Fighting hunger through small-scale farming?

Investigating the farm size-productivity relationship in Zambian food production

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[W]e must now come to realize that we can produce more, and fail to tackle hunger at the same time; that increases in yields, while a necessary condition for alleviating hunger and malnutrition, are not a sufficient condition (...)"
(Schutter, 2009).

Preface

This thesis is written as part of the project *Disseminating MDG statistics to the Norwegian public* at Statistics Norway, Division for Development Cooperation. The project is funded by Norad and Statistics Norway.

I am very grateful for all the support from Statistics Norway in my work with the thesis. The Division for Development Cooperation have given me financial support to write the thesis. In addition they have given me the opportunity to work with MDG- statistics when providing me with a summer job on the MDG-project. I am also grateful for all input through interesting discussions with Siv Irene Pedersen, Dag Roll Hansen, Stein Terje Vikan, Ellen Cathrine Kiøsterud, Bjørn K. Wold and Geir Øvensen.

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At last I will thank my supervisors Silje Aslaksen and Halvor Mehlum at ESOP. They have given me advice when it was needed the most. My project proposal for the thesis included originally an econometric investigation of the potential inverse relationship, however the dataset did not arrive on time. Thanks to Silje and Halvor I managed to alter my project plan and find a new path for the discussion on the role of small-scale farming in Zambia.

Through this process I have learned a lot. Especially I have learned how much I don't know and all the questions to which we still have to search for the answers.

Abstract

In this thesis I use Zambia as a country case to discuss the role small-scale agriculture can play in achieving the MDG no. 1 on halving the proportion of people suffering from hunger. Within the field of agricultural development there is an ongoing debate concerning the future of small-scale farming in developing economies. The question is whether small-scale, owner-occupied farms can play a vital role in fighting hunger and poverty, or if further development of large mechanized farms is needed to feed the world's increasing population. At the core of this discussion we find a widely debated economic theory concerning the relationship between land size and productivity. This theory from development economics points out that small land plots are more productive than larger farms, and the reason is that small-scale farmers are able to better take advantage of the resources available to them, and especially land. In this thesis I use economic theory on the inverse relationship and results from empirical observations on the farm size-productivity relation to investigate the role of small-scale farmers in fighting hunger in Zambia. I discuss my findings in light of updated research on opportunities and constraints for Zambian peasants. I show that there is evidence of a negative relationship between farm size and productivity for a large proportion of the most marginalized Zambian smallholders, and this has important policy implications for the development of the agricultural sector in Zambia.

My analysis of the farm size-productivity relationship indicates a potential poverty trap for small-scale farmers. Increasing returns to farm size is evident, however only above a threshold plot size of 3 hectares. The potential poverty trap is caused by market imperfections in rural markets and the fact that most small-scale farmers rely on wage-income from casual work on larger farms. This makes them potential losers on export-led agricultural growth. Because of this small-scale farming can play a key role in fighting hunger, however it can also do the direct opposite and instead keep farmers stuck in a low level equilibrium. Smallholder farmers dependent on agricultural wage-income are possible losers on agricultural growth, and it is essential to address the constraints faced by this group.

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1 Introduction

At the dawn of the new millennium world leaders gathered in September 2000 at the United Nations Headquarters in New York to adopt the United Nations Millennium Declaration. The member nations reaffirmed their faith in global collaboration and committed themselves to eradicate extreme poverty and hunger as well as seven other goals for global development. The deadline was set to 2015 for what have been known as the Millennium Development Goals. Since the launch of the eight goals, they have become the guiding framework for joint efforts towards economic, social and environmental progress in developing countries. Now the goals are the main benchmarks in measuring impacts of various efforts in developing countries; national and governmental development programs, development assistance from bilateral donors and large operations run by UN and other multilateral organizations. The goals are broken down to 21 quantified targets measured by a list of 60 indicators as an accountability mechanism.

The MDGs are as follows:
Goal 1: Eradicate extreme poverty and hunger
Goal 2: Achieve universal primary education
Goal 3: Promote gender equality and empower women
Goal 4: Reduce child mortality
Goal 5: Improve maternal health
Goal 6: Combat HIV/AIDS, malaria and other diseases
Goal 7: Ensure environmental sustainability
Goal 8: Develop a Global Partnership for Development

Goal 1 is broken down into three targets where Target 1C is "Halve between 1990 and 2012, the proportion of people who suffer from hunger." Despite of the joint efforts and long- term plans, the world is struggling to reach the target. The share of undernourished people decreased in the period up to 2000- 2002, however since then there has not been any progress (UN, 2010). The difficulties in reaching the target are largest in Sub-Saharan Africa where the proportion of undernourished population increased from 26 to 30 during the 1990s and in 2005- 2007, the latest period with available data, the proportion had additionally increased to 31 (UN, 2010). About 70% of the MDGs' target group lives in rural areas (WB, 2006) and the main livelihood for rural poor is food production and other forms of agricultural activity. At the same time 70% of the worlds population living in hunger are the ones producing food, that is smallholder farmers and rural landless (FAO, 2010). This paradox gives root to a debate on what strategies to follow to combat hunger in an efficient and sustainable way. To reverse the negative development and fight hunger, the role of agriculture in development have to be addressed.

The Millennium Development Goals lay ground for Norwegian development cooperation and Zambia is one of the largest recipients of Norwegian foreign aid. In the period 2006- 2009 it was the sixth most largest recipient country measured by value of transfers (NORAD, 2011). One of the priorities for Norwegian aid is agricultural development. Zambia is a typical example of a country in Sub- Saharan Africa where agriculture is the main source of livelihood for the population, and reaching the MDG no. 1 within 2015 appears to be beyond the country's grasp. Through national development plans the Government of Zambia have pointed out agriculture as the sector to fuel growth in the country's economy and one of the main priorities is to increase agricultural production and export of agricultural products. According to The World Bank (WB) the reasoning behind this is that farmers that are enabled to grow more food will get both higher incomes and better diets (WB, 2006). Increased income will again increase farmers ability to diversify production and they are more likely to grow higher value crops. This will through backwards and forward linkages benefit the whole economy. Increased supply of food products will contribute to lower prices and higher consumption for the people suffering from hunger and malnutrition.

Within the field of agricultural development there is an ongoing debate concerning the future of small-scale farming in developing economies. After several decades of debt-crises and structural adjustment programs, the majority of food producers in developing countries have been neglected and relegated to subsistence agriculture (Schutter, 2009). This situation can be changed, however there are different opinions of what role peasant farmers can and should take in reversing the trend. On the one hand Via Campesina, the international peasant movement, and food rights activist and researcher, Peter Rosset, are two ambassadors of the view that to fight hunger and promote rural development the only viable strategy is to increase food production in small-scale farming based on traditional methods (Rosset, 2000; ViaCampesina, 2010). Arguments for this strategy are both that rural poor can produce food in an environmental sustainable way and that small farms are associated with intrinsic productivity advantages compared to large mechanized farms. The last part of this argument is based on a widely debated economic theory concerning the relationship between land size and productivity. This theory from development economics points out that small land plots are more productive than larger farms and has been used as an argument for redistribution of land from large to small farms. On the other hand The World Bank (WB) and The International Fund for Agricultural Development (IFAD) promotes pro-poor agricultural growth not primarily by increasing production in small-scale agriculture, but through a comprehensive approach to rural development that includes both agriculture and the rural non-farm economy(IFAD, 2011; WB, 2006).

In this thesis I will use Zambia as a country case to discuss the role small-scale agriculture can play in achieving the MDG no. 1 on halving the proportion of people suffering from hunger. I will use economic theory on the inverse relationship and results from empirical observations on the farm size-productivity relation to investigate the role of small-scale farmers in fighting hunger in Zambia. I will discuss my findings in light of updated research on opportunities and constraints for Zambian peasants. My analysis will be limited to explore the potential for fighting hunger through increased agricultural production, and I will not attempt to consider institutional factors like the possibility of redistribution through taxes, potential gains from provision of universal education and health care or impact of HIV and AIDS on production.

2 Food production in Zambia

Figure 1: Map of regions in Zambia. Source: USAID (2011)

2.1 The history of agricultural development and reform

Zambia is a land abundant country located in Africa south of Sahara. Its population was estimated to be 13,4 million in 2010 (CIA, 2011). The country's climate is tropical and in large parts of the country the soil is fertile, however only 7% of the land is arable land (CIA, 2011) and this gives a great potential for agricultural expansion. The last years Zambia has experienced a positive economical development with increasing annual growth rates; 5,7% in 2008, 6,3% in 2009 and estimates for 2010 show 7% (CIA, 2011). This development gives rise to an optimistic view on the future. However Zambia is still a low income country with 53% urban and 78% rural poverty rates (UNstats, 2010). The extremely high rural poverty might be explained by low agricultural productivity. As much as 85% of the labor force is occupied in agriculture while at the same time the sector only contributes to 19,7% of the nations GDP (CIA, 2011). To understand the underlying factors of the structure and organization of the agricultural sector in Zambia one has to look at the country's history and the dynamics of the nation's development.

2.1.1 The colonial period

Despite more than forty years of independence the colonial heritage still heavily influences agriculture in Zambia today. This is visible in the structure of land tenure, regional distribution of farms and crop patterns as well as ideas and discussions that currently are relevant for the development of the sector have roots in the colonial period.

The British government represented by the Governor of Northern Rhodesia, Sir Herbert Stanley, took over direct control of the territories that constitute Zambia today in 1924 (Adams, 2003). According to Wood et al. (1990) the main value of the territories was at first its great value as labor reserves for mines in other parts of Southern Africa. This resulted in female-headed households because of labor migration among men. Wood argues that this created labor shortage in agriculture, disrupted traditional farming systems and developed a negative attitude toward rural life.

As the British discovered the great potential for cobber mining in the central districts, the urban demand for food was growing and the colonial state sought to solve this through increased settler farming. The extraction of cobber was also dependent of the development of infrastructure and this led to the construction of "the line of rail", a railway crossing the border in the south going through Livingstone, Lusaka to the Cobberbelt and further to Congo and Angola. In 1928 the colonial territories were divided into two categories of land: Crown Land and Reserves. The Crown Land was dedicated to settler farmers and was located in the areas along the line of rail and the African population was relocated out of the areas by force. The Reserves were set aside for indigenous people (Adams, 2003). The available land for Europeans proved to be much larger than the number of settlers farmers could take advantage of and in 1947 a large proportion of the Crown Land was converted into Trust Land and made available for Africans. However the best agricultural soils was kept for Europeans (Adams, 2003). Even after the conversion into Trust Lands only 34% of the farmland available to Africans was suitable for cultivation and only 7% was quality arable land (Wood et al., 1990). The settler farmers, on the other hand, had large land holdings, were few in numbers and the development of commercial farms went slowly. This resulted in a duality of the use of farmland; Africans fully exploited the small land holdings they had while settler framers underused the land available to them (Wood et al., 1990).

According to Wood et al. (1990), the lack of success for the European farmers constitutes the background for state intervention in marketing and sales of agricultural commodities. In 1936 the gun went off for state intervention in agricultural markets with the establishment of the Maize Control Board (MCB). The MCB laid out a marketing and pricing policy, with the state as a monopoly buyer and retailer, and encouraged producers to grow maize rather than other more traditional crops, such as sorghum, cassava or millet. The policy of the board included, among others, a division of the market between local and settler farmers and a discriminating pricing policy. Three quarters of the export market was allocated to settlers, and on average African farmers received only 70% of the price received by Europeans (Dodge, 1977). The dualistic approach of the state in offering extension services to local and settler farmers continued in 1947 with the establishment of the Land Board, offering credit only to European farmers (Wood et al., 1990).

After the Second World War the colonial government introduced a Ten- Year Development Plan. Funds allocated to rural development were scarce and in the revised version from 1952 only 2% were allocated to this purpose (Dodge, 1977). In the period from 1945 to 1956 three major rural schemes were introduced to improve agricultural productivity by transforming a small number of farmers into modern market oriented producers. However all schemes failed to make any noticeable impact and they never involved more than 2% of the farm population (Wood et al., 1990).

The summary of the colonial period is that it laid the ground for a clear dualism in Zambian agriculture. There was no attempt to give village producers an opportunity to intensify production and gain market access and it seems the colonialists had a fear of settler farmers going to be ousted by Africans. Until 1940 the dominant view was that local farming traditions should be maintained at a level to meet subsistence needs. Wood et al. (1990) notes that one argument used to justify the policy of keeping local Zambian farmers at low levels of production was to avoid soil erosion and ecological damage.

2.1.2 The early post independence period, 1964- 1979

From the colonial period the country inherited four categories of land in 1964: State land (formerly Crown land), Reserves, Trust land and the remaining was Freehold land (Adams, 2003). From 1973, Zambia became a one- party state ruled by the United National Independence Party (UNIP). The party adopted a socialist- leaning philosophy and permitted only small-scale private property, all large- scale enterprises had to be directly or indirectly controlled by the state. The land nationalization program, The Land (Conversion of Titles) Act of 1975, prohibited all sales of land and converted Freehold land held by commercial farmers into leaseholds for 100 years. However The Land Act did not replace the laws regulating Reserve and Trust Land (Adams, 2003; McEwan, 2003).

At the time of independence, Zambia had very positive economic prospects because of the strong mining sector. Due to large copper revenues the state could afford to support agricultural producers and urban consumers through extensive subsidy schemes. The parastatal National Agricultural Marketing Board (NAM-Board) was established to keep control of and regulate agricultural input and supply markets. McEwan (2003) explains that through regional cooperatives NAM-Board had monopoly in rural markets and controlled fertilizer sale to farmers and shipped agricultural products from rural producers to central marketing and storage centers. A price policy that involved one single price for maize each season for the country as a whole was put in place. This made maize into a predictable and low-risk crop and farmers got incentives to shift production. NAMboard and other government supported agencies such as Lima bank, also supported farmers with seasonal credit.

In the mid- 1970s the economic difficulties started to hit Zambia. After the oil shock in 1973 the world copper prices fell dramatically in 1974. The government chose to borrow from abroad to maintain consumption instead of undergoing internal reforms and cut in subsidies (WB, 2006). The inward- oriented development strategy of the government failed in the 1970s because of the vulnerability of the copper-dependent economy and because the system was not sustainable. The subsidy policies led to a poorly developed agricultural sector dominated by maize. Production shifted away from other potential cash crops and traditional and drought resistant food staples such as sorghum, millet and cassava. The strategy also made farmers dependent on the government and led to a lax attitude toward credit repayment and a lack of understanding of the functioning of markets (Mwanaumo, 1999).

2.1.3 Growing debt and transition policy, 1980- 1990

The 1980s introduced a small shift in the policy environment for Zambian agriculture. Up to 1983 the excessive state control prevailed, mostly based on government price control and subsidy support in production and marketing (Nyanga, 2006). However from 1984 liberal reforms were slowly beginning to take form and a phase of economic transition started.

With the international debt growing out of control in the late 1970s, Zambian authorities faced pressure from donors and creditors to conduct reforms in the country's system for the political economy of farming. The first move towards more market liberal arrangements came in 1980 when price control was removed from non-basic consumer goods. In the years from 1984 to 1987 the government made several additional steps in liberal direction as a part of the country's approach to the International Monetary Fund (IMF). This included, among other things, the government letting go of control over the producer price for all crops but maize and wheat; removing of monopoly powers of parastatal marketing agencies and reductions in fertilizer subsidies (Wood et al., 1990). The immediate effect of these first liberalizing reforms was an increase in the cost of crucial agricultural inputs like seeds and fertilizer that again led to increased urban food prices (Nyanga, 2006). According to Wood et al. (1990) the crucial problem with the maize subsidy was that the urban population had become used to cheap food and the cuts in subsidies led to riots in Lusaka and the Copperbelt. The riots caused a pressure on the government and the result was that Zambia broke the cooperation with IMF in May 1987.

The break with the IMF led to a halt in the liberalization phase in Zambia and subsidies were again raised. The government tried to develop its own economic reform program and to reduce payments on overseas debt (Wood et al., 1990). The measures were not sufficient to stop the negative development of the poor performing economy and after the elections in 1991 there was a change of government.

2.1.4 Structural adjustment program (SAP) phase, 1991- 2000

After the elections in 1991 the Movement of Multi party Democracy (MMD) formed a new government. In close collaboration with The World Bank (WB) and IMF it designed and implemented a broad reform of structural adjustments. These reforms aimed at stabilizing the economy by curbing inflation, restoring growth and laying grounds for an economic environment that promoted private enterprise (WB, 2006). The measures implemented included cutting public expenditure, closing or selling unproductive public enterprises, removing agricultural subsidies and opening up the local economy to foreign competition. In addition, strict fiscal discipline was introduced to reduce inflation, the local currency was devaluated, exchange rates were freed and capital controls were removed (McEwan, 2003).

In the short and medium run the results from the reforms were unsatisfactory and did not match expectations (IMF, 2007). Economic growth was not realized and in the 1990s the country experienced 6 out of 10 years with negative or zero growth (UNstats, 2011). Per capita income declined, unemployment rose and inflation eroded people's savings (McEwan, 2003). One factor that influenced this bad performance of the country's economy was the serious drought seasons that hit Southern Africa in 1991 and 1992. In Zambia the 1992 cereal production went down to 39% of the average of the previous 5 years. Other factors were stagnant investments and decay of key infrastructure. In addition, the structural challenge of privatizing the mining sector demanded many years of negotiations and before the deal was signed the value of the state's property had dropped significantly (McEwan, 2003).

The deregulations of the financial markets and the removing of subsidies gave sharp increases in food prices. Inflation during the early 1990s undermined real incomes (WB, 2006) and, for the majority of the population, living expenses became unbearable. The situation harmed the urban population in particular and resulted in a migration flow of urban unskilled laborers from cities to rural areas. According to WB (2006) almost 10% of the urban population moved to rural areas and most of them took up small-scale farming as the main livelihood. Up to 1991 the migration trend had been the opposite with the urban population in this year reaching 40% of the total population (WB, 2006).

One of the important factors of the Zambian government's structural adjustment strategy was to create a competitive agricultural sector. Self-sufficiency in the country's food production and increased export of agricultural products were the main goals (Saasa, 2003). In order to facilitate the structural adjustments in agriculture, the Agricultural Sector Investment Program (ASIP) was launched in 1996. Ten strategies were adopted for ASIP, namely, liberalization of agricultural markets, diversification of crop production, development of the livestock sector, emphasizing services to smallholders, expanding economic opportunities for outlying areas, improving the economic status of women, improving the use of the available water resources, full utilization of land suitable for agriculture, helping farmers deal with natural disasters, and emphasizing sustainable agriculture (Saasa, 2003).

Market liberalization and elimination of subsidies changed the incentives for farmers. The artificial profitability of maize production was abolished and the production halved during the 1990s. Producers started to change their cropping patterns. In the dry southern provinces many shifted to millet production, while the more rainy Northern and Luapula provinces reverted to cassava (WB, 2006). McEwan (2003) notes that the ASIP sector performance analysis for 1996- 2000 found that there had been a rising trend in the total area cultivated by the smallholder sector between 1996 and 2000 compared to the period 1990/91 to 1995/96.

With regard to debt relief to selected small-scale farmers, the government announced in mid-1995 its intention to write off the debt incurred by small and emergent farmers in those districts that were worst affected by drought. The announcement was made before the needed administrative and operational structures and procedures were agreed upon and put in place. Most of the lending institutions finally collapsed under the heavy weight of a misguided policy decision. The effect of this policy decision resulted in closing down of the few institutions that were lending to the smallholders (Saasa, 2003).

In 1995 the government changed the land administration policy and replaced the Land (Conversion of Titles) Act of 1975 with The Land Act of 1995. Just like the act from 1975, the reform vested all land in Zambia in the President, who holds it on behalf of the people of Zambia. However the new Land Act introduced the possibility of land ownership and all Zambians of 21 years of age or older could own land and non-Zambians from certain groups, like investors or resident permit holders, could acquire and hold land (IMF, 2007). The purpose and goals of The Land Act was improving security of tenure, enhancing productivity, and increasing the value of land (Jorgensen and Loudjeva, 2005). The land is divided into two categories, land under state title and land under customary tenure. According to Jorgensen and Loudjeva (2005) the Land Act introduced as a result of equity concerns, a reservation of 30% of land allocations for women and other vulnerable groups. However Jorgensen and Loudjeva (2005) note that most customary laws do not allocate land to women, and there was not introduced any means to enforce land distribution to these groups.

The SAP period was tough for rural producers. The majority of small-scale farmers lost access to credit facilities, fertilizer and other inputs as well as agricultural markets. However crop diversification in production increased and so did the fraction of cultivated land area.

2.1.5 Phase of Poverty Reduction Strategy Paper (PRSP), 2001- 2010

At the beginning of the new millennium the projections for future demand in minerals indicated a falling curve, especially for copper. In Zambia, agriculture was defined by many as the new potential cornerstone of the country's economy and in all development strategies since 2000, agriculture has been given a central place (Farrington and Saasa, 2002).

Zambia has had a period with two Poverty Reduction Strategy Papers (PRSP). The first was launched in 2002 and lasted until the end of 2005, and the second was for the period 2006- 2010. The evaluations of the last period are currently still not available, however during the first PRSP period two progress reports were produced and in 2007 the World Bank produced a Poverty and Vulnerability Assessment. This makes it possible to say something about the development of the first part of the last decade.

The first PRSP was developed in a period when the effect of the liberalization process on agriculture became evident. Between 1995 and 2002, the agricultural sector's contribution to GDP first stagnated and then fell progressively from 18.4% in 1995 to 15.0% in 2002 (McEwan, 2003). The SAP reforms had especially negative impacts on smallholder farmers. The removing of security in access to inputs and markets led to reduced maize production and many farmers scaled down to subsistence production of traditional crops (WB, 2007). However there were also some positive trends in the heritage from the ASIP period, especially regarding uptake in conservation farming and rise in the contribution of non-traditional exports (McEwan, 2003). Under these conditions the main national challenge was to work out good strategies to stimulate the private sector to provide inputs and identify what kind of transitional support small farmers needed (Farrington and Saasa, 2002).

The Agriculture Commercialization Program (ACP) was developed as a part of the first PRSP. The main interventions of the ACP were centered around agribusiness promotion and training, finance and investment land development and support services, infrastructure development, technology development and transfer and improved coordination of agricultural policy and institutional capacity. The ACP promoted increased adoption of out-growers schemes, and the re-introduction of farm blocks for large-scale farming (McEwan, 2003).

The rural population still has to overcome many constraints to be able to take part in an agriculture-led growth process. Participants in the Rural Participatory Study, conducted as a part of the work with the Poverty and Vulnerability Assessment, identified the major constraints they face to be lack of fertilizer and a guaranteed market price for maize (WB, 2007). According to Farrington and Saasa (2002) the prevalence of traditional land titling implies that land cannot be used as collateral against loans. In addition the credit market is highly insecure and defaults are common, resulting in lack of confidence among smallholders and credit suppliers, for instance suppliers of fertilizer on credit. The result is that many smallholders lack access to credit, fertilizer and other inputs and this has given rise to demands government support. Because of this the government has not fully withdrawn from the market of agricultural inputs. Since 2002 it has delivered fertilizer and seeds through two programs reaching at total approximately one-third of the country's 1.2 million smallholder agricultural households (WB, 2007).

The WB (2006) reports that the current growth path suggests that agriculture-led development is desirable and the future for the agricultural development in Zambia is optimistic, but still it is highly uncertain what the outcome will be in the medium and long run. Zambia faces serious challenges in reaching MDG goal number 1 and halving the proportion of the population suffering from hunger. It is crucial to promote pro-poor growth in the rural sector to make sure that small-scale producers in the less central regions are not left behind. According to McEwan (2003) there are concerns about the implications of out-grower schemes and the reintroduction of farm blocks since this might contribute to an enhancement of the dualistic structure of the sector and will not contribute to poverty reduction.

2.2 Structure of the agricultural sector

The history of agricultural development in Zambia have resulted in a strong dualistic structure of the agricultural sector. According to Siegel and Alwang (2005) this duality is visible in differences in technology, cultivation practices, crops produced, geographical conditions and land distribution.

2.2.1 Agro- ecological regions

Agricultural production is strongly influenced by ecological factors and in particular by rainfall. Zambia can be divided into three main agro- ecological regions, (Jorgensen and Loudjeva, 2005; Siegel and Alwang, 2005; WB, 2003).

Siegel (2008) uses the following characteristic of the agro- ecological regions:

Region I
: The first region covers the southern parts of Western and Southern Provinces. Climate is dry and hot and dominated by low rainfall. The soil is sandy and the fertility is poor. Crops grown in the region are maize, sorghum, groundnuts, sunflowers and cowpeas. The region covers 12% of the total area in Zambia and is populated by nearly half of the rural population.

Region II
: Region II runs east- west through Central, Lusaka, Southern and Eastern provinces and the precipitation is classified as medium rainfall. This is the region with the most favorable agro- ecological conditions with respect to rainfall and soil quality. Maize is the main crop, in addition to beans, groundnuts, sorghum, cassava, millet, sweet potato, sunflower, cotton, rice, tobacco,

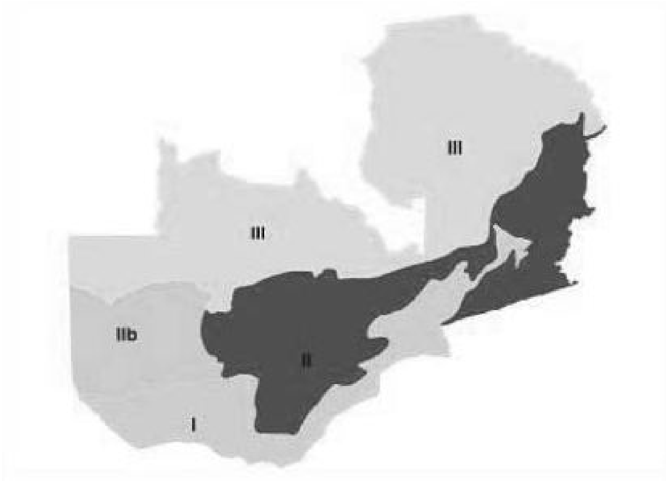


Figure 2: Map of agro- ecological regions of Zambia. Source: FAO, Country Pasture/Forage Resource Profiles (Aregheore, 2011)

paprika and different vegetables and fruits. Region II covers 42% of the total area in Zambia. Included in zone II is a low- rainfall area in the west with poorer soil with somewhat lower fertility. In addition, region II has advantages like major urban centers and markets as well as good access to infrastructure like roads and railway.

Region III

Region III is a high rainfall area in the north. It runs through Copperbelt, Luapula, Northern and North- Western provinces. Included in this region are several major river systems, such as Luapula and Mansa rivers, and numerous lakes. Major crops are cassava, maize, groundnuts, millet, sorghum, beans and sweet potatoes. Region III covers the last 46% of the country's total area.

	Provinces Covered	% Share of Rural Population	Rainfall	Growing Season	Major Agricultural Activities	Soil Quality, Agricultural Potential
Region I	Southern parts of Western and Southern Province	48	600-800mm	80-120 days	Maize limited by rainfall. Sorghum, millet, sunflower, cassava, cotton, tobacco. Livestock limited by tse-tse fly.	Soils: Shallow Sands Ag Potential: Poor
Region II	Most parts of Central, Eastern, Lusaka, Southern Provinces	43	800-1000mm	100-140 days	Maize, groundnuts, and wide range of crops and livestock.	Soils: Moderately leached sandy loams Ag Potential: Good
Region III	Northern, Luapala, Copperbelt, Northwestern Provinces	9	1100-1700mm	120-150 days	Maize, bananas, coffee, tea. Limited by high acid soils.	Leached and acidic sands Ag Potential: Moderate

Figure 3: Table of agro- ecological regions of Zambia. Source: Siegel and Alwang (2005)

2.2.2 Land use and distribution

Zambia has got good potential for agricultural expansion with respect to land abundance. According to MACO (2010) out of the country's total land size of approximately 75 million hectares, 43 million hectares is classified as medium to high potential for agricultural production. Out of this currently only 6.02 million hectares (14%) is utilized MACO (2010) also present their estimate for potential land for irrigation to be 2.7 million hectares. Today about 156,000 hectares are under irrigation.

Land tenure arrangements affect both producers' access to agricultural land and credit. In Zambia 94% of the land is under "customary tenure" and is distributed to small-scale farmers by the local chiefs. This type of tenure is not a uniform land policy for the country, but includes 73 ethnic traditions and four types of marriage and social organizational systems, which affect access to land. The last 6% is state land and includes cities and towns, mining areas and land that was set aside for commercial agriculture in the colonial time. The structures from colonial time are still visible and only commercial farmers have titles to lease state land (Jorgensen and Loudjeva, 2005; Siegel and Alwang, 2005).

All land is vested in the president, however the powers to make and execute grants and dispositions of land have been delegated to the commissioner of lands, who receives policy guidelines from the minister of land. The Ministry of Agriculture and Co- operatives (MACO) identifies, plans and recommends land for agriculture. District, municipal and city councils act as agents for the land commissioner, dividing land into plots and recommending applicants to be granted certificates of title (Jorgensen and Loudjeva, 2005).

2.2.3 Farmer classification

The population of Zambia is estimated to be 13,8 million (CIA, 2011) and some 75% are engaged in agriculture (CSO, 2003). Most of the people contributing to the agricultural sector are rural residents and small-scale subsistence farmers. In 1998 the Living Conditions Monitoring Survey reported that overall rural poverty rate was as high as 83% and extreme rural poverty was 70%.

There are several possible ways of dividing farmers and farming households in Zambia into categories, however the estimations done by WB (2003) distinguishes four categories based on farm size, technology, market orientation and location:

small-scale farmers

- includes approximately 800,000 households
- cultivate on average 1.45 hectares of land
- use low-input, hand hoe technology and relies upon family labor
- consume a large proportion of own output

Emergent farmers

- 40,000 to 60,000 households
- cultivate 5 to 20 hectares
- use draught power and purchased inputs
- have relatively higher levels of education and work experience
- use both family and hired labor

- food production is primarily marketed

Large scale commercial farms

- 600 to 750 farms
- cultivate between 50 and 150 hectares
- have extensive mechanization and rely upon a combination of permanent and casual staff
- the majority of these farms are family-owned
- production is for commercial sale

Large corporate operations

- less than a dozen in number
- cultivate several thousand hectares (or more) of crops and/or one thousand or more heads of livestock
- managed by hired professionals
- most operations involve vertical integration with agro-processing

This classificiation is also shown in figure 4.

	Approx. # of Producers	Approx Farm Size	Technology, Cultivation Practice	Market Orientation	Location	Major Constraints
Small-Scale Producers	800,000 hhs	< 5ha (with majority cultivating 2 or less ha of rain-fed land)	Hand hoe, minimal inputs, household labor	Staple foods, primarily home consumption	Entire country	Remoteness, seasonal labor constraints, lack of input and output markets
Emergent Farmers	50,000 hhs	5 - 20 ha	Oxen, hybrid seed and fertilizer, few with irrigation, mostly household labor	Staple foods and cash crops, primarily market orientation	Mostly line-of-rail (Central, Lusaka, Southern Provinces), some Eastern, Western Provinces	Seasonal labor constraints, lack of credit, weak market information
Large-Scale Commercial Farms	700 farms	50 - 150ha	Tractors, hybrid seed, fertilizer, some irrigation, modern mang., hired labor	Maize and cash crops	Mostly Central, Lusaka, Southern Provinces	High cost of credit, indebtedness
Large Corporate Operations	10 farms	1000+ ha	High mechanization, irrigation, modern mang., hired labor	Maize, cash crops, vertical integration	Mostly Central, Lusaka, Southern Provinces	Uncertain policy environment

Figure 4: Classification of farmers. Source: Jorgensen and Loudjeva (2005); WB (2003)

2.2.4 Crop production

Main food crops produced in Zambia are cereals, like maize, sorghum and millet; root crops, like cassava; and other food crops, like oil crops, groundnuts, vegetables and fruits. In addition high value crops like tobacco, cotton and sugar are grown, mainly for export. According to Haankuku (2010), maize production covers 54% of area produced, cassava covers 13%, other cereal and oilseeds 13% each and all other crops are produced on the remaining 7% of land area under cultivation.

In figure 5a, showing crop yield for 2004, we can see that the production volume is greatest for sugarcane, fruits, vegetables and root crops. However figure 5b, showing production value of harvested crops clearly states that maize had the largest contribution and accounted for 23% of agricultural GDP in 2004 (Thurlow et al., 2008).

	mt/ha 2004
Cereal crops	
Maize	1.42
Sorghum & millet	0.67
Other cereal crops	1.19
Root crops	5.99
Other food crops	
Pulses & oil crops	0.60
Groundnuts	0.44
Vegetables	6.27
Fruits	6.35
High-value crops	
Cotton	0.52
Sugarcane	60.55
Tobacco	1.08
Other crops	2.77

(a) Crop yield

	Initial value of GDP (Kw bil.)	Percentage share of total (%)	
	2004	Total GDP 2004	Agricultural GDP 2004
Total GDP	23,699	100.0	
Agriculture	4,859	20.5	100.0
Cereals	1,307	5.5	26.9
Maize	1,143	4.8	23.5
Sorghum & millet	53	0.2	1.1
Other cereals	111	0.5	2.3
Root crops	444	1.9	9.1
Other food crops	895	3.8	18.4
Pulses & oil crops	100	0.4	2.1
Groundnuts	344	1.5	7.1
Vegetables	283	1.2	5.8
Fruits	168	0.7	3.4
High-value crops	818	3.5	16.8
Cotton	312	1.3	6.4
Sugar	337	1.4	6.9
Tobacco	109	0.5	2.2
Other export crops	61	0.3	1.3

(b) Production value

Figure 5: Production statistics 2004. Source: Thurlow et al. (2008)

3 Theory

The history of the development of the agricultural sector shows that in the early stages of colonial time, traditional Zambian agriculture was efficient relative to that of settler farmers. African farmers were to a much larger extent than Europeans able to take full advantage of the agricultural land devoted to them. However, land policy and government subsidies up to the 1990s were heavily biased towards large farms run by European settlers and the liberalization in the following decade further worsened the situation for small-scale local farmers. The result is a sharp dualistic structure of the agricultural sector in Zambia. On the one hand agriculture is dominated by small-holder subsistence farmers using hand- hoe and oxen technology, on the other hand a small number of large scale mechanized farms occupy the most fertile areas with the most efficient infrastructure. Development plans for Zambia lay grounds for agriculture-led poverty reduction, however it is not clear what the potential for small-scale farming is in this process. A well known and much debated theory in development economics points out that small farms are more efficient than large farms because they are able to use inputs like land

and labor more efficiently. The result is that small farms have higher output or yields per acre than large farms and the policy implications might be far reaching.

3.1 Land size and productivity

Economists started to take notice of the possible inverse relationship between size and productivity in the 1960s, and the literature points to an article by Sen (1962) as one of the very first publications on the subject. After Sens famous article, a substantial number of researchers have devoted their time to empirical studies of this inverse relationship.

One of the foundations of the theory is how it measures productivity, or efficiency in production. Both the classical studies and more recent empirical analyses measure output, or value of output, per hectare or acre. This measures the productivity of land in production, thus not total factor productivity. Binswanger and Rosenzweig (1986) notes that output or yields per acre as a measure of productivity is limited and only represents a partial productivity measure that does not take into account differences in input use.However Barrett (1996) underlines that the results in the literature is bridged empirically and the results stand even when one accounts for differences in use of other inputs than land. Ray (1998) argues that, talking about agricultural production, a broad notion of efficiency is necessary. According to him an adequate definition is that production efficiency is achieved when the values of the marginal product of all inputs equal their true marginal costs. This is a notion of productivity in the sense of market efficiency and he argues that this definition of efficiency is tested in empirical investigations of the relationship between land size and productivity. Ray (1998) explains that when the conditions for production efficiency are violated in agriculture in developing countries it will be in the direction of under- or over-application of inputs. For example when large farms use less labor than optimal because of market imperfections and incentive problems that raise the cost of labor or incur fixed costs for labor supervision. And similarly, when small farms employ more family labor than optimal because of the possibility of unemployment.

The classic studies of the inverse relationship regress the value of output of specific crops per unit of operated area, and are based on simple models using ordinary least squares (OLS) regression of the form:

$$\log y = \alpha + \beta \log OP + \epsilon$$

where y typically is value of output per acre, OP is operational size and ϵ is an error term (Bhalla and Roy, 1988; Heltberg, 1998). Many studies find a significant negative relationship, that is a negative β, including Berry and Cline (1979), Bhalla (1979) and Carter (1984). During the 1970s and 80s the inverse relationship became a stylized fact in development economics and since then the theory has been challenged and reaffirmed by many studies.

The reason why the theory of the inverse relationship has received much attention and has become the subject of numerous empirical studies is that it can potentially have far- reaching policy implications for agricultural development policies. The core arguments are those in favor of re-distributive land reform, and the reasoning is that land redistribution into family farms can increase production, rural employment and the equality of income distribution (Berry and Cline, 1979). Another central aspect is the implications for natural resource management and migration. Large farms use input intensive practices, dependent on pesticides, fertilizer and machinery, that can have devastating ecological consequences and lead to land degradation. When these externalities are considered, small farms may be viewed as more efficient (Fan and Chan-Kang, 2005).

3.2 Explanations for the inverse relationship puzzle

The literature shows that the empirical studies of the theory have concentrated on finding evidence, or lack of, for economic explanations of systematic differences in input- output ratios between large and small farms. The simple model have been extended to control for numerous exogenous factors like differences in observed land quality, farmer's skills, irrigation facilities, among other. There exists several possible explanations for the inverse relationship in the literature. Barrett (1996) divides the explanations into three categories:

- Decreasing returns to scale.
- Labor market dualism.
- Factor prices dependent on farm size.

First, it might be that larger farms are less productive than small farms because of special features of agricultural production that give decreasing returns to scale. However Ray (1998) points out that this is not a very likely explanation. If all inputs are being expanded in the same proportion we would at least experience constant returns to scale. In addition large plots are suitable for mechanization, and farms above a certain threshold in size that can take advantage of this, could experience increasing returns to size. According to Berry and Cline (1979) empirical studies on returns to scale in developing country agriculture generally have found approximately constant returns.

The second explanation is the classical explanation and it tells us that there is a duality in the alternative cost for labor. For large farms that rely on hired labor, the opportunity cost of another unit of labor is the going market wage rate, however for family farms the opportunity cost is lower because of the opportunity of unemployment (Ray, 1998).

The third explanation includes the second, however it has a much wider approach. It relies on failures in rural markets that generate binding constraints for farms and these constraints are dependent of farm size (Barrett, 1996). Duality in the alternative cost of labor is one possible failure in the labor market, however other market failures might also cause the inverse relationship. Because of market failures in multiple markets, the incentives facing larger farms systematically differ from those facing smaller farms (Berry and Cline, 1979). The markets affecting agricultural producers in addition to the labor market are markets for land, credit and insurance. I will use this third explanation in the further review of the theory and it's foundations.

3.3 Agricultural market failures in developing economies

Binswanger and Rosenzweig (1986) put up a dualistic model of agriculture that constitutes a good theoretical framework for the relations between market failures and the inverse farm- size relationship. In the model we have a large farm, or modern, sector that is contrasted with a small farm, or traditional, sector. The difference between the two sectors lies in the fact that the large farm sector has a greater use of hired labor and capital per acre.

The model of Binswanger and Rosenzweig (1986) implies that the capital- labor ratio and the productivity per acre for an operational holding will vary with the scale of the operational holding (OP), with the size of the ownership holding (OW), and with family size (FS). The assumptions can be shown by the first derivatives:

$$\frac{K}{L} = \theta(OP, OW, FS) \qquad \theta_1 > 0, \theta_2 > 0, \theta_3 < 0$$
$$\frac{Q}{OP} = \psi(OP, OW, FS) \qquad \psi_1 < 0, \psi_2 > 0, \psi_3 > 0$$

Where K is capital, L is labor and Q is output value. The capital labor ratio will vary positively with both operational holding and ownership holding and negatively with family size. The ratio of output value to size of operational holding will however vary positively with both ownership holding and family size and negatively with operational holding.

This simple model's prediction for differences in factor ratios and productivity across farms is explained by market failures in rural markets for land, labor and insurance. To understand the theory we have to understand the concepts of market failures in the rural economy that are related to farm size.

3.3.1 Land

Markets for land can be divided into to two general categories, land rental markets and land sales markets. The hypothesis of constraints dependent on farm size because of dysfunctional land markets is the dual assumption that operational holding is limited due to imperfect land rental markets, and owned holding is inflexible due to sales market imperfections (Heltberg, 1998). The result from both assumptions is that large farms hold more land than they can take advantage of in an efficient way and small farms have restricted access to land. Thus small farms will apply more labor per acre and be relatively more productive.

Land rental markets experience failures because of contractual and incentive problems, or agency problems. In the literature this is explained by modeling relationships between land owner and tenants within a game theory framework called the principal- agent model. For land lease there are in general two types of contracts; sharecropping contracts and fixed-rent contracts (Ray, 1998). Under sharecropping contracts, on the one hand, the rent is specified as a fixed proportion of the harvest, giving tenants incentives to supply less input than an owner-cultivator and to under report output (Heltberg, 1998). On the other hand, under fixed rent contracts the rent is predetermined and independent of output. This contract does not give the adverse incentive effects that sharecropping does, and for the tenant utility will be maximized by applying the same amount of effort as if the land was owner cultivated. However, fixed rent contracts are not risk neutral, but place the entire yield and price risk on the tenant. Because of this a risk averse tenant will implicitly demand a risk premium deducted from the rent (Heltberg, 1998). The result is that land owners with large holdings will have a less than optimal number of workers or peasants to cultivate their land while smaller farms will apply more labor than optimal.

There are several reasons to expect market failures in land sales markets that contribute to the inverse relationship. Even if land sales markets exists, the effective price of land on small farms is likely to be higher than on large farms. Purchases of small plots probably carry a higher price per hectare than do large plots (Berry and Cline, 1979). However, in most situations land sales are restricted by various factors and this obstructs an efficient distribution of land from large farms to smaller farms. First, there might be formal restrictions on land sales through legislation. In many countries land sales markets are limited or non- existent, like in Zambia. Second, there might be other restrictions like incentives to hold land for purposes other than production. Berry and Cline (1979) point out that one influence to low production relative to operated holding on large farms is the holding of land for purpose of asset replacement or for prestige and political purposes. In countries with badly functioning capital markets, land can be one of the most stable assets to invest in and large land holdings might give political influence. In addition, fear of future land reform might make land owners unwilling to lease out land for cultivation. The more objectives, other than production for profit, that effects the decision of land owners, the lower land productivity on large farms is likely to be (Berry and Cline, 1979).

3.3.2 Labor

Failure in the market for labor creates a discrepancy between the cost of hiring labor and the cost of applying family labor for own cultivation. On the one hand this discrepancy might stem from the problem of moral hazard in wage labor. The hired worker has an incentive to apply less than maximal effort in working for the landlord and because of this the landlord must supervise his workers. This creates supervision costs. Carter and Wiebe (1990) put up a model to explain how supervision costs depend on farm size, where total units of effective labor L_{eff} depends on the number of units of own labor, L_h, and units of hired labor, L_d:

$$L_{eff} = L_h + \lambda\left(\frac{L_h}{OP}\right)L_d$$

One of the assumptions in the model is an informal family labor supervision technology, λ, which is a function of the density of household labor, L_h, per operational holding, OP. The first derivative is positive, $\lambda'(\cdot) > 0$ and $0 < \lambda < 1$. The model suggests that larger operational holding give less units of effective labor if the farm is using hired labor, holding everything else equal. In addition one additional unit of hired labor will give less than one more unit of effective labor.

On the other hand the wage cost discrepancy might stem from factors on the family farm. The family farm employs household members to cultivate the farm land and the family shares the produced output so that workers are paid the average product. On the larger farm that uses hired labor the workers are paid the marginal product of the last unit of labor. This creates a labor market dualism where in equilibrium the average productivity of labor on the small farm equals the marginal product of labor on the large farm, thus marginal productivity is higher on the larger farm (Bhalla, 1979). Small farms will apply relatively more labor per acre than larger farms and this might result in the inverse relationship. The potential efficiency gain to the economy as a whole of peasants taking on employment outside of the family will not be realized because this implies a loss to the individual worker (Bhalla, 1979). If the outside work is not adjacent to the farm, pooling of family income might not be possible and workers who leave the farm will have their income reduced by the difference between the wage rate and the average product on the family farm.

Ray (1998) argues that the situation of oversupply of household labor on the family farm might stem from unemployment. If there is unemployment in the economy there will be a difference in the alternative cost of labor for a small farm that applies family labor and larger farms that use hired labor. The alternative cost for the larger farm will be the going market wage rate, however for the small farm the alternative cost will be less than the market wage rate because of the possibility of unemployment. This results in that small farms will put in more labor per acre than large farms and will produce higher output per acre Ray (1998).

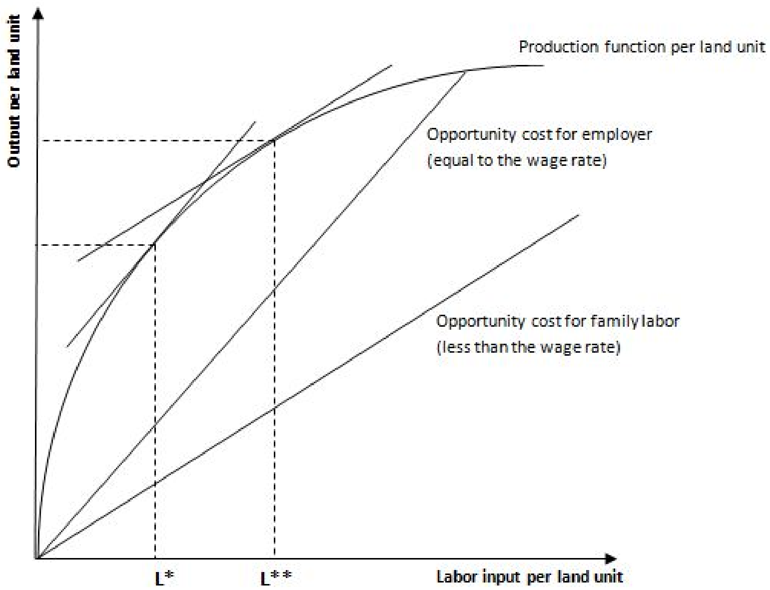


Figure 6: Imperfect labor markets and small- farm productivity. Source: Ray (1998)

Figure 6 shows the situation described by Ray. The production function shows the relationship between labor input per land unit and output per land unit. The production function has standard neoclassical qualities, such that return to labor input per land unit is positive and decreasing. With a lower opportunity cost of labor, because of the possibility of unemployment, small farms that use family labor will apply L^{**} units of labor per land unit. Large farms that hire labor until the marginal product equals the wage rate. Since the wage rate is higher (steeper slope of the curve) than the opportunity cost of family labor, large farms will use less labor per land unit, L^{*}.

3.3.3 Credit

Credit markets might fail for two main reasons. First, because lenders have limited possibility of monitoring what is being done with a loan, and second, because borrowers might default on the loan for strategic reasons (Ray, 1998). Because of this, both involuntary and voluntary default is likely. The result is segmentations in rural credit markets and credit rationing. small-scale farmers and landless have restricted access to credit because financial institutions routinely require collateral in the form of land or other fixed assets as a condition for offering loans (Binswanger and Rosenzweig, 1986). What we observe are binding constraints on farmers that make price on credit dependent on farm size.

Feder (1985) argues that there is evidence that yields may be positively related to farm size or that they do not vary systematically with farm size. This might stem from the existence of price distortions in credit markets which might have countervailing effects. Feder (1985) models credit, S, to be a function of land owned:

$$S = S(OW), \qquad S' > 0$$

The resulting lack of liquidity during the planting and growing season limit the ability of small-holder farmers to buy necessary farm inputs in time, hire seasonal labor and make long term investments. Accordingly, the dual model of Binswanger and Rosenzweig (1986) assumes a positive relationship between owned land and output because of credit constraints.

However, there are several reasons why market failures in credit markets can have the opposite effect, and instead enhance the inverse relationship in output to land ratio between large and small farms. First, differential access to credit combined with distress land sales may, over time, reinforce an unequal and inefficient distribution of land (Carter and Wiebe, 1990). Carter and Wiebe (1990) explains that if small farmers lack access to credit they may be forced to sell off land in temporary distress to smooth consumption. Second, peasant farmers without land, and with credit constraints, will not have the capital requirements to invest in machinery, irrigation or other inputs and this will increase small farms dependence of family labor (Binswanger and Rosenzweig, 1986).

Kevane (1996) puts up a model to explain the ambiguity of the effect of credit markets failure. Cash flow of a household must be equal to zero or positive:

$$A + w(L_w - L_d) - J \geq 0$$

Where A is access to credit, w is the wage rate, L_w is household labor allocated to wage-income activities outside of the household, L_d is hired labor and J is a fixed subsistence requirement of consumption that the household is not able to produce. The model illustrates that even wealthier households, with the ability to put up collateral and thus get access to credit, will still have a limited ability to employ outside labor since labor must be paid at the time of the work, before production is realized. However, it is obvious that households with access to credit will have a larger possibility to hire labor and expand production than household without possibility to borrow.

The possible ambiguous effect of credit market failures on the land to output ratio makes it important to isolate owned land from operated land and labor market effects from credit market effects in a proper way in empirical studies of the relationship.

3.3.4 Insurance

Ray (1998) distinguishes between two forms of insurance: self- insurance and mutual insurance. Self insurance is smoothing of consumption using own assets, while mutual insurance reduces individual risk by interaction across a number of agents. In rural markets both self- insurance and mutual insurance will be available to farmers to a degree dependent of the size of their land holdings.

Heltberg (1998) notes that wealth and post harvest access to credit is a buffer against risk that is available to farmers with large land holdings, so self insurance is more likely to be available to large farms than to small farms. Self insurance of this form will create a buffer against risk and make wealthy farmers able to invest in riskier crops with higher yields. This can reduce the potential for an inverse relationship, because small farmers are more vulnerable to weather riskiness even though they may be more productive in the first place. (Heltberg, 1998). However, small-scale agriculture might exploit mutual insurance in the form of local social structures in the village and the extended family to compensate.

This is the basic reasoning when Barrett (1996) offers an alternative explanation of the inverse relationship that has root in insufficient access to insurance for small-scale farmers. He finds that price risk and distinct agrarian classes of farmers can explain the oft- observed inverse relationship. The conclusion is based on three empirically stylized facts on rural agricultural organization:

- Poor farmers can not fully hedge uncertain staple crop prices.
- Land is unevenly distributed across the agricultural population.
- Small farms tend to be net purchasers of agricultural commodities, large farms tend to be net sellers.

The basic intuition is that small, net buyer farming households experience food price risk and food security stress that leads to an over- application of family labor. It is even possible that family labor is utilized beyond the point where their own shadow value of labor equals the actual gain (Barrett, 1996).

4 Literature review

Many economists have criticized the assumptions made, model specifications and reliability of data in the classical studies, much because of the controversy of the redistribution policies that the theory is used as an argument for. For example Barbier (1984) accused the theory of being "a product of imagination" because of bad model design. Defenders of the theory have met these challenges and extended the simple model to correct for a wide range of other factors that might affect the productivity other than land size. As Fan and Chan-Kang (2005) puts it, the debate has gone through a complete circle. In the 1970s the theory was regarded as a stylized fact and redistribution of land was viewed as efficient. In the 1980s the theory was questioned and small farms were viewed as an obstacle to efficient labor application and it was argued that labor was more efficiently applied if it was moved to industry. During the 1990s the agricultural production became more diversified and producers shifted from grain to cash crops and horticultural products, in which small farms may have a comparative advantage (Fan and Chan-Kang, 2005).

Since Fan and Chan-Kang (2005) wrote this summary, the debate has developed further. During the first decade of the 2000 the inverse relationship has again been questioned because of the rapid population increase and the need for increased food production. This is evident when one compares the two different Rural Poverty Reports by the International Fund for Agricultural Development (IFAD) published in 2001 and 2011 respectively. The report from 2001 states clearly that small farms remain usually at least as productive as large farms and that control of farmland is crucial for overcoming rural poverty (IFAD, 2001). The report in addition notes that in low-income areas rural labor income alone seldom is sufficient to avoid poverty, so most landless or near-landless rural people stay poor (IFAD, 2001). In the report from 2011 the foreword states that "The world has changed dramatically since IFAD released its last Rural Poverty Report in 2001." (IFAD, 2011). The striking changes are the forecasts for population increase: *"Strikingly, current forecasts estimate a 50 per cent population increase by 2050, with most growth expected in developing countries. Feeding the projected 9.1 billion will require overall global food production to increase by 70 per cent, while production in developing countries may well have to almost double"* (IFAD, 2011). According to the updated policy if IFAD, rural economic growth and poverty reduction requires a broad approach, not only dependent on agriculture but also on development of the rural non- farm economy.

There is no doubt that the theory has been tested, questioned and re- examined several times since the first classical studies. Some studies find strong evidence for the theory, other find that there is no inverse relationship and some find that the relation between land size and productivity is ambiguous. I will give a brief literature review on a selection of empirical studies of the inverse relationship, structured by the conclusions the different researchers make.

4.1 Support of the theory

Bardhan (1973) uses individual farm-level data for nearly 1,000 Indian farms to investigate the inverse relationship between farm size and output per acre in paddy agriculture. He concludes that the observations are likely to be the result of production uncertainty in agriculture and other factors involving the interlinked phenomenon of land- and labor-market imperfections. In order to test the heterogeneity of family and hired labor he uses the regression equation:

$$\log Q = \log C + \beta_1 \log M + \beta_2 \log F + \beta_3 \log A + \beta_4 \log w + \epsilon$$

Where Q is value of crop production, C is the constant term, M is gross cropped area per net sown area, F is number of fragments (into which the farm is parceled) per acre, A is net sown area and w is the average wage paid to hired labor by each farm. ϵ is an error term that represents all other variables that determine the value of crop production. OLS- regression results show that in paddy agriculture A has a significantly negative coefficient, which suggests that even after taking into account the impact of cropping intensity, fragmentation, and the wage rate on the use of labor per acre, value of production decreases as the size of area increases.

Carter (1984) uses a pooled farm level dataset of Indian agricultural data from the 1950s and he find a significant, monotonic inverse relationship. He test the hypothesis that the inverse relationship stems from the fact that small farms tend to have skilled self- employed farmers, while large farms employ unskilled, less productive landless workers. In addition, he tests the hypothesis that the inverse relationship may be a misidentification of the effect of soil quality on production, because in areas of greater soil quality, population may have grown relatively rapidly, leading to a subdivision of land into small holdings. The basic conclusions from his study are that the relationship is not a reflection of bias resulting from sample selection based on farmer literacy, nor is it a misidentification of village effects. The analysis favors the explanation that the inverse relationship stems from family labor surplus on small farms.

Byiringiro and Reardon (1996) use data from Rwanda and examine how farm size affect land and labor productivity, how land degradation affects farm productivity, and conversely, how soil conservation investments affects crop productivity. They find that there is a strong inverse relationship between farm size and land productivity, and the opposite for labor productivity. The marginal value of labor on smaller farms was well below the market wage, and this might explain the inverse relationship. However they introduce an additional possible explanation, namely that small farms are more productive because they invest more in soil conservation. Despite the fact that small-scale farming is more intensive, the inverse relationship is not mitigated by the smaller farms being more eroded. Rather they observe that small farms have twice the soil conservation investments than do large farms and that they are not more eroded. They find that farms with greater investment in soil conservation have much higher land productivity than the average.

4.2 Evidence of a positive relationship

Fafchamps (1992) investigates the relationship between farm size and cash crop production and finds a theoretical explanation for why large farms produce crops of higher value than small farms. He does not conduct an empirical investigation, but applies a simple theoretical model of crop portfolio choice and investigates the effects of consumption preferences on output choices. He finds that large farmers differ from small farmers in that they have better access to credit, better ability to sustain risk and staple foods make out a smaller share of their total consumption expenditures. Smaller farmers are in a situation were food security at the household level is best achieved by a high degree of food self-sufficiency. Subsistence concerns for smallholder farmers make them specialize in less profitable staple crops, while large scale farmers specialize in cash crops. Fafchamps (1992) explains this by failures in rural food markets, leading to a high variance in food prices. When households are risk averse and face food security stress, this gives high covariance between individual and market supply and smallholder farmers will produce low value food crops for own consumption.

Kevane (1996) demonstrates that a positive relationship between size and productivity is both theoretically and empirically possible for Western Sudan. He uses two different data sets, a survey of Bireka village and a survey of 116 households in four village clusters to the south of Bireka around the market town of Jaibat. He shows that the positive relationship is likely to arise in settings where households have limited access to credit and mutual insurance, and where landlords are reluctant to rent out land because of the fear of losing property rights. He argues that these settings are as common as the labor market dualism invoked to explain the inverse relationship. Market failures in credit and insurance markets lead poor farmers to adopt less profitable, extensive strategies of cultivation and Kevane (1996) notes that this might lead to small farmers being more and more marginalized as the large farm sector buy more land and are able to expand.

Dorward (1999) contributes to the limited literature on farm size and productivity in smallholder agriculture in sub-Saharan Africa using farm survey data from Malawi for four seasons in the 1980s. He uses a linear programming farm-household model and provide evidence of a positive relationship between farm size and productivity in both labor scarce and land scarce smallholder farming. He argues that poorer farmers might be less productive since they may be driven to take outside work and thus only be part time farmers because of poverty. In addition, he notes that even in the absence of capital intensive technology, almost all farming requires working capital to finance family or hired labor up to harvest time. The positive farm size relationship in Malawi can thus be explained by market failures in capital and insurance markets.

4.3 Ambiguous effects

Bhattacharya and Saini (1972) examine disaggregated farm management data for individual farms and apply tests for the correlation between farm size and gross value of output per acre. The data relate to Ferozepore district for the years 1955-56, 1956-57, 1967-68 and 1968-69 and to Muzaffarnagar for the same years and also for 1966-67, both districts in India. Their investigation shows changes in the size-productivity relationship in these regions from the period before and after the green revolution. They regress value of output, V, per acre of gross cropped area, G, that is $\frac{V}{G}$, on gross cropped area, G, and they find mixed results. In the periods up to 1967- 68 for Muzzafarnagar the average village correlation seems to be significantly negative and for Forezepore the results are much closer to zero but still significantly negative for 1956- 57. However, for 1968- 69 the correlation between G and $\frac{V}{G}$ seems to have become positive in both the regions. This means a change from negative correlation to positive correlation in the district of Muzaffarnagar and from near zero correlation to positive correlation in the district of Ferozepore. The authors explain this shift with the technological change the regions went through in the green revolution.

Deolalikar (1981) follows up on the results from Bhattacharya and Saini (1972) and uses regional data from India to test two hypotheses: 1) Whether the small farm sector enjoys a yield advantage over the large farm sector and 2) if this advantage diminishes, or reverses, with technical change. The data seem to confirm both hypotheses; small farms are more productive than large farms, however technical progress reduces yields of the small farm sector relative to the large farm sector. According to Deolalikar (1981) is seems that the explanation, on the one hand, lies in the reduced importance of labor, since this abundant on small farms. On the other hand, the reversing of the inverse relationship might stem from increased importance of cash inputs like fertilizer and improved seeds and the fact that small farms can't afford to apply these.

Carter and Wiebe (1990) analyze data for Kenya and find that a statistically significant U-shape characterizes the relationship between farm size and both output and family income. They observe that the intensity of family labor application on small farms is clear, and this sharply drives down profits on smaller farms. Profits even fall below zero for the smallest farms. However, Carter and Wiebe (1990) notes that this is because the price of family labor is set to the market wage, overstating the real opportunity cost of family labor to farm households. In the Kenya data used by Carter and Wiebe (1990), farms less than 3 acres in size borrow an average of 2 shillings per acre to finance production costs, while large farms borrow 250 shillings per acre. This clear sign of credit market imperfections, interacting with an imperfect labor market, is mentioned as one possible explanation for the striking size-productivity relationship displayed in figure 7. The analysis suggests that, despite their access to cheap labor, the potential hyperproductivity of small farms is eventually overwhelmed by capital constraints.

Lamb (2003) examines the role that land quality and imperfect markets play in

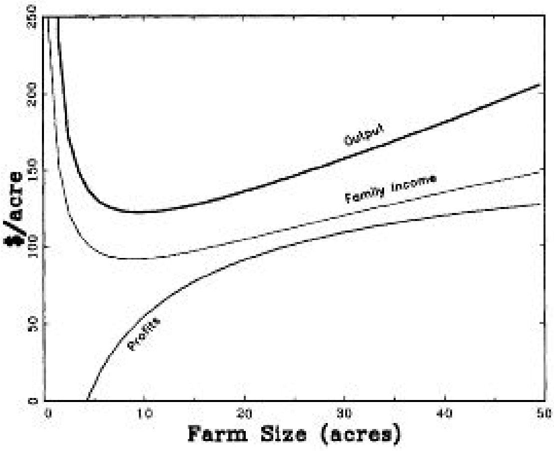


Figure 7: Farm size and net returns per acre. Source: Carter and Wiebe (1990)

generating the inverse productivity relationship in the International Crop Research Institute for the Semi Arid Tropics (ICRISAT) data. He finds that the inverse relationship could not be explained by unobserved land quality differences or rural market imperfections alone. After controlling for imperfections in village labor and land markets, along with differences in household land quality, the inverse relationship in male labor demand vanishes, but not in female labor (Lamb, 2003). However, when he uses instrumental variables estimation to correct for measurement error, the relationship vanishes also in the female labor demand model. Thus, there is a possibility that the inverse relationship is a result of measurement error causing land size to be an endogenous variable.

4.4 Competing explanations

As this short literature review demonstrates, there is no clear conclusion on neither the validity of nor the explanation for the inverse relationship. Assuncao and Braido (2005) attempt to make a summary of the most important hypothesis and reviews five competing explanations for the inverse relationship. Using data from India and Village Level Studies from ICRISAT, they test all of the following five hypothesis: 1) Imperfect labor supervision capability; 2)Food security stress; 3) Differences in farmer skills; 4) Plot heterogeneity; 5) Measurement error.

Imperfect labor supervision capability
Assuncao and Braido (2005) note that supervision capability depends on the total area managed by the farmer. They run regressions that correct for both plot area and total area managed by the farmer. The results show that plot productivity

is inversely related to plot area, however it is positively related to the additional area managed by the farmer. Because of this the authors reject this as a possible explanation.

Food security stress and differences in farmer skills
According to these explanations, the inverse relation is caused by stress and skill, which are unobserved characteristics of the farmer. Assuncao and Braido (2005) use farmer fixed effects to account for household characteristics that are constant over periods. In addition, to control for farmer unobserved characteristics that varies over periods, the authors apply dummy variables for each farmer and period. The results show that the plot productivity remains inversely related to the plot area, rejecting these two theories as possible explanations.

Plot heterogeneity and measurement error
Critics of the inverse relationship have noted that the puzzle may be generated by plot characteristics which are privately observed by the farmers or by measurement error in plot size (Lamb, 2003). The ICRISAT data used by Assuncao and Braido (2005) display plot level information in different periods and the cropped area of each plot is not constant over time. To correct for unobserved land quality they apply plot fixed effects, however the inverse relationship is still significant. Because of this they argue that the inverse relationship is not due to unobserved land quality unless it evolves over time. The authors reason that privately observed land quality and shocks will affect the choice of inputs, then if follows that input choices would partially reveal plot-level heterogeneity that was observed by the farmer but not by the econometrician. Therefore they introduce inputs into the regression to correct for both plot heterogeneity and measurement error. They find that the inverse relation vanishes after the introduction of per acre value of non labor and labor inputs as control variables.

The findings of Assuncao and Braido (2005) are very conclusive in rejecting all explanations based on farmers unobservables. According to them, plot- specific features that evolve over time, such as privately observed land quality and weather conditions, as well as measurement errors in the plot size remain as the possible explanations for the puzzle.

5 Evidence from Zambia

5.1 Inverse relationship in Zambian maize production

There exists one study on the inverse relationship in Zambia. Kimhi (2006) examines the relationship between maize productivity and plot size in Zambia. Maize is the major crop on small and medium size farms in Zambia. He uses data from two separate surveys conducted for the crop season 1993- 94 by the Central Statistical Office (CSO) in Zambia; Crop Forecast Survey and Post Harvest Survey. The sample was designed to be representative for Zambia as a whole. Large commercial farms were excluded so that the population was defined as small- and medium-scale farm households.

Kimhi (2006) follows up the results from Assuncao and Braido (2005) and Lamb (2003) and the econometric specification of his model accounts for the possible bias caused by crop composition effects, in addition to nonlinear effects of size on productivity, differences in land quality across farms and measurement error in observed plot size. The author argues that he overcomes crop composition effects by focusing on plots devoted only to maize and this avoids the problems that small and large farms choose to grow crops of different value, as noted by Fafchamps (1992). In addition, by correcting for the endogeneity of plot size devoted to maize, he avoids crop composition effects and bias in the sample distribution of farms. He also corrects for measurement error. The reasoning behind this is that farms with a comparative disadvantage in maize cultivation will devote only small plots, or none at all, to maize and this can possibly create a bias in the relationship between size and productivity. Kimhi (2006) uses a 2SLS procedure with the two following equations forming a recursive model:

$$a = \alpha_0 + \alpha_A A + \mathbf{X_a}\alpha_X + u_a \quad (1)$$

$$Y = \beta_0 + \beta_a a + \beta_{aa} a^2 + \mathbf{X_Y}\beta_x + u_Y \quad (2)$$

Where A is total land, a is land allocated to maize, Y is yield, X_a and X_Y are matrices of explanatory variables and X_a is a subset of X_Y. a^2 is included as an explanatory variable in order to allow a nonlinear effect of plot size on yield.The results from the first stage regression is shown in figure 8a and from the second stage in figure 8b.

From figure 8a we can see that the fraction of land allocated to maize is negatively associated with the variable "Total land", that is the amount of total land used to grow field crops. According to Kimhi (2006) this means that farms with larger plots of field crops tend to have a more diversified crop mix than smaller farms. It also seems to be a contradiction in the effect of market access on plot

Results of the censored regression of the fraction of land allocated to maize

Variable	Coefficient	T-value
Intercept	0.9666	30.529**
Total land	−0.0146	−3.984**
Female	−0.0626	−3.868**
Age	0.0624	3.725**
Higher education	0.1516	8.626**
Distant road	−0.0764	−5.009**
Distant market	−0.1028	−4.807**
No market access	0.0435	2.408**
Extension	0.0019	0.129
Irrigation	−0.0276	−1.322
No irrigation-know	−0.0332	−1.884*
No irrigation-funds	0.0122	0.188
Hired workers perm.	0.1312	2.642**
Family male workers	−0.0043	−1.583
Family female workers	−0.003	−1.217
Draught animals	−0.0225	−2.046*
Machines	0.0523	4.225**
Sigma	0.5427[a]	
Number of cases	5,280	
Log likelihood	−4,273.99	

Notes: The model also included district dummies.
*Coefficient significant at the 5% level.
**Coefficient significant at the 1% level.
[a]The standard deviation coefficient was transformed prior to estimation to assure convergence; hence the standard error of the untransformed estimate is not reported.

(a) Land allocated to maize

Results of the maize yield equation

Variable	Actual maize land		Predicted maize land	
	Coefficient	T-value	Coefficient	T-value
Intercept	9.6788	10.0739**	11.3500	11.3067**
Maize land	1.3486	7.6524**	−0.6094	−2.4300*
Maize land squared	−0.0288	−2.3330*	0.1013	4.2906**
Female	−0.4273	−0.9959	−0.9118	−2.0826*
Age	−2.7361	−2.3890*	−0.9763	−0.8371
Higher education	0.5412	1.2533	0.9814	2.2532*
Distant road	−0.3519	−0.7735	−0.2104	−0.4379
Distant market	0.5598	0.9594	0.5735	0.9589
No market access	0.0552	0.1257	−0.3701	−0.8248
Extension	0.4723	1.3410	0.5978	1.6580
Irrigation	−0.2127	−0.3194	0.0109	0.0161
No irrigation-know	0.1157	0.2616	−0.0107	−0.0238
No irrigation-funds	−0.5401	−1.2554	−0.4491	−1.0275
Hired workers perm.	2.6201	1.8720	3.0567	2.1574*
Family male workers	0.4711	7.3517**	0.4052	6.2123**
Family female workers	0.3259	5.8977**	0.3052	5.2160**
Draught animals	−0.2318	−1.1729	−0.1882	−0.9406
Machines	1.0100	4.2197**	0.9679	3.9926**
Credit received	0.3846	6.8329**	0.4867	8.5920**
Chemical fertilizer	0.0357	2.0076*	0.0362	2.0056*
Selectivity correction term			4.8091	1.8692
Sigma	9.86		9.98	
Number of cases	3,973		3,973	
R^2	0.207		0.188	
Adjusted R^2	0.193		0.173	
F-statistic	14.357		12.565	

Notes: Both models also included district dummies.
*Coefficient significant at the 5% level.
**Coefficient significant at the 1% level.

(b) Maize yield

Figure 8: Regression results. Source: Kimhi (2006)

size devoted to maize. Both the coefficients for "Distant road" and "Distant market" are significantly negative, however the coefficient for "No market access" is significantly positive. Kimhi (2006) interprets this to mean that market access affects crop composition choices. Farms with no access to markets are those with the highest fraction of land devoted to maize, other things being equal. When markets become accessible but are relatively distant, farmers allocate more land to other crops. Finally when markets become more accessible plot size devoted to maize again rises (Kimhi, 2006). This implies that farmers without market access grow maize as a food crop for own consumption, farmers with some, but poor market access grow less maize and farmers with good market access grow maize as cash crop. Maize is thus both a food crop and a cash crop and almost all farmers grow some maize.

In figure 8b, two versions of the yield regression, based on equation 2, are reported. In the first version on the left hand column actual plot size is used as an explanatory variable, without correcting for endogeneity, while the version on the right hand column uses the predicted plot size from the regression based on equation 1. The two results are shown graphically in figure 9.

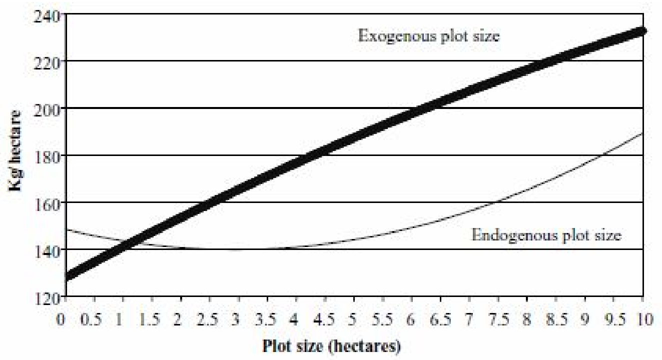


Figure 9: Calculated yield as a function of plot size. Source: Kimhi (2006)

From figure 8b and 9 it is obvious that when plot size it treated as an exogenous variable, maize yield is monotonically increasing with plot size. However, when controlling for endogeneity, the yield is first decreasing with size and then increasing. The size in which the minimum yield is attained in this latter case is approximately 3 hectares. Kimhi (2006) notes that 86% of the households in the dataset use less than 3 hectares of land for maize cultivation.

Kimhi (2006) states that in Zambia there exists an inverse relationship between plot size and the yield of maize for most small- and medium-size farms. However, he notes that the results imply that economies of scale in maize cultivation in Zambia become operative above a certain plot size threshold. The results supports the trend of a dualistic distribution of Zambian farms with respect to size. Because of this Kimhi (2006) concludes that in a land-abundant country such as Zambia, the inverse relationship is likely to be a result of market imperfections and that it is necessary to target imperfections in the land market, in the credit market, and in markets for inputs and products to improve the conditions for small farmers in Zambia.

5.2 Zambian small-scale farmers: opportunities and constraints

I will interpret the findings of Kimhi (2006) in the light of updated research on the opportunities and constraints faced by Zambian small-scale farmers. There has been made several studies of Zambian peasants, among others are different participatory studies, analyzes based on general equilibrium models and several other models. In this section I give a short review of the results from these studies.

As noted earlier, there exists a clear dualism in Zambian agriculture, however smallholder farmers are not a heterogeneous group. Siegel (2008) analyses the population of small-scale farmers and his observations point to the direction of a "dualism within dualism". The opportunities and constraints for smallholder farmers depends on many factors like the assets, livelihoods, income and consumption of households. Siegel (2008) and Pinder and Wood (2003) note that agricultural growth and better possibilities for small-scale farmers does not unambiguously come hand in hand, and a significant proportion of smallholder households should not expect to directly benefit from commercialization in the short run. However, in some areas of the country the possibilities for intensification and increased commercial production are good. The investigation of the inverse relationship in maize production by Kimhi (2006) also reveals this ambiguity of the role of small-scale food production in regard to economic growth. Small-scale farmers experience many constraints, Deininger and Olinto (2000) highlight the three most important:

- Inputs
- Productive assets
- Markets

All of these constraints are non-price factors and together they induce risk on smallholder farmers that forces them to make conservative decisions. First, access to purchased inputs is restricted because of lack of support services like credit, and in addition smallholders have restricted access to inputs like land and labor. Second, access to complementary productive assets, like animal draught power, is a key constraint on productivity and amount of land cultivated, in addition lack of assets restricts access to credit. Third, lack of markets for timely buying and selling restricts income possibilities.

5.2.1 Access to land

Siegel and Alwang (2005) finds that the average household that use hand-hoe technologies cultivates approximately 3.2 hectares of land. Households cannot cultivate more due to limited availability of household labor during the peak seasons of planting and weeding. For the hand-hoe household, the minimum feasible amount of land is about 2.2 hectares. If the household holds less land than this it cannot produce enough maize to meet its food-security constraint (Siegel and Alwang, 2005). A household that can cultivate using animal drought power, that is oxen, get more out of family labor and can survive on 2.17 hectares on average. Siegel and Alwang (2005) notes that his result shows how land reform, together with the introduction of labor-saving technology, can help even relatively poor farmers.

Siegel (2008) comments on the distribution of land when comparing smallholder households. The results are shown in figure 10. Households are divided into quintiles ranged from poorest to richest. He finds that average total operated land varies little by quintile. However when looking at allocation decisions with regard to type of crop, the richest households allocate on average more than twice as much land to non-food crops as the poorest households do.

		Quintile of National Distribution				
	All	Poorest 20%	2	3	4	Richest 20%
Hectares of food crops	1.08	0.97	1.11	1.11	1.05	1.16
Hectares of non-food crops	0.11	0.05	0.09	0.14	0.12	0.12
Hectares of all crops	1.19	1.02	1.20	1.26	1.16	1.28
Hectares of all crops per capita	0.25	0.16	0.21	0.24	0.28	0.36

Figure 10: Land use patterns. Source: WB (2007)

5.2.2 Access to fertilizer

The poorest farmers with the smallest land holdings lack access to inputs like fertilizer and hybrid seeds. Regression results indicate that the combination of hybrid seeds and fertilizer strongly boost maize output compared to farmers who plant local varieties with no fertilizer (Siegel and Alwang, 2005). This indicates that fertilizer access to the poorest can increase productivity. Jorgensen and Loudjeva (2005) have reviewed results from participatory research done among farmers in ten communities in Zambia. They find that the top two answers when respondents rank the causes of poor crop yields are that; 1) Fertilizer is not available on loan; and 2) Fertilizer is always late or too expensive.

In participatory studies, fertilizer is the most commonly mentioned production constraint in every agricultural zone (Jorgensen and Loudjeva, 2005). However, the authors argue that generous subsidies have led to fertilizer overuse in the past. Siegel and Alwang (2005) also find evidence of inefficient overuse of fertilizer. His results show that 20% decline in fertilizer prices is associated with only a 6% increase in income. Further, as the fertilizer price is reduced from 80 to 70 percent of current prices, a one percent decrease in the price of fertilizer is associated with a 0.3% increase in household income. At the point where the price is reduced to 70% of current prices, we reach a ceiling on fertilizer use (Siegel and Alwang, 2005).

Jorgensen and Loudjeva (2005) argues that fertilizer investments do not necessarily address the real problems. Because small farmers experience labor constraints in periods of planting and harvesting in addition to lack of access to infrastructure, land, draft animals and equipment, people see fertilizer as key to problems such as climatic risk. However, to improve the situation for smallholders it might be more efficient to address the structural problems than subsidizing fertilizer.

5.2.3 Access to animal draught power

Nationally, not more than 10 percent, or 84,000 farmers, of Zambia's small- and medium-scale holdings use their own animal draft power (Haggblade and Tembo, 2003). This low number is caused by a low number of cattle, high concentration of cattle ownership and limited access to the necessary implements. Cattle ownership remains highly concentrated with 10% of the holdings accounting for 95% of the cattle. This means that only the better- off small-scale farmers can afford to invest in oxen, while the majority of smallholders must either cultivate with hand hoes or obtain oxen from neighbors via rental or borrowing (Haggblade and Tembo, 2003).

For smallholder farmers with less than 5 hectares of land, lack of animal draft power, like oxen, is a central productivity hampering factor. Siegel and Alwang (2005) note that the use of oxen can especially save labor at critical points in the cropping cycle and help smallholders plant more land without resorting to hired labor. Increasing land under production by smallholders is one of the keys for agricultural growth to be poverty reducing. Siegel and Alwang (2005) use a baseline smallholder model to evaluate policy reform scenarios. They show that households using hand-hoe technologies cannot cultivate more than approximately 3.2 hectares of land due to limited household labor availability during months of land preparation and beginning of season weeding. However, with oxen land in production grows to 4.2 hectares and the household is instead bound by labor availability in the months of maize harvest.

5.2.4 Access to markets

The large commercial farms are mostly located in the central parts in close connection to the central road network and the the main transport route, the line-of-rail. Smallholders are dispersed throughout the country, many located far away from the railway and the rural road system is poorly developed. The poor state of rural infrastructure, and the geographical dispersion of smallholders induces heavy transaction costs for marketing of both agricultural inputs and outputs (Siegel and Alwang, 2005).

Median distances seem large for the nearest bank (48 km), public phone (40 km), and agricultural input markets (25 km) selling equipment and fertilizer needed for modern agriculture (Siegel, 2008), thus it is evident that central and export markets are hard to access for smallholders. Local markets are more accessible to rural households, Siegel (2008) finds that the median distance to a food market is 9 kilometers. Siegel and Alwang (2005) concludes that remoteness and low confidence in markets imply important welfare costs. The combination of less remoteness and increased confidence in the market is associated with about a 25 percent increase in net returns for all households compared to remote, food-security-constrained households.

5.2.5 Conservation farming

Since 1996, a growing coalition of stakeholders from the private sector, government and donor communities has promoted a new package of agronomic practices for smallholders in Zambia, called conservation farming (CF) (Haggblade and Tembo, 2003). CF is a method developed to conserve farmland, keep water and nutrients in the soil for longer and hamper land degradation. Instead of churning up the soil, CF farmers leave a permanent soil cover and drill through the upper layers to plant the seeds. They use herbicides and organic matter in the soil to deal with the weed problem. Leaving the soil intact also increases its ability to hold onto carbon dioxide, which means less CO_2 is released into the atmosphere (Layton, 2011). In areas where land has been severely damaged by longterm ox plowing and repeated heavy doses of inorganic fertilizer, investments in conservation farming can help reclaim damaged farmland by restoring soil fertility (Haggblade and Tembo, 2003). The conservation farming system in Zambia involves:

- dry-season land preparation using minimum tillage methods (either ox-drawn rip lines or hand-hoe basins laid out in a precise grid of 15,850 basins per hectare)

- no burning but rather retention of crop residue from the prior harvest
- planting and input application in fixed planting stations
- nitrogen-fixing crop rotations

(Haggblade and Tembo, 2003)

Conservation farming might be a way to both increase small-scale farmers incomes, reduce the reliance on fertilizer and better ensure sustainable farming practices. Haggblade and Tembo (2003) have conducted budget analyses which compare the value of increased output with the increased input and labor costs. The results suggest that hand hoe conservation farming outperforms conventional tillage, generating higher returns to both land and peak season labor. In it's animal draft variant, conservation farming with ox drawn rippers likewise holds the potential to outperform conventional ox plowing, offering higher returns to peak season labor (Haggblade and Tembo, 2003). However, the results are not equally promising in all parts of the country. Population growth and increased reliance on agriculture have fueled migration into less fertile areas where fertilizer has helped improve yields. Participatory research by Jorgensen and Loudjeva (2005) in these areas show that stakeholders report a need for fertilizer even if conservation farming is used (Jorgensen and Loudjeva, 2005).

6 Discussion

The classical debate on small-scale versus large scale farming caused by a dualistic structure of agriculture takes a different turn for Zambia than the stylized fact of the inverse relationship have implied. The dualistic structure of agriculture is strong, with a large population of small-scale farmers at the one end and a small population with large estates on the other end of the distribution. At the same time the relationship between farm size and productivity is ambiguous. small-scale farming households are defined as households with less than 5 hectares of land, however the results from Kimhi (2006) show that land plots devoted to maize smaller than 3 hectares experience decreasing returns to plot size. Above the 3 hectares- threshold we observe increasing returns to plot size. This implies that small-scale farmers are not a homogenous group and that farmers with the smallest land holdings experience different constraints than more better off farmers with a couple of more hectares of land. As notet by Siegel (2008), there seems to exist a dualism within dualism.

The following discussion will show that the main difference between ultra poor and less poor small-scale farmers are the degree of dependency of wage-income and the dependency of wage-income again depends on the access to land. It follows that small-scale farmers dependent on income from casual labor on lager farms are most likely to loose on agriculture-led growth. To fight hunger the constraints of this group must be addressed.

6.1 Potential poverty trap for small-scale farmers

Failures in rural markets can help explain the U- shaped relationship shown in the results from Kimhi (2006). The inverse relationship for plots below 3 hectares in size might stem from market failures in the labor market, credit market, insurance market and the land market. It is evident that smallholders faces a wide range of constraints that can cause them to be stuck in a low level equilibrium, a potential poverty trap.

Labor market
The downward sloping part of the U- curve in figure 9 might stem from labor shortage. Small farms with simple technology and family labor experience serious constraints because of labor shortage in the period of land preparation and in the harvest season. This makes the smallest plots more productive than plots close to 3 hectares in size, because small farms apply more family labor per land unit.

Credit market
Lack of access to credit makes small-scale farmers unable to buy inputs or employ extra labor and repay after the harvesting season. It is plausible to assume that the access to credit is the same for all smallholders with maize plots up to 3 hectares in size. Cash flow constraints become evident for all small-scale farmers, however the smallest farmers have the ability to use their scarce resources like seeds and fertilizer more intensively per land unit than slightly larger farms that experience the same credit restrictions. Lack of access to credit also restrict smallholders' ability to invest in productive assets like animal draught power that potentially could have made them able to overcome the labor constraint threshold that is evident at approximately 3 hectares of operated land.

Insurance market
The smallest farms might also be more productive because of the lack of insurance. Smallholders generally lack access to irrigated land and are highly vulnerable to weather risk. This combined with lack of credit opportunities gives few, or none, possibilities for self insurance. The weather also affects all in the same region, so

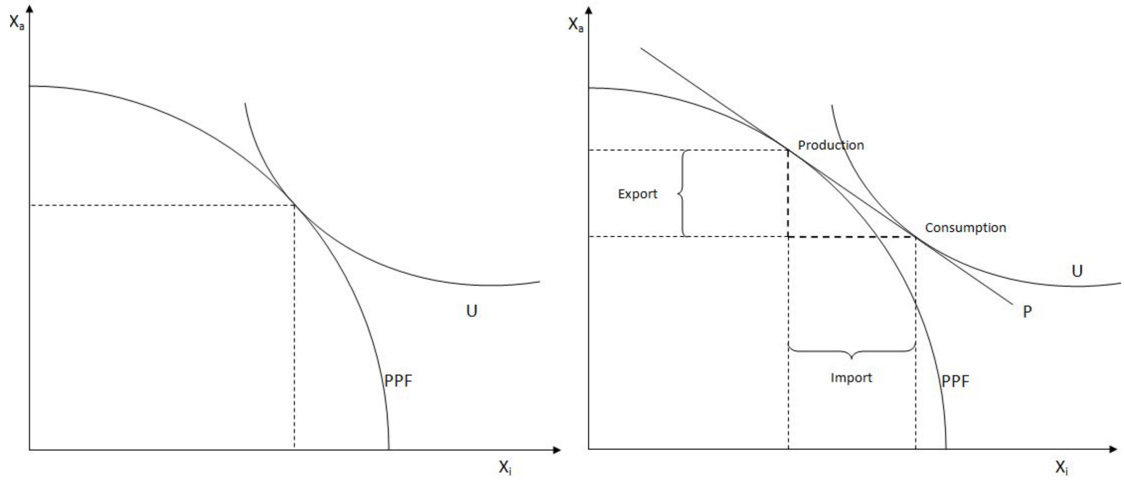
mutual insurance is difficult. This gives two effects that are possible causes of the negative relationship between size and productivity up to 3 hectares. First, the smallest farms might choose a more diversified crop composition than larger farms in order to be less vulnerable against weather risk or diseases. More diversified production can lead to more efficient land use and higher yields per land unit. Second, the smallest farms experience food security stress to a larger extent than households with larger holdings. Farms with smaller holdings than what is necessary to be self sufficient might use their resources more efficient because of food security stress. This can contribute to higher output per land unit on the smallest plots compared to plots closer to 3 hectares in size.

Land market
Land is abundant in Zambia, however it is highly unequally distributed. According to figure 4 (WB, 2003), the majority of small-scale producers cultivate less than 2 hectares of land, which is less than the subsistence requirement size. Failures in the land tenure system resulting in vulnerable groups lacking access to land might enhance the food security stress that causes the downward sloping part of the U-curve in figure 9.

Thus, the results of Kimhi (2006) illustrates a potential poverty trap for the poorest smallholder farmers. This is the same trap that is shown in the results of the analysis of Siegel and Alwang (2005). Siegel and Alwang (2005) states that smallholders with less than 2,2 hectares of land cannot feed themselves and that at 3,2 hectares labor constraints become binding. To overcome the poverty trap they will need access to a combination of more land and labor saving technology, like animal draught power (Siegel and Alwang, 2005).

6.2 Potential losers with agriculture-led growth.

The PRSP for 2006- 2010 for Zambia promotes agriculture-led growth through increased production of export crops. Export-orientated growth is viewed as essential for obtaining the foreign exchange Zambia needs to meet its import bill, keep down inflation, and fuel its economic growth (Pinder and Wood, 2003). This is based on classical economic theory of gains from trade. A simple model that can illustrate this is shown in figure 11. Assume we have a country with a two-sector economy with no unemployment. One sector is the agricultural sector that produces agricultural goods, X_a, the other sector is the industrial sector producing industrial goods, X_i. All possible combinations of production of these two goods given the country's endowment of factors of production is shown in the production possibilities frontier, marked PPF. The equilibrium without trade can be found using the indifference curve for a representative consumer, marked U. The equilibrium without trade is shown in figure 11a.



(a) Without trade (b) With trade

Figure 11: Gains from trade.

The situation with trade is shown in figure 11b. With trade the country is no longer bound by its production possibilities and the consumption possibilities are given by the exchange opportunities caused by the international market prices, this is illustrated by the line marked P. Production of agricultural products will increase and a large share of the production will be exported. Production of industrial products will decrease, however the revenues from export will finance import of industrial products and consumption will increase. The country as a whole will gain from trade since total consumption increases. It is possible that not all consumers will gain from the new situation, i.e. if there exists hunger in the country and the consumption of agricultural products does not increase, hunger might prevail even with trade. However, this is a question of distribution of the gains from trade. There is no doubt that the welfare of the country as a whole increases.

Despite of this, the path of agriculture-led growth in Zambia has been questioned. Higher agricultural production, low inflation and higher growth are not sufficient conditions to fight hunger and improve the situation for smallholder farmers. There is a potential for agriculture-led growth not to be pro-poor. I will show that the reason is closely connected to the lack of possibilities of small-scale farmers to be self- employed. The classification of farmers in figure 4 shows that there is approximately 800.000 households defined as smallholders with less than 5 hectares of cultivated land. Pinder and Wood (2003) investigates this group even closer and finds that Zambian smallholders are far from a homogeneous group. According to them, the social characteristics of each group of small-scale farmers are broadly:

(Sub-)Subsistence farmers
: This group constitutes approximately 200,000 households that are not commercially viable farmers, and are unlikely to ever become so. They represent the most vulnerable social groups: ultra poor, often female headed households, or elderly or child headed households, the chronically sick and / or disabled – with less than sufficient production to feed themselves throughout the year. They are usually far distant from main rail and road routes, occupy the least arable land in the community, and have no resources on which to call in event of a 'shock' (eg drought, death, sickness). They usually provide seasonal unskilled labor to large farm estates and out-growers' holdings.

Marginal small farmers
: 300,000 households could, potentially, become self-sufficient in food and capable of producing a small marketable surplus. They are also ultra poor, or bordering on ultra poor, but have some resources, even though very small and weak, on which to call. This is for example greater physical strength and better health, slightly more and better land closer to means of irrigation, some small savings or livestock to use as collateral for informal or micro-loans. They often rely on obtaining casual work on larger farms and estates.

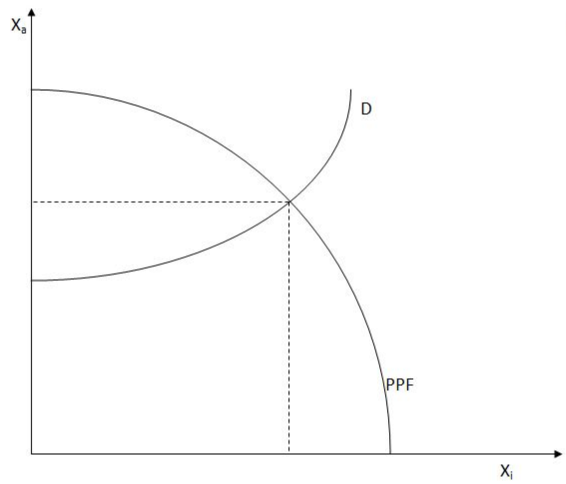
Emergent small farmers
: Approximately 300,000 households are poor but potentially, or already, commercially viable small-scale farmers. They often have resources which are not always maximized due to structural economic conditions such as lack of access to markets because of poor infrastructure, or inability to raise small loans for investment because they do not hold title to their land. They have the potential to participate, or may well be participating already, in export-out-grower schemes, or they are functioning as commercially viable, independent small-scale farmers selling on to the domestic market instead.

At an average of between 5-6 per household these 800,000 households together total the estimated 4.6 million rural poor and ultra poor in Zambia (Pinder and Wood, 2003).

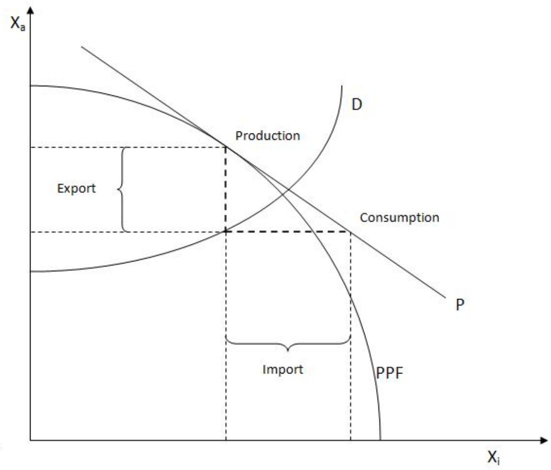
The central point of this sub- classification of small-scale farmers is that sub-subsistence farmers and marginal small farmers, together 500 000 households, are dependent on income from labor work on larger farms and estates. They consume all output they produce themselves, however they do not have enough land and resources to solely depend on own cultivation and be self sufficient. This means that they are not necessarily primarily small-scale farmers, but instead agricultural workers and net buyers of food. If these household do not get access to more land and are enabled to be self sufficient, they will need increased labor income and access to well functioning local food markets to buy their necessary food bundle. However the following discussion will show that wage-income might decrease with export-led growth.

Pinder and Wood (2003) notes that, although they will undoubtedly contribute to economic growth, the policies to promote export of non-traditional agricultural products are unlikely to have more than minimal impact on the livelihoods of the very poor rural households who are dependent on, and likely to remain dependent on, sub-subsistence agriculture. In addition, Pinder and Wood (2003) argues that export-led growth is likely to contribute to deepening the existing dualistic structure of agriculture, with large and medium export oriented farmers experiencing growth, whilst marginalized and sub-subsistence farmers continue to experience chronic food insecurity. This is the same point made by Fafchamps (1992). He shows that improving cash crop productivity will fail to reach small-scale farmers who, for food security reasons, are unable to allocate a significant amount of resources to cash crop production. Besides, it would favor only better-off farmers who are in a position to grow cash crops.

The arguments of Pinder and Wood (2003) and Fafchamps (1992) can formally be shown by a simple model for a two- sector economy with international trade by Mehlum (2009). Consider again the dual economy in figure 11 with two sectors, one agricultural sector producing agricultural products, X_a, and one industrial sector producing industrial products, X_i. Assume now that the country's population is divided into two classes with different consumption patterns, we still assume that there is no unemployment. One class consists of workers, both agricultural- and industrial workers, that consume agricultural products. The other class consists of capitalists and owners of medium- and large scale farms that market their output, this class receives all profits and consumes industrial products. In figure 12a the equilibrium of consumption and production in the situation without trade is shown. The production possibilities frontier is the curve marked PPF. The PPF shows how the country can take advantage of labor and productive assets to produce industrial products or agricultural products for sale. Food produced for own consumption is not included since these goods never reach the market. Since our economy has two classes of consumers, we do not use the classical preferences of an representative consumer to illustrate the production- consumption equilibrium as we did in figure 11. Instead we have the demand curve, marked D, that captures the relationship between labor allocated to agriculture, agricultural productivity and demand for agricultural products. The reasoning is as follows: The wage is determined by the marginal productivity of the last employed unit of labor. Starting with all labor in the agricultural sector, we must transfer labor from the agricultural sector to the industrial sector for industrial production to increase, this will increase the marginal productivity and thus the wage. Increased wage will increase the demand for agricultural products since only wage laborers consume these products. Because of this the demand curve is upward sloping. For the situation without trade, the equilibrium is shown in figure 12a. In equlibrium the wage-income is exactly equal to the value of all produced agricultural products and all capital income and profits from agricultural production is equal to the value of all produced industrial products.



(a) Without trade



(b) With trade

Figure 12: Simple model for trade. Source: Mehlum (2009)

With trade, shown in figure 12b, the exchange possibilities given by the market price are exactly as in figure 11 and the production and consumption allocations will be identical in the two models. However in figure 12b the effect on the welfare of the working class is evident on the curve D. Agricultural production will increase, thus more labor is needed in agriculture and the productivity and the wage will decrease. When wage decreases the consumption of agricultural products decreases, the surplus of agricultural products will be exported and the incomes from this export is used to finance import of industrial commodities. The result is that the welfare of capitalists and owners of large farms increases since they get increased incomes and consumption, while the incomes and consumption of the labor class decreases. When the rural labor class consists of small-scale sub-subsistence and marginal farmers, like in Zambia, this welfare loss will make them even more marginalized and keep them stuck in the poverty trap. The productivity in small-scale farming households will be affected through increased food security stress as well as reduced access to inputs and productive assets. This simple model illustrates the possibility that agricultural production and hunger might increase at the same time since incomes of workers will decline.

Because of the potential unbalanced growth that might benefit capitalists and owners of large scale farmers in stead of being pro-poor, Pinder and Wood (2003) argues that for Zambia it is important to also look at other routes for extending commercial agriculture, in addition to promotion of export-orientated agriculture. For example, development of a larger share in regional markets, and a stronger position in the domestic market for Zambian products that can be improved to competitively substitute for imports (Pinder and Wood, 2003).

According to WB (2006) one crucial measure to ensure well functioning rural food markets and market access for small-scale farmers, is building roads: *"Despite slower growth and less impressive export performance, building feeder roads and improving market access for staple crops is better at reducing poverty since the benefits accrue to the larger and poorer small-scale farm population."* This is also evident in the analysis by Kimhi (2006), where the coefficient for "Distant road" is statistically significantly negative in the second stage regression for maize yield, see figure 8b.

Research done by Thurlow et al. (2008) at IFPRI, using a computable general equilibrium model, shows that both food production and production of export crop can increase if Zambia follows a balanced agriculture-led growth path. Not only will broad agriculture-led growth increase incomes, food production and the opportunities for small-scale farmers, it will also increase GDP and overall growth more than export-led growth alone. Despite of this optimism, Thurlow et al. (2008) notes that not everyone will benefit equally under the scenario of agriculture-led growth. Just as noted by Mehlum (2009), housholds growing higher value export-oriented crops stand to gain more than food producing households.

6.3 Is there a need for redistribution of land?

Even though the 2011 Rural Poverty Report by IFAD indicates that there has been a shift in the discussion concerning rural development from a debate on redistribution of land to a debate on how to raise rural incomes through productive employment in the non- farm economy, it does not have to be a debate on choosing one strategy over the other. There is no doubt that the distribution of wealth in Zambia today is closely linked to the distribution of land that has root in the colonial period. One way to loosen the link is to give poor people income opportunities independent of their landholdings. That is, give opportunities for productive employment in the rural non- farm economy. However, current development plans have a clear focus on agriculture, and to fight hunger it is essential that the growth in agriculture is balanced and pro-poor. If questions of a more equal distribution of land is not addressed, the result might be an even sharper dualistic structure of the agricultural sector where the vulnerable rural households are stuck in a low level equilibrium as sub-subsistence producers dependent on casual labor income from work on large farms.

As referred to earlier, Siegel and Alwang (2005) finds that the minimum amount of land to be self sufficient is 2,2 hectares and in addition, as shown in figure 4, WB (2003) states that the majority of small-scale producers cultivate 2 hectares or less. This clearly implies that most small-scale farmers is dependent on labor income to survive. Pinder and Wood (2003) argues that the poorest and most vulnerable smallholders are not able to feed themselves and that parallel policies need to be in place to ensure equitable, pro-poor distribution of the benefits of growth that results from export-oriented agriculture. It is essential that these parallel policies both include social protection measures for the very poor, but should also aim to help marginal smallholders to commercialize their production and become full participants in the market economy (Pinder and Wood, 2003). For this to be possible most small-scale farmers need access to more land.

Land policy in Zambia is regulated by the Land Act of 1995. According to Jorgensen and Loudjeva (2005) the land policy is vague in respect to vulnerable groups. Despite the 30% figure of land supposed to be set aside for women and vulnerable groups, it defines neither "vulnerable groups" nor implementation mechanisms. The policy conflicts with many traditional tenure systems, and the government does not have the capacity to enforce reallocation. Even redistribution of state land would be difficult to implement or monitor, since the land registry is outdated (Jorgensen and Loudjeva, 2005). Since the act was introduced, there has not been made any attempts to fulfill the promises made.

There has been made attempts to amend the 1995 Land Act, but these attempts have stalled. The government have attempted to provide more land for commercial and emergent farmers by making un- utilized land into farm blocks (Jorgensen and Loudjeva, 2005). In addition commercial farmers have called for changes in how rents are assessed on state land, to take into account things like the rainfall a land receives and its access to infrastructure (Siegel and Alwang, 2005). Such changes would most likely lead to better use of land, however it might at the same time increase inequality since it will force already poor people onto lower-quality but more affordable land, while allowing already wealthy people to work the best land (Jorgensen and Loudjeva, 2005).

For agriculture-led growth to be pro-poor and contribute to fighting hunger, it is necessary to address the challenges of the land tenure system. The Poverty and Social Impact Analysis (PSIA) of land reform in Zambia by Jorgensen and Loudjeva (2005) recommends the government to improve the existing state system by providing secure title and access to good dispute resolution systems for the existing state land, before expanding it. In addition, immediate steps are recommended to address inequities in the traditional, customary tenure system, and after these steps are made traditional tenure should be given legal status (Jorgensen and Loudjeva, 2005).

7 Conclusion

I have shown that there is evidence of a negative relationship between farm size and productivity for a large proportion of Zambian smallholders, and this has important policy implications for the development of the agricultural sector in Zambia.

The investigation of the farm size-productivity relationship indicates a potential poverty trap for small-scale farmers. Increasing returns to farm size is evident, however only above the threshold plot size of 3 hectares. The potential poverty trap is caused by market imperfections in rural markets and the fact that most small-scale farmers rely on wage-income from casual work on larger farms. This makes them potential losers on export-led agricultural growth. Because of this small-scale farming can play a key role in fighting hunger, however it can also do the direct opposite and instead keep farmers stuck in a low level equilibrium. Smallholder farmers dependent on agricultural wage-income are potential losers on agricultural growth, and it is essential to address the constraints faced by this group.

Small-scale farmers in Zambia are estimated to consist of as much as 800 000 households, each operating less than 5 hectares of land and producing staple crops primarily for home consumption. They lack productive assets and cultivate land using hand- hoe, minimal input and household labor. Major constraints for smallholders are land holdings too small for self sufficiency, seasonal labor constraints, lack of input and output markets because of remoteness and credit constraints. If agriculture-led growth is to result in food security improvements, small-scale farmers have to be able to increase production both for own consumption and for sale. The most vulnerable groups are those with the smallest farms, sub- subsistence producers, in addition to marginal small farmers. These will need access to more land and more secure access to social security. For smallholders to be able to become viable small-scale producers, access to credit, inputs and productive assets is crucial. In addition they need market access to be able to increase incomes. The best way to ensure that agriculture-led growth can fight hunger in small-scale agricultural households is to reform the land tenure system and in addition develop well functioning local and regional food markets by building rural roads, especially feeder roads. This will give market access to potentially viable small-scale farmers and increase local food supply. Most rural households experience labor shortage in peak seasons, and productive employment in the rural non-farm economy in off-seasons is essential to increase incomes and reduce hunger.

Land degradation because of unsustainable practices like overuse of fertilizer is a potential problem for Zambian peasants. In addition smallholder farmers are very vulnerable to weather risk because of lack of irrigation. Conservation farming might be a part of the solution for many farmers. Conservation farming reduces the need for fertilizer, conserves water better in the soil and increases yields and incomes. However, access to irrigation, inputs and productive assets are crucial and conservation farming should act as an important supplement and not an alternative.

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