged as follows: Chapter 2 outlines the study conceptual framework starting with a review of literature on the relationship between smallholder initial asset distribution and agricultural growth followed by a descriptive analysis of the relationship between smallholder farm size, commercialization and poverty using Zambia nationally representative rural household survey data; it then lays down the structural model for the analysis of the effect of smallholder farm size on commercialization and poverty reduction. Chapter 3 describes the data and methods used in the study while Chapters 4 and 5 discuss the study results and conclusions respectively.

2. CONCEPTUAL FRAMEWORK

2.1. Relationship between Iinitial Asset Distribution and Agricultural Growth

There is a direct relationship between smallholder initial asset endowments, of which land is one of the most important, and agricultural growth and poverty reduction. Land ownership inequality is one factor that has been traditionally used to explain high levels of income inequality especially in economies where the agricultural sector predominates (Carter 2000). Deininger and Ohinto (1999), and Deininger and Squire (1998) in Carter (2000) empirically find that initial land ownership inequality retards economic growth in and that land ownership inequality creates low and insecure incomes for the rural poor. Carter (2000) further states that land ownership inequality can have continuing and perhaps increasing effect on income inequality because it can create extraordinary patterns of growth that deepens inequality over time and supports the notion that asset re-distribution in largely agrarian economies could have a major impact on the level of income inequality.

It may be argued that smallholders with the smallest farms could be earning their living largely from non-farm sources. However, in most African countries, off-farm income shares for households in the bottom farm size quartiles are below 40%. Households in the other three farm size quartiles earn even smaller income shares from off-farm sources (Jayne et al. 2003). Because off-farm employment opportunities are growing more slowly than the rise in Zambia's labor force (Central Statistical Office 2007), sustained income growth for the poorest strata of the rural population is likely to depend largely on their being able to earn a decent livelihood from agriculture.

Another finding of major importance in the development economics literature is that egalitarian land distribution patterns tend to generate higher rates of economic growth than concentrated ones (Johnston and Kilby 1975; Mellor 1976; Quan and Koo 1985; Deininger and Squire 1998; Lipton 2010). The basic explanation for this finding is that broad based agricultural growth tends to generate second round expenditures in support of local non-tradable goods in rural areas and towns. These multiplier effects tend to be weaker when the source of agricultural growth is concentrated in relatively few hands.

2.2. Farm Size, Commercialisation, and Poverty

Smallholder farmers in Zambia largely own and cultivate small pieces of land. According to the Rural Agricultural Livelihoods Survey (CSO/MAL/IAPRI 2012), 64% of the smallholder farmers own less than 2 Ha of land while 30% own from 2 Ha to under 5 Ha and only 6% own 5 Ha and above. The nation-wide representative annual Crop Forecast Survey (CFS) data shows that 54% of smallholder farmers in Zambia in the 2010/11 season cultivated all the land they owned, while only 41% cultivated less than they owned and 4% cultivated more than they own (Ministry of Agriculture and Livestock – MAL/CFS 2011). About 62% of those who cultivate more land than they own do not own any land at all but accessed some land through borrowing and renting. The overall proportion of smallholder owned land that is cultivated has always exceeded 75% (CSO/MAL/FSRP Supplemental Surveys 2001, 2004, 2008 and CSO/MAL/IAPRI 2012).

Though the Zambia smallholder sector recorded bumper maize harvests in the three seasons from 2009/10, rural poverty remains stubbornly high despite the fact that the government has spent over 2% of the nation's GDP in supporting maize production and subsidizing inputs for farmers. Jayne et al (2011) note that the smallest farmers cultivating less than 2 Ha who account for over 70% of all the smallholder farms in the country participated only marginally in the maize production expansion of 2010/11. These farmers received relatively little subsidised fertiliser and sold very little maize, hence they were unable to benefit from the Government supported producer price. The farmers benefiting the most from the government's expenditures on supporting maize prices were clearly those selling the most maize.

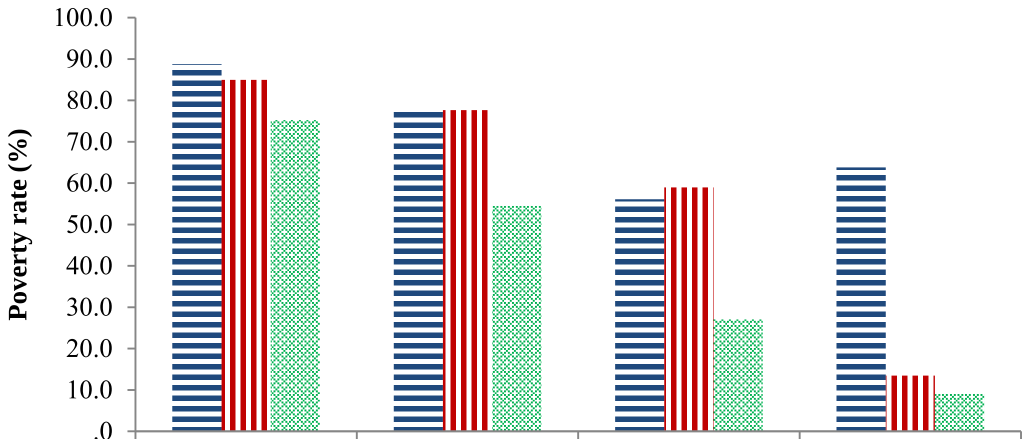
Furthermore, Table 1 shows that these small farmers who account for over 70% of all the smallholders only accounted for 31% of the total value of farm output in the 2010/11 agricultural season. Their income share of crop production is only 57% compared to 76% for those who cultivate the largest land areas. Seemingly, these households' income share from off-farm income is higher at 39% compared to 16% for those who cultivate 10 to 20 Ha but the absolute amounts per household are still much lower. Using the figures in Table 1, it can be estimated that the median income from off-farm income for these farmers is only Zambian Kwacha (ZMW)1,286 per household compared to ZMW8,540 per household for the smallholders that cultivate the largest land areas. This seems to imply that the off-farm income generation is not really a viable option for increased income and poverty reduction for the land-constrained smallholders. It is no wonder that poverty rates (per capita income of less than US$1.25 per day) have remained consistently higher for the household who cultivate smaller areas as is shown in Figure 1). This also implies that these smallholders need to participate more in the agricultural supply chains if rural poverty is to be significantly reduced. In fact Chapoto et al. (2013) report that it is the more commercialised smallholders in Zambia that are able to diversify into non-farm income generating activities.

Table 1. Smallholder Distribution by Cultivated Area and Income Attributes in 2010/11 Season

Area cultivated (Ha)	Per cent of total			Median total income (2011 ZMW)	Per cent income share from			
	%Farm households	Cultivated area	Value of farm output		Crop production	Production of animal/ products	Off-farm income	Total
0 to 0.99	39.0	12.7	20.3	3,322	57.4	4.0	38.7	100.1
1 to 1.99	32.8	27.2	10.7	5,608	69.3	5.0	25.8	100.1
2 to 4.99	24.2	41.7	59.8	9,228	73.6	5.4	21.1	100.1
5 to 9.99	3.4	13.2	7.2	20,355	74.4	7.7	18.2	100.2
10 to 20	0.7	5.2	1.9	54,053	75.9	8.3	15.8	100.1
Total	100.0	100.0	100.0	5,582	65.9	4.8	29.4	100.1

Source: CSO/MAL/IAPRI 2012 and authors' computations.

Figure 1. Poverty Rates by Smallholder Cultivated Area by Seasons



	less than 2 Ha	2 to 4.99 Ha	5 to 9.99 Ha	10 to 20 Ha
2002/3	88.7	78.0	56.1	63.8
2006/7	85.0	77.6	59.0	13.5
2010/11	75.2	54.5	27.1	9.0

Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

2.3. Factors Affecting Smallholder Commercialisation

This section describes the market participation model used to determine the *certeris paribus* effects of landholding size on smallholder commercialization. The market participation model was motivated from an output supply response framework. This means modeling output supply (Y) as:

$$Y = f(X_i, Y_i, W_i, Z_i) \quad (1)$$

where X_i is a vector of input and output prices, Y_i a vector of main Government of Zambia agricultural policy instruments, W_i a vector of long-run agro-ecological conditions and Z_i is a vector of household characteristics. The first set of factors were prices of fertilizer, maize seed and maize grain while the second set was composed of lagged district maize purchases by the Food Reserve Agency (FRA) and a dummy variable equal to one when the household participated in the Farmer Input Support Program (FISP) and zero otherwise. The third set of vectors was composed of 30 years district level average rainfall and dummy variables for agro-ecological zones. The final set of vectors included farm size, adult equivalents, productive assets, and sex, education and age of household head. Chapoto et al. (2013) working on maize, cotton and horticultural commercialization among smallholder farmers reports that household male headedness, educational level of the household head and lagged farm size positively and significantly affected smallholder commercialization while the opposite is the case with age of household head especially with respect to the horticultural sub-sector. In view of the foregoing and based on variables available in the three data sets used, the following were used for analysis as factors affecting smallholder commercialization or agricultural sales:

1) Maize price measured as the farm gate price collected for the 1999/2000, 2002/3, 2006/7 and 2010/11 seasons during the rural nation-wide household surveys conducted in 2001, 2004, 2008 and 2012 respectively;
2) Fertiliser price;
3) Maize seed price;
4) Government agricultural policy instruments represented by:
    a) Maize input subsidies provision through FISP as captured by household participation in the programme; and
    b) Maize marketing support through pan-territorial above market prices and purchasing from every willing and able smallholder measured by the lagged FRA district purchases;
5) Landholding size;
6) Labour, measured as household adult equivalents;
7) Resource endowments, measured as the value of productive assets including farm implements and livestock;
8) Sex of the household head – male and female heads in rural Zambia have different competing gender roles and this is bound to affect their application of agricultural production practices;
9) Educational level of household head;
10) Age of the household head – better experience expected with age while relatively younger household heads may be more dynamic and amenable to innovative and productivity enhancing techniques;
11) Environmental conditions, measured by:
    a) 30 years average district rainfall;
    b) Agro-ecological zone; and
    c) The different seasons during which data was collected.

Using the above factors, the probability that smallholder households will participate in agricultural output markets is given by:

$$\text{Probit}(E(dy)) = \beta_0 + \beta_1 lmzp + \beta_2 ladp + \beta_3 lrain + \beta_4 larea + \beta_5 lasset + \beta_6 laehh + \beta_7 lage + \beta_8 leduc + \beta_9 lfra + \phi_1 fisphh + \phi_2 female + \phi_3 year2008 + \phi_4 year2012 + \phi_5 zone2a + \phi_6 zone2b + \phi_7 zone3 + \mu \quad (2)$$

Where:

dy is 1 when the household sold and 0 otherwise;
lmzprice is log of maize price;
lsdp is log of maize seed price;
lrain is log of 30-year rainfall average
larea is the log of household farm size in m^2 (farm size is defined as the area controlled by the household, including both area cultivated, left in fallow, and uncultivated);

lasset is the log of total value in ZMW of household productive assets including livestock and farm implements;
laehh is the log of total number of household adult equivalents;
lfra is the log of the lagged FRA district maize purchases;
fisphh is a binary variable equal to 1 when the household participated in the FISP and zero otherwise;
female is a binary variable representing female headed households (compared to male headed ones=0);
lage is the log of the age of the household head;
leduc is the log of the highest level of education of the household head in years;
year2008 is the binary variable representing the 2006/7 agricultural season (compared 2002/3 season=0);
year2012 is the binary variable representing the 2010/11 season (compared 2002/3 season=0);
zone2a, zone2b, and *zone3* are the binary variables representing the agro-ecological zones IIA, IIB, and III respectively compared to zone I: and
μ is a randomly distributed error term which also represents the other unobserved factors.

The β_0 is the estimated intercept while the β_1 *to* β_9 and ϕ_1 *to* ϕ_7 are the estimated coefficients for the respective explanatory variables.

The factors determining the value of smallholder agricultural sales on the other hand can be represented by the regression framework:

$$Y = \beta_0 + \beta_1 lmzp + \beta_2 ladp + \beta_3 lrain + \beta_4 larea + \beta_5 lasset + \beta_6 laehh + \beta_7 lage + \beta_8 leduc + \beta_9 lfra + \phi_1 fisphh + \phi_2 female + \phi_3 year2008 + \phi_4 year2012 + \phi_5 zone2a + \phi_6 zone2b + \phi_7 zone3 + \mu \quad (3)$$

Where y is the log of the value of agricultural sales and the other notations remain as described under equation 2 above.

3. DATA AND METHODS

The study used three nationally representative data sets containing a total of 22,234 observations. First and second are the supplemental surveys carried out in 2004 and 2008 by CSO in conjunction with MAL and Michigan State University's Food Security Research Project (FSRP), now the Indaba Agricultural Policy Research Institute (IAPRI)[2]. These were the second and third panel surveys linked to the 1999/2000 Post Harvest Survey (PHS) which collected information on all rural livelihood aspects in addition to agricultural production with respect to the 2002/3 and 2006/7 agricultural seasons respectively. The data set contained 5,369 households from 394 Standard Enumeration Areas[3] (SEAs) which were interviewed in 2004, of which 78% were re-interviewed in 2008. The total number of observations from the 2008 survey was 7,967, of which 53% were panel households interviewed in 2004 as well. Due to attrition between the two panel survey waves, attrition bias is a potential concern and we used the significance of the re-interview variable to test for attrition bias but fail to reject the null of no attrition bias in both models ($p>0.10$).

The third survey utilized was the Rural Agricultural Livelihoods Survey (RALS) conducted in 2012 by IAPRI in conjunction with CSO and MAL as a new wave of panel surveys using a new sampling frame based on the 2010 Census of Population and Housing. The survey contributed 8,721 household interviews in 442 SEAs with respect to the 2010/11 agricultural season. The three data sets were pooled into a single cross section for analysis but with provisions for controlling for the year or agricultural season. Commodity prices and/or values were all inflated to 2011 levels using the CSO Consumer Price Indices. Data on FRA district maize purchases was obtained from FRA.

The study employed the lognormal double hurdle model in which Equation 1 formed the probit part and Equation 2 the lognormal regression part of the model. The double hurdle model is popular in analyzing smallholder market participation as it allows for two separate stochastic processes of market participation and the extent of level of market participation in its respective equations.

The market participation Average Partial Effect (APE) from the first equation was estimated using probit with margins while the conditional APE from the second equation was estimated using ordinary least squares (OLS) regression. The participation APE estimated the effect of various factors in the structural model on smallholders' probability to participate in agricultural output markets, while the conditional APE estimated the effects of these factors on the value of smallholder agricultural sales among market participants. The total or overall or unconditional APE was estimated following the modified post-estimation syntax provided by Burke (2009). The standard errors (SE) and p values of the unconditional APEs were estimated through bootstrapping.

The dependent variable used was the household has agricultural sales=1, 0 otherwise for the probit part and log value of agricultural sales for the truncated regression part. All continuous explanatory variables were transformed to log in order to have a uniform and comparable interpretation of the APE. Because the dependent and explanatory variables are in log form,

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[2] For sampling procedures see Megill 2004.

[3] SEAs are the lowest geographical sampling units used by CSO and were the primary sampling units in the RALS. An Standard Enumeration Area (SEA) typically contains 100-200 households.

the estimated APE is each factor's elasticity of smallholder agricultural sales i.e. the percentage change that will result in agricultural sales following a percentage increase in the factor.

All zero values were recoded to 1 before log transformations in order to preserve the zero values in the model estimation. The farm size in m^2 was used in the transformations rather than the Ha in order to avoid negative log values resulting from small values in Ha. The descriptive statistics of the qualitative and quantitative variables used in the study for the pooled data set are shown in Table 2.

The possibility that smallholders expand farm size as a result of commercialization brings in potential endogeneity problems. Endogeneity was tested and found to be significant in both tiers of the double hurdle model and was controlled for using the Control Function approach.

Table 2. Descriptive Statistics of Variables Used in the Study

Variables	Mean	Median	Maximum	Standard Deviation
Dependent				
Household has agricultural sales=1	0.757	0.000	1.000	.428
Household agricultural sales (ZMW)	1,806	435	49,790	3,991
Explanatory				
Maize price (ZMW/ton)	1,074	1,130	1,367	128
Fertilizer price (ZMW/ton)	2,273	2,100	3,876	950
Seed price (ZMW/ton)	8,868	8,929	13,922	1,569
30 years average rainfall (mm)	990	963	1,329	184
Household in agro-ecological zone I=1	.068	.000	1.000	.252
Household in 1gro-ecological zone IIA=1	.406	.000	1.000	.491
Household in agro-ecological zone IIB=1	.081	.000	1.000	.272
Household in agro-ecological zone III=1	.445	.000	1.000	.497
Household in 2002/3 season=1	.292	.000	1.000	.455
Household in 2007/8 season=1	.381	.000	1.000	.486
Household in 2010/11 season=1	.327	.000	1.000	.469
Household female headed	.238	.000	1.000	.426
Age of household head	47.144	44.000	111.000	15.421
Household adult equivalents	4.683	4.460	32.710	2.318
Level of education of head (years)	5.528	6.000	19.000	3.931
Household productive assets (ZMW)	6,029	860	8,323,300	39,094
Farm size (Ha)	2.170	1.465	60.000	3.169
Number of observations	22,234			

Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

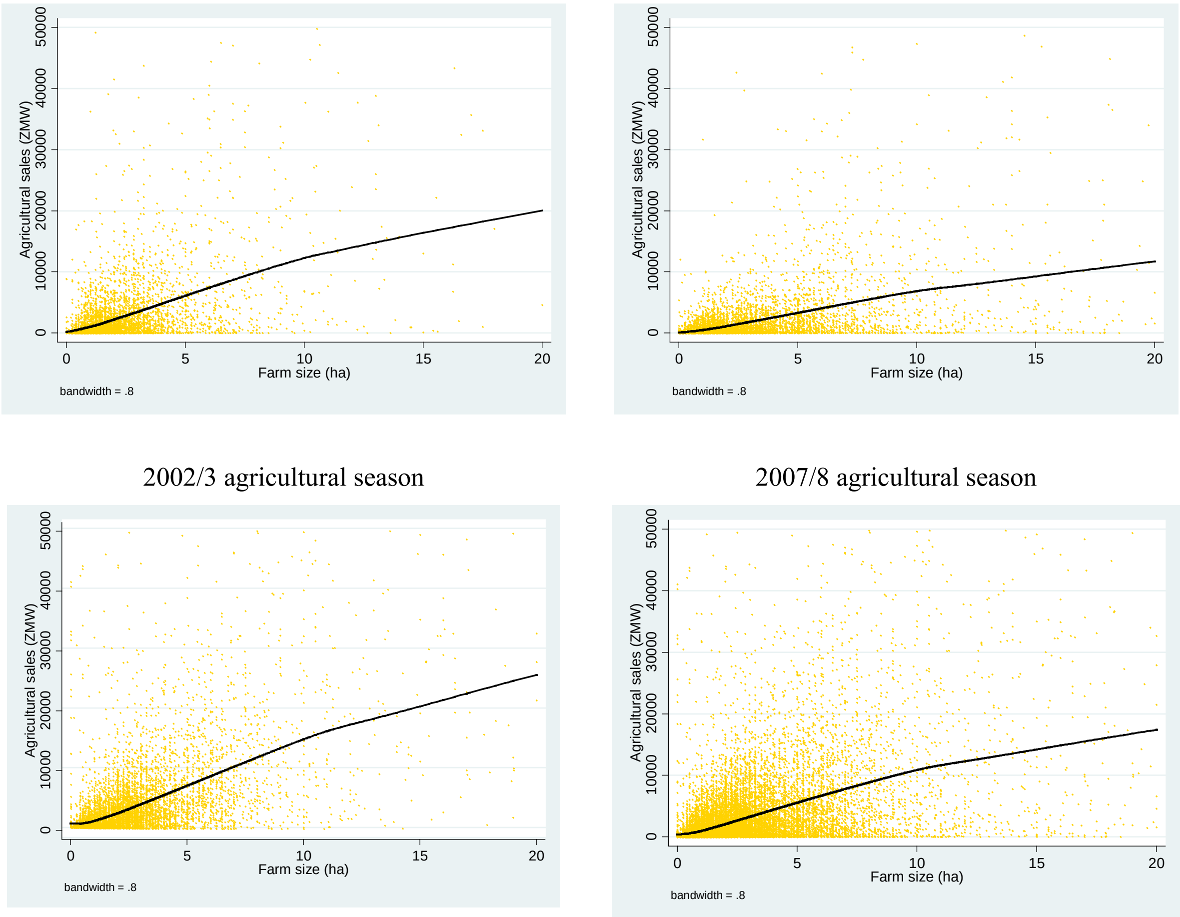
4. RESULTS

4.1. Bivariate Relationships between Farm Size and Agricultural Sales

The graphs in Figure 2 plot the relationship between smallholder farm size and agricultural sales for each of the three agricultural seasons covered in this study as well as for all the three seasons pooled together. All the four graphs show smallholder agricultural sales increasing sharply as farm size increases from 0 to between 8 and 10 Ha after which minimal increases in sales are noticeable if any at all. This suggests that policy strategies that promote investments in increasing farm sizes of the majority of the smallholders who own less than 2 Ha have potentially great pay-offs as far as supporting broad-based agricultural commercialization is concerned.

Further analysis of smallholder agricultural sales by farm size category shows that, smallholders owning less than 2 Ha of land consistently have the lowest value of gross agricultural sales (Table 3), and have the highest proportion of farmers not participating in agricultural markets (Table 4).

Figure 2. Relationship between Farm Size and the Value of Gross Agricultural Sales



2002/3 agricultural season

2007/8 agricultural season

2010/11 agricultural season

All 3 agricultural seasons

Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

Table 3. Distribution of Smallholder Farms and Mean Annual Gross Agricultural Sales, by Farm Size Category by Season (constant 2011 ZMW)

Farm size category	2002/3 Season		2006/7 season		2010/11 season		Total	
	Per cent farms	Mean hh Sales (ZMW)	Per cent farms	Mean hh Sales (ZMW)	Per cent farms	Mean Sales hh (ZMW)	Per cent farms	Mean Sales hh (ZMW)
< 1 Ha	27.6	582	33.7	222	32.4	778	31.5	501
1 to < 2 Ha	34.9	1,423	29.4	761	31.4	1,500	31.7	1,213
2 to < 5 Ha	31.4	3,121	26.6	1,680	30.1	3,406	29.1	2,716
5 ha and above	6.0	7,223	10.2	3,602	6.2	10,124	7.7	6,147
Total	100.0	2,074	100.0	1,115	100.0	2,374	100.0	1,806

Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.
Note: All the means are significantly different from each other at $p<0.01$.

Table 4. Proportion of Households Selling One or More Agricultural Commodities by Farm Size Category

Farm size category	Per cent households selling by season			
	2002/3	2006/7	2010/11	Total
< 1 Ha	53.6	44.2	69.2	55.0
1 to < 2 Ha	79.4	75.0	87.3	80.4
2 to < 5 Ha	86.8	84.4	94.1	88.5
5 ha and above	92.6	89.7	97.9	92.5
Total	75.4	68.6	84.2	75.7

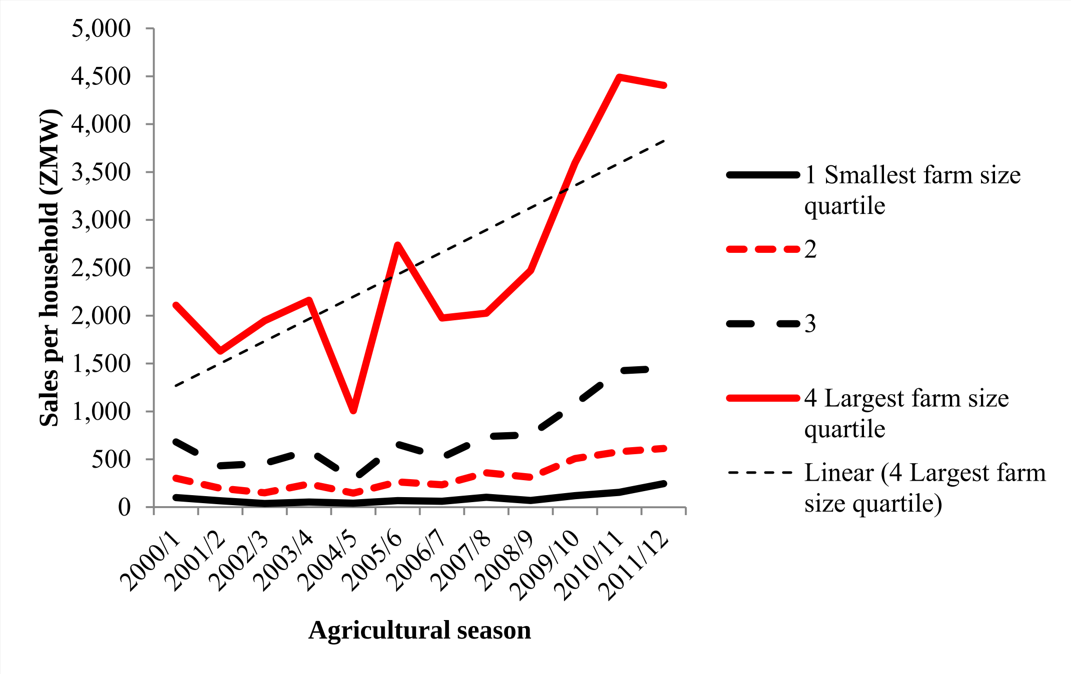
Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

4.2. Relationship between Farm Size, Agricultural Growth, and Poverty Reduction

Analysis of the annual CFS shows that smallholder crop sales which account for over three quarters of agricultural income in Zambia have generally increased by over 100% over the past decade but this growth has occurred mostly with the smallholders with relatively larger farm sizes as is shown in Figure 3. Consequently, poverty rates are only effectively decreasing to less than 50% only for the smallholders in the largest farm size quartile (Figure 4), remaining above 70% for the second largest and close to 80% for the two smallest farm size quartiles.

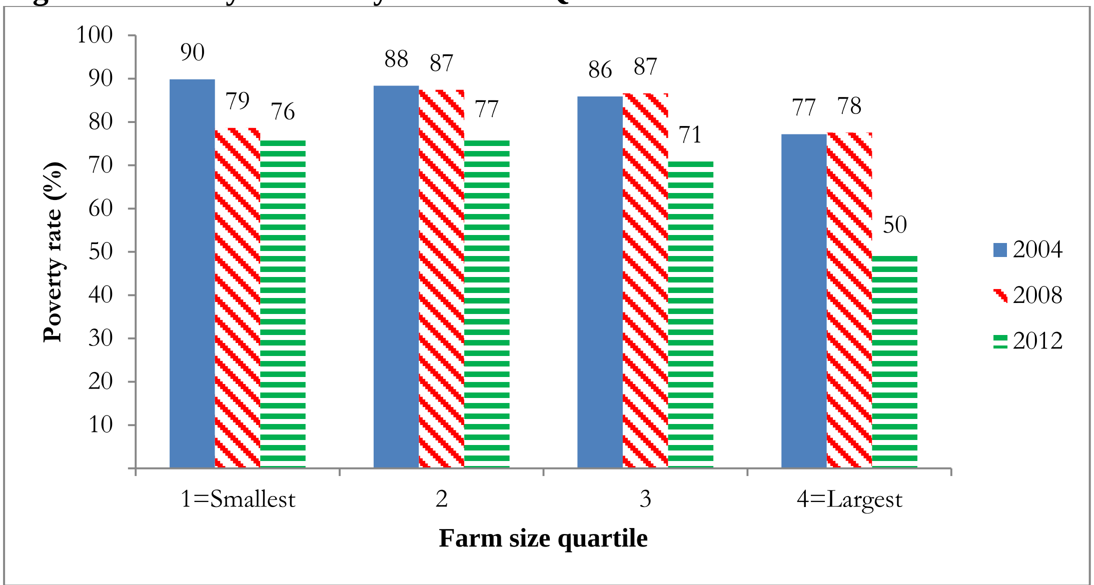
Table 5 shows the changes in agricultural sales and poverty rates between the 2002/3 and 2010/11 seasons by different farm size categories. While agricultural sales for the smallholders with farm sizes less than 2 Ha increased by only 8% from an average of about ZMW1,051 per household per year and poverty rate reduced by 13% to 76%, agricultural sales of the smallholders with larger farm sizes (5 Ha and above) increased by 36-41% from an annual household average of ZMW6,536 – 11,633. It was among these smallholders that poverty rates declined during this period by 36-38% to 26-36% while the overall poverty rate remained high at close to 70%[4].

Figure 3. Trends in Smallholder Crop Sales per Farm Size Quartile at Constant 2011 ZMW Prices



Source: MAL/CSO Crop Forecast Surveys 2000/1 to 2011/12 and authors' computations.

Figure 4. Poverty Trends by Farm Size Quartile



Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

[4] The official CSO rural poverty rates for 2010/11 period had not been released.

Table 5. Smallholder Agricultural Sales Growth and Poverty Reduction by Farm Size (2002/3 to 2010/11)

	Agricultural sales at constant 2011 ZMW		Poverty rate		
Farm size category	2002/3 mean (ZMW)	% Growth (2002/3 to 2010/11)	2002/3	2010/11	%Change
> 2 Ha	1,051	7.8	88.9	75.5	-13.3
2 to >5 Ha	3,121	9.1	81.2	60.5	-20.7
5 to >10 Ha	6,536	35.9	71.9	36.2	-35.7
10 to 20 Ha	11,633	40.6	63.4	25.6	-37.9
Total	2,063	14.8	85.4	68.5	-16.9

Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

4.3. Effect of Farm Size on Agricultural Sales

The full regression results of the lognormal double-hurdle model of factors affecting smallholder agricultural sales are shown in Appendix 1. The results were significant for almost all the factors in both equations of the model except for 30-year district average rainfall. Table 6 shows a summary of the participation, conditional, and unconditional APEs, SEs,[5] and the p values of each of the factors estimated in this model.

Among the input and output prices, *ceteris paribus,* the farm-gate price of maize had the largest positive and significant effect on smallholder agricultural sales as indicated by the unconditional APE (column 9 in Table 6) followed by that of maize seed price. Note was taken that the participation APE (column 1) of maize grain price was not as large and significant as the conditional (column 5) or unconditional one which means that increasing the maize output price seemingly increases agricultural sales among sellers rather than increase the broader smallholder cohort's probability to participate in agricultural output markets.

The fertilizer price was unsurprisingly negatively and significantly related to smallholder agricultural sales as this forms part of the inputs side of the supply function. The opposite was true for the maize seed price even if it is also an input because higher seed price is related to higher quality hybrid varieties which have higher yielding potentials and actually are more productive.

Among the household characteristics, it was noted that female headedness had a negative and significant unconditional APE while the opposite was true for the participation APE while the conditional APE was not significant. This implies that although female headedness of the smallholder households significantly increases the probability of participating in agricultural markets, all other factors held constant, it has no significant effect on the actual extent of the value of sales and actually has a significant negative effect on overall agricultural sales. Age of the household head and number of household adult equivalents had significant and negative APEs which mean that households with older heads and larger family sizes are less

[5] The participation and conditional SEs were estimated using the Delta Method; those of the unconditional APEs were estimated by bootstrapping.

likely to sell agricultural produce and their sales are likely to be smaller, though the unconditional APE of number of adult equivalents was not significant, all other factors held constant.

The household characteristics which have positive and significant APEs are, in order of the size of the APEs, farm size, value of productive assets and years of formal education of the household head. Increasing smallholder farm size by 1% increases the smallholder probability of participating in agricultural market by 0.13 percentage points, all other factors held constant. All in all, there would be significant positive effects with regard to smallholder agricultural sales that would be derived from increasing farm size. A percentage increase in farm sales would on average increase smallholder agricultural sales by 0.31% among all smallholders and 0.79% among selling smallholders all other factors held constant.

With regard to the environmental factors that were controlled for, 30 years average district annual rainfall had little significant effect (none or only at 10% level of probability) on smallholder agricultural sales most probably because the variation in rainfall conditions in the model was captured by the agro-ecological zones and the agricultural seasons in which each observation was made. The agro-ecological zones in Zambia are largely conditioned by the mean average rainfall received as well as the length of the rain season itself with Zone I being in the lowland valley areas receiving less than 600 mm of rainfall per annum; Zone IIA in the main plateau with 800 to 1,000 mm; Zone IIB in proximity to the Zambezi plains with annual rainfall slightly more than 600 mm; and Zone III in the northern parts of the country with average rainfall largely over 1,000 mm but its soils tend to be highly leached and acidic in nature. Agro-ecological Zone IIA had the best APEs as it is the most suitable for agricultural production and productivity in Zambia followed by Zone III.

Table 6. Average Partial Effects of Factors Affecting Smallholder Agricultural Sales

	Participation				Conditional				Unconditional			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Explanatory variables	APE	SE	Aster	p-value	APE	SE	Aster	p-value	APE	SE	Aster	p-value
Output/input prices												
Log maize price	0.427	0.093	***	0.000	3.864	0.663	***	0.000	2.127	0.427	***	0.000
Log fertiliser price	-0.036	0.007	***	0.000	-0.248	0.051	***	0.000	-0.101	0.032	***	0.002
Log seed price	0.040	0.020	**	0.041	0.628	0.147	***	0.000	0.451	0.094	***	0.000
Policy thrust variables												
Log distance to nearest FRA depot	0.001	0.001		0.299	0.026	0.010	***	0.007	0.024	0.006	***	0.000
Household participating in FISP=1	0.022	0.008	***	0.005	0.502	0.053	***	0.000	0.492	0.034	***	0.000
Household characteristics												
Household headed by female=1	0.018	0.008	**	0.020	-0.086	0.059		0.147	-0.174	0.040	***	0.000
Log age of household head	-0.104	0.013	***	0.000	-0.644	0.089	***	0.000	-0.161	0.063	**	0.011
Log household adult equivalents	-0.040	0.009	***	0.000	-0.138	0.065	**	0.034	0.048	0.044		0.273
Log household head years of education	0.023	0.004	***	0.000	0.234	0.031	***	0.000	0.168	0.022	***	0.000
Log household productive assets	0.024	0.002	***	0.000	0.319	0.014	***	0.000	0.249	0.010	***	0.000
Log farm size	0.130	0.014	***	0.000	0.788	0.098	***	0.000	0.308	0.066	***	0.000
Long-run agro-ecological conditions												
Log average 30 years annual rainfall	0.026	0.034		0.445	0.431	0.230	*	0.061	0.271	0.152	*	0.075
Agro-ecological zone IIA=1, base=I	0.130	0.013	***	0.000	1.420	0.107	***	0.000	0.926	0.072	***	0.000
Agro-ecological zone IIB=1, base=I	-0.065	0.021	***	0.002	-0.617	0.147	***	0.000	-0.429	0.110	***	0.000
Agro-ecological zone III=1, base=I	0.099	0.019	***	0.000	0.739	0.137	***	0.000	0.323	0.090	***	0.000
2006/7 agricultural season=1	-0.017	0.012		0.159	-0.666	0.087	***	0.000	-0.819	0.056	***	0.000
2010/11 agricultural season=1	0.039	0.012	***	0.001	0.002	0.086		0.986	-0.176	0.055	***	0.001
Observations	22,057				22,057				22,057			

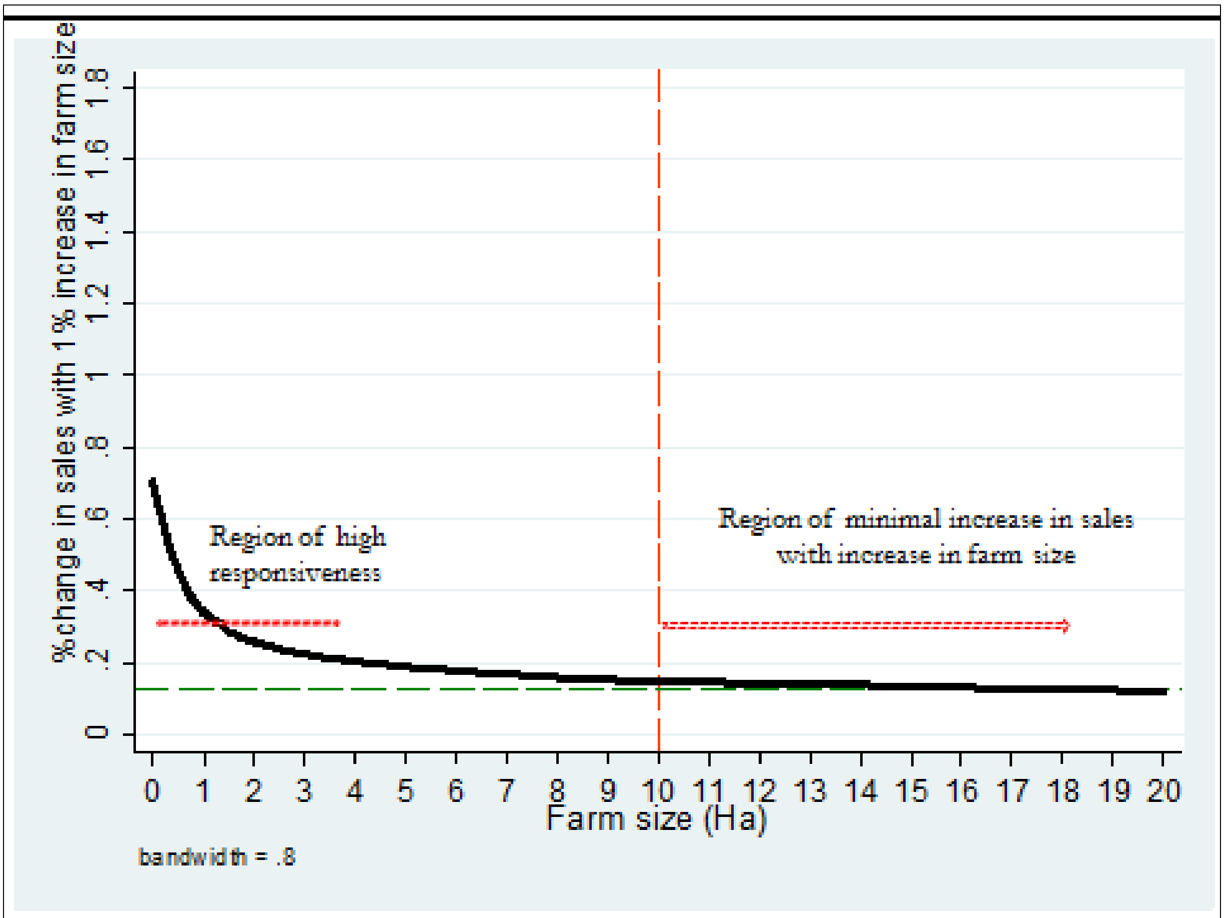
Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.
**** p<0.01, ** p<0.05, * p<0.1*

4.4. Simulation Model for Poverty Reduction Potential

Before simulating the poverty reduction potential of increasing smallholder farm size especially for the most land-constrained, we present in Figure 5 the distribution of the APE of farm size on smallholder agricultural sales by farm size. The figure shows that the percentage increase in agricultural sales associated with a unit percentage increase in farm size all other factors held constant is greatest with lower farm size ranges and increases as farm size increases up to appoint beyond 10 Ha where increase in farm size does not seem to result in any significant increase in agricultural sales. Thus the simulation in increasing farm size is expected to result in a much higher proportional increase in agricultural sales for the smallholders with smaller farms.

To demonstrate the poverty reduction potential of increasing smallholder farm size, we use the partial effect of each observation in the data set to estimate the expected new agricultural sales, total household income and ultimately poverty rates by: 1) leaving the farm sizes as they are; 2) Increasing farm size by 1 Ha; and 3) increasing farm size by 2 Ha.

Figure 5. Distribution of Farm Size and % Change in Sales per 1% Increase in Ha *ceteris paribus*



Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

The results of the simulation are presented in Table 7 by farm size category. Increasing farm size by 1 Ha increased agricultural sales so much that the poverty rate reduced from 86% to 53% for the most land-constrained smallholders (farm size of less than 1 Ha) while the poverty rates for the other farm size categories reduced to the 44-50% range with the overall average reducing to 48% from 84%. Not only were the poverty rates drastically reduced but they were more equitably distributed as well. Increasing farm size by 2 Ha reduced the poverty rates for the most land-constrained smallholders to 46% and the overall average to 38%.

Table 7. Simulated Agricultural Sales and Poverty Rates by Farm Size Category

	Mean agricultural sales (2011 ZMW) and poverty rates (%) per scenario					
	1=Current, mean farm size of 2.17 Ha		2=Farm size increase by 1 Ha, mean farm size of 3.17 Ha		3=Farm size increase by 2 Ha, mean farm size of 4.17 Ha	
Category of farm size	Sales	Poverty rate	Sales	Poverty rate	Sales	Poverty rate
less than 1 Ha	501	85.5	34,935	53.1	69,362	46.2
1 to 1.99 Ha	1,213	88.0	20,707	46.3	40,201	36.2
2 to 4.99 Ha	2,716	81.8	18,774	43.7	34,832	32.1
5 to 9.99 Ha	5,467	70.4	17,508	46.0	29,548	35.7
10 to 20 Ha	9,487	61.6	18,072	49.7	26,657	42.7
Total	1,790	84.0	24,039	47.5	46,239	37.9

Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

5. DISCUSSIONS AND POLICY IMPLICATIONS

The above results have shown that farm size is a very important factor in increasing smallholder agricultural sales and consequently reducing rural poverty. Thus increasing the average smallholder farm size is cardinal if significant smallholder commercialization which can trigger agricultural transformation and lead to broad based rural poverty reduction is to be achieved.

Although it is generally agreed that there is plenty of unutilized arable land in SSA, evidence of smallholders facing land constraints is emerging. For example, the high level expert forum on how to feed the world in 2050 held under the auspices of the Food and Agriculture Organization (FAO) estimate that arable land in developing countries (mostly Latin America and SSA) will expand by 120 million hectares or 12% by 2050 (FAO 2009). Deininger at al. (2011) actually indicate that more than half of land in the world that could potentially be used for expansion of cultivated area is in ten countries, of which six[6] are in Africa. They estimated the currently non-cultivated land suitable for cropping that is non-forested, non-protected, and populated with less than 25 persons/Km^2 (or 20 Ha/household) as 446 million hectares of which 45% is in SSA but 53% of this is located in areas with more than six hours of travel to markets. This is an indication that most of unutilized arable land in Africa in general and in SSA in particular is located relatively away from developed infrastructure.

Furthermore, Jayne, Chamberlin, and Muyanga (2012) report that a significant and growing share of Africa’s farm households live in densely populated areas, exceeding 500 persons/Km^2 which was also estimated as an indicative maximum carrying capacity for areas of rain-fed agriculture in the region. They resolve the apparent paradox of a large proportion of Africa’s rural population living in densely populated conditions amidst a situation of massive unutilized land by changing the unit of observation from land units to people. Though current population densities are not as high as to make access to agricultural land a politically critical issue, smallholder farmers in Zambia face land constraints mostly arising from the limited or non-existent infrastructure in many parts of the country with unutilized arable land. Chapoto et al. (2013) aptly put that increasing rural land pressure and land fragmentation increase the difficulty that smallholders face in consolidating continuous land allocations of sufficient scale to support commercial farming, and in response, many commercialized smallholders confront this problem by relocating to areas where land remains available

Therefore, current efforts to increase smallholder productivity need to be complemented with those aimed at increasing the average farm size from the current 2.17 Ha to the 3-5 Ha range from which significant agricultural sales can be achieved. The target, resources permitting, should be to reach 10 Ha as the average smallholder farm size at which agricultural sales would be maximized. This calls for basic public goods investments in fertile regions suitable for agricultural commercialization to promote voluntary migration into such areas to stimulate a smallholder-based agricultural system. Such investments would include trunk highways, health care facilities, schools, electrification, etc. to open up more land for cultivation in agro-ecologically suitable areas that are currently under-utilized.

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[6] These are Sudan, the Democratic Republic of Congo, Mozambique, Madagascar, Chad, and Zambia.

This is advocated for because the current farm block development program is very unlikely to benefit smallholders for two main reasons. First the smallest sizes in these farm blocks (30 - 50 Ha) are too big for the majority of the smallholders and as result the farm blocks can each only accommodate very few. Second, the majority of the smallholders lack the necessary resources and knowledge to participate in the farm block farm allocation process. Therefore, in its current form, the farm block development program is unlikely to increase many smallholders’ access to land, and consequently cannot be expected to be an effective instrument for broad based rural poverty reduction.

APPENDICES

Appendix 1. Double Hurdle Model of Factors Affecting Smallholder Agricultural Sales

Explanatory variables	Probit				Lognormal				Sigma			
	Coefficient	Robust SE	Aster	P-value	Coefficient	Robust SE	Aster	P-value	Coefficient	Robust SE	Aster	P-value
Output/input prices												
Log maize price	1.749	0.379	***	0.000	1.383	0.411	***	0.001				
Log fertiliser price	-0.148	0.030	***	0.000	-0.038	0.031		0.228				
Log seed price	0.166	0.081	**	0.041	0.380	0.093	***	0.000				
Policy thrust variables												
Log distance to nearest FRA depot	0.006	0.005		0.299	0.021	0.006	***	0.000				
Household participating in FISP=1	0.090	0.032	***	0.005	0.453	0.031	***	0.000				
Long-run agro-ecological conditions												
Log average 30 years annual rainfall	0.108	0.141		0.444	0.226	0.142		0.111				
Agro-ecological zone IIA=1, base=I	0.548	0.058	***	0.000	0.705	0.067	***	0.000				
Agro-ecological zone IIB=1, base=I	-0.250	0.077	***	0.001	-0.312	0.102	***	0.002				
Agro-ecological zone III=1, base=I	0.412	0.079	***	0.000	0.148	0.086	*	0.087				
2006/7 agricultural season=1	-0.069	0.048		0.156	-0.790	0.053	***	0.000				
2010/11 agricultural season=1	0.164	0.051	***	0.001	-0.243	0.051	***	0.000				
Household characteristics												
Household headed by female=1	0.075	0.033	**	0.022	-0.205	0.037	***	0.000				
Log age of household head	-0.428	0.053	***	0.000	0.021	0.055		0.697				
Log household adult equivalents	-0.163	0.038	***	0.000	0.117	0.039	***	0.003				
Log household head years of education	0.093	0.017	***	0.000	0.128	0.018	***	0.000				
Log household productive assets	0.097	0.008	***	0.000	0.208	0.009	***	0.000				
Log farm size	0.531	0.059	***	0.000	0.082	0.061		0.180				
Control function (residuals)	-0.329	0.059	***	0.000	0.244	0.059	***	0.000				
Constant	-16.833	3.058	***	0.000	-10.779	3.227	***	0.001	1.376	0.011	***	0.000
Observations	22,057				22,057				22,057			

Source: CSO/MACO/FSRP Supplemental Surveys 2004 and 2008, CSO/MAL/IAPRI 2012, and authors' computations.

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

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