



Universität für Bodenkultur Wien
University of Natural Resources
and Life Sciences, Vienna

ASSESSING STRATEGIES TO REDUCE POVERTY IN RURAL MOZAMBIQUE

Benedito Cunguara

Doctoral Thesis

Supervisor:

Assoc. Prof. Ika Darnhofer

Reviewers (in alphabetical order):

Jochen Kantelhardt Professor of Economics of Sustainable Agricultural Systems,
University of Natural Resources and Life Sciences, Vienna

Julie Silva Assistant Professor of Geography,
University of Maryland, College Park

Marc Wuyts Professor of Quantitative Applied Economics,
Erasmus University Rotterdam

Institute of Agricultural and Forestry Economics
Department of Economics and Social Sciences

and

Centre for Development Research
cunguara@gmail.com

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*“The structural adjustment program has arrived but poverty
has worsened and its reduction remains chimerical.”*

Tazi, a popular singer
in the early 1990s in central Mozambique

Dedicated to my late dad
Armando Cunguara (1954 – 2006)

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Abstract

An overwhelming majority of the population in Africa relies on subsistence agriculture for their livelihoods. Agriculture also contributes to a large percentage of the national income. Yet in Africa, agricultural productivity is extremely low, which is correlated with several intertwined factors, such as the low use of improved technologies, market failure, obsolete or lack of basic infrastructure and poor health during the beginning of the cropping season. Smallholder farmers are caught in poverty traps and are unable to participate either in the input market, partly because they cannot afford to purchase the inputs, or in the output market because they do not produce enough and/or market infrastructure is missing. Therefore, poverty reduction is the main goal of many African countries, and this study looks at the specific case of Mozambique.

The poverty reduction literature can be roughly grouped into the following three lines of economic research: the role of economic growth, the role of nonfarm employment activities, and the role of agricultural productivity growth. These three strands of the literature will guide the analysis presented throughout this study. Thus, the first objective is to assess the trends in household incomes, poverty, and food security, in the midst of a neoliberal development model adopted by Mozambique, which focuses heavily on economic growth. The second objective is to assess the role of nonfarm activities in reducing household vulnerability to drought, while exploring the recent advances in econometric modeling of censored regressions. The third objective is to evaluate the economic impact of interventions that can enhance agricultural productivity, such as the use of improved technologies and the receipt of extension services, while exploring the recent advances in impact assessment analysis. The analysis is based on several nationally representative agricultural surveys in Mozambique, covering the period 1996 to 2008.

The results suggest that in rural areas the number of poor households has increased in the last decade. This may be linked to a combination of the development policy adopted by the Government of Mozambique, and to recurrent droughts and floods. The receipt of extension services had a significantly positive impact on farm income, but they are unlikely to reduce poverty at present, due to their lower (and decreasing) coverage, and the inability of visited smallholder farmers to follow up with the technical recommendations. In general, the use of improved agricultural technologies did not have a significant impact on household incomes, which might be linked to the fact that market infrastructure development is not keeping pace with their promotion. Results also show that poorer households are more likely to engage in nonfarm activities. However, they also tend to earn the lowest incomes because they are unable to overcome the barriers to participation in nonfarm activities offering higher returns.

These results indicate that a more proactive and interventionist role by the government could help in the fight against poverty. The policy options include increased investments in market infrastructure and agricultural services. This is particularly the case in central and northern Mozambique, where the agricultural potential is relatively higher and the average cropped area is larger. The southern provinces might benefit from a slightly different set of development policies, due to their lower potential for crop production and the smaller landholdings. There, the emphasis could be on promoting participation in nonfarm activities to compensate for poorer crop production, while ensuring that such access does not increase income inequality. Generally, households in all regions would benefit from better access to nonfarm activities, both as a means to cope with the vagaries of the weather, and as a more permanent strategy to reduce poverty.

Keywords: poverty reduction; technology adoption; nonfarm income; Southern Africa.

Thesis structure

This dissertation comprises two constituent parts: an introductory part (Part A) and a collection of five papers (Part B).

Part A starts with a review of the relevant literature on poverty in Africa and analyses the specific situation in Mozambique. It then covers relevant theoretical concepts of poverty alleviation and presents the conceptual framework of the thesis. The data used in the thesis is characterized and the econometric approaches used are briefly discussed. Part A shows how the papers in Part B are related to each other and how their results allow a comprehensive assessment of several strategies to alleviate rural poverty in Mozambique. It also provides some perspectives for future research as well as the methodological, theoretical, and policy implications derived from the study.

Part B comprises the following five papers:

1. Cunguara, B., Langyuntuo, A., Darnhofer, I. (2011). The role of nonfarm income in coping with the effects of drought in southern Mozambique. *Agricultural Economics*, in press. (JCR SCI Impact Factor: 0.673)
2. Cunguara, B., Darnhofer, I. (2011). The impact of improved agricultural technologies on household incomes in rural Mozambique. *Food Policy*, 36(3): 378-390. (JCR SCI Impact Factor: 1.606)
3. Cunguara, B., Moder, K. (2011). Is agricultural extension helping the poor? Evidence from rural Mozambique. *Journal of African Economies*, in press – Published on-line: doi: 10.1093/jae/ejr015 (JCR, SSCI Impact Factor: 0.698)
4. Cunguara, B., Hanlon, J., Whose wealth is it anyway? Mozambique's outstanding economic growth with worsening rural poverty. Resubmitted to *Development and Change* in June 2011.
5. Cunguara, B., Mabiso, A., Hanlon, J., Trends in food security in Mozambique, 1996/2008. Submitted to *Food Policy* in October 2010.

These five papers are referred to in curly brackets throughout the thesis.

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Part A:**Whose wealth is it anyway?****Worsening poverty in rural Mozambique despite
rapid economic growth**

1 Introduction

This chapter provides background information on poverty in Mozambique. It also reviews and discusses the main strands of the poverty reduction literature, while identifying the research gaps, which in turn justify the present study. This leads to the overall outline of the study, presented at the end of the chapter.

1.1 Background: Rural poverty in Mozambique

Mozambique has undergone significant structural changes in the last 50 years. First, it suffered from three decades of almost continuous war: the 1964-74 liberation war, the 1976-80 Rhodesia war, and the 1981-92 destabilization war (Hanlon, 2010). Second, the implementation of the structural adjustment program (SAP) in the mid-1980s started the transition from a socialist to a capitalist regime, with marked macroeconomic effects on employment, economic growth, inflation and exchange rates. Third, the peace agreement signed in 1992 allowed once again the movement of people between rural and urban areas, which would later encourage migration to cities and towns. Since 2001, the implementation of the poverty reduction strategy papers (known under their acronym: PARPA) contributed to the structural changes. But there is one thing that barely changed over the course of this period: poverty reduction has always been the government's overarching goal.

Mozambique has been consistently ranked among the poorest countries in the world for at least the last two decades (UNDP, 2009). Its population is predominantly rural and 80 percent is engaged in agriculture, contributing about 20 percent of the Gross Domestic Products (GDP) (INE, 2010). This suggests that labor productivity in the agricultural sector is significantly lower than in the non-agricultural sector, given that the former employs the majority of the population but the latter has the largest share of the GDP.

In 1996-97 the mean consumption per capita was below the absolute national poverty line (Arndt et al., 2006). This implies that even if the total consumption had been equally distributed among Mozambicans, all citizens would have lived in absolute poverty. In the so-called 'Washington Consensus,' economic growth was therefore identified as the prime mover in poverty reduction. At the core of the 'Washington Consensus' – as reflected in the SAP and subsequently in the PARPA – are macroeconomic policies presumed to lead to economic growth, which in turn would trickle down to the poor (Dollar and Kraay, 2000; Shorrocks and Van der Hoeven, 2004).

In Mozambique, the official poverty statistics are derived from the consumption expenditure surveys. So far, there have been three surveys. The first survey showed that in 1996-97 an overwhelming 69 percent of the population was poor. Nevertheless, significant improvement has been made, resulting in a sharp decline in poverty headcount to 54 percent in 2002-03. This was made possible through the on-going political stability following the end of the war in 1992, and may reflect the expansion of cultivated area (Arndt et al., 2006; Virtanen and Ehrenpreis, 2007). However, agricultural productivity remained low, and there is also no evidence of improvement between 1996 and 2002. Indeed, between 1996 and 2002 the production of most crops fell, measured both per hectare and per adult household member (Boughton et al., 2006). Furthermore, caloric production per capita shows a decline in the subsequent period up to 2008 (MPD/DNEAP, 2010). The main constraints to productivity growth include the cyclical occurrence of natural hazards, limited access to public services (e.g., agricultural extension), low use of improved agricultural technologies, poor market infrastructure, and poor farmers' health in late dry season (Joubert and Tyson, 1996; Usman and Reason, 2004; Walker et al., 2004; Skarstein, 2005; Mather, 2009; Cunguara and Darnhofer, 2011; Cunguara and Moder, 2011).

The third consumption expenditure survey showed that 55 percent of Mozambicans were poor in 2008-09 (MPD/DNEAP, 2010). This is not only above the government's target of 45 percent by 2009, but also suggests that at the national level poverty has barely been reduced compared to 2002. While empirical evidence exists on the relationship between economic growth and poverty reduction (Roemer and Gugerty, 1997; Dollar and Kraay, 2000; Fischer, 2003), this relationship tends to be demonstrated in cross-country studies, using aggregate data. This can conceal that within a country, compared over time, such a correlation may be weak. Also, at one point in time, statistics aggregated at the national level may mask successful cases of poverty reduction. In Mozambique, although poverty incidence remained virtually unchanged between 2002 and 2009, poverty incidence changed by 26 percentage points in both Cabo Delgado and Zambézia provinces, however with a decline in the former and an increase in the latter. It would therefore be of little consolation to the population in Zambézia to be told that on average poverty incidence remained unchanged.

Three potential factors can explain the weak correlation between economic growth and poverty reduction. First, the accuracy of official statistics can be questioned. Arndt et al. (2010) point to the examples of Tanzania and Mozambique, two countries with rapid economic growth but little change in poverty levels. They argue that differences in the methods, as well as the accuracy of national growth and poverty accounting may explain the paradox. Indeed, the official statistics show that on average the agricultural output is increasing by about six percent a year in the last decade (INE, 2010), even in a year of widespread drought such as 2005. However, the third national poverty assessment blames the underperformance of the agricultural sector as one of the main reasons for the lack of progress in poverty reduction (MPD/DNEAP, 2010), raising doubts on the accuracy of the official statistics and the national accounts.

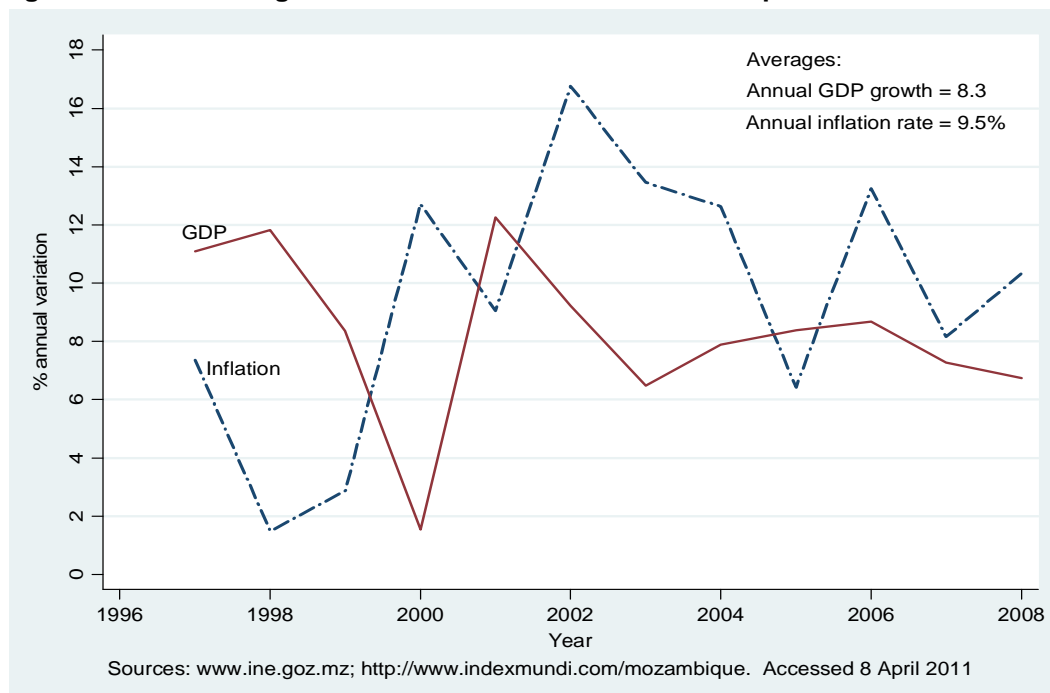
Second, the extent of the effect of economic growth on poverty reduction depends on the structural characteristics of the country, a feature often not accounted for in cross-country studies. Historically, Mozambique possesses two distinct poles of development, the relatively urban south and the predominantly rural areas in central and northern Mozambique (Silva, 2007). Most Portuguese settlers lived in the south where some urbanization took place. Agricultural production from the central and northern provinces was exported from the northern ports, thus there were few incentives to connect the south and the north. Market segmentation contributes to the fact that the southern provinces remain dependent on food imports, and thus vulnerable to price fluctuations in the international markets. Additionally, not least as a result of internal migration, the urban population is growing rapidly, especially in the food-deficit southern provinces (INE, 2010).

Economic growth and (urban) population growth, combined a stagnating agricultural sector may result in inflation of prices for staple foods, exacerbating poverty (Kalecki, 1976; Bhaduri, 2006; Rakshit, 2009). An increase in prices for staple foods may have a negative impact on farmers' wellbeing because the demand for food is usually inelastic (Engel's law), and the majority of the population (including farmers) is net consumer of food (Boughton et al., 2007). Handa and Mlay (2006) found high (nearly unitary) income elasticity for basic staple foods (e.g., cassava) among poor households in rural Mozambique.

Furthermore, price instability discourages investment in staple food production by surplus households in northern Mozambique, which have the assets and the favorable conditions to produce more (Poulton et al., 2006a). It also encourages deficit households in the southern provinces to devote scarce resources to staple food production to ensure their livelihoods, limiting diversification and the increased incomes that typically come with it (Tostão and Tschirley, 2010). Furthermore, the uncertain returns due limit investments in services such as input supply, provision of credit, storage and processing, thus reinforcing behaviors that lead to continued price instability (Tostão and Tschirley, 2010).

Cirera and Nhate (2007) argue that changes in the exchange rate in neighboring countries tend to be fully transmitted to consumer prices in the domestic market. Although available statistics show that the GDP has been increasing rapidly, inflation rates tend to be higher (Figure 1). This suggests an increased cost of living, which disproportionately affects the poor, who spend most of their income on food. A robust GDP growth and the lack of progress in poverty reduction in the last decade suggest that most of the benefits of economic growth accrue to wealthier households. As a result, inequality levels are likely to increase over time. Nevertheless, the Gini coefficient remained almost the same between 2002-03 and 2008-09, raising questions about who is really benefiting from the economic growth.

Figure 1 Annual GDP growth and inflation rates in Mozambique



The third potential explanation for the weak correlation between rapid economic growth without significant changes in either poverty headcount or inequality is that the benefits of economic growth may accrue to foreign investors. Mozambique was quite successful in attracting foreign investment, such as the aluminum smelter (Mozal), the pipeline for exporting natural gas to South Africa, the mining of titanium in Chibuto and Moma, and the coal mines in Tete (Arndt and Tarp, 2009). However, these 'mega projects' create few local jobs, have few local linkages, and have a small impact on poverty reduction (Thirtle et al., 2003a). They benefit from large tax exemptions, rely heavily on imported goods, and only a very small fraction of their production is consumed locally (Virtanen and Ehrenpreis, 2007). For instance, in 2006 Mozal contributed about 56 percent of total exports and 6.5 percent of the GDP (Sonne-Schmidt et al., 2009). However, the standard income tax of 32 percent that Mozal foundry would be entitled to bear has been replaced by a fixed turnover tax of \$4 million, which is less than one percent of Mozal's total export value in 2006 (Andersson, 2001; Sonne-Schmidt et al., 2009).

In the last few years, the rising cost of living has sparked a series of riots throughout the country, especially in urban areas (Hanlon, 2010). This led the government to readjust some development policies. First, in 2008 subsidies were introduced, e.g. for diesel, wheat, water and electricity. These measures proved to be financially unsustainable, and in 2011 some of the subsidies are either due to expire (e.g., diesel subsidies) or will be replaced by cheaper measures (e.g., food vouchers to be given to households below a certain salary threshold).

But these measures are usually biased towards the urban population, and do not address the underlying problems of population growth and stagnating agricultural productivity.

Access to economic opportunities outside agriculture would help increasing consumption, but low educational attainment, poor access to financial markets, and weak infrastructure prevent many smallholders from participating in nonfarm activities, especially those of high return {Cunguara et al., 2011a}. The education system is particularly fragile. Indeed, the war that erupted a year after the independence had a significantly negative effect on education levels. In 1990 only seven percent of the population had completed the primary education, about 68 percent had no formal education, and primary school dropout rates were as high as 60 percent (Caucutt, 2007). In 2002, household heads in rural Mozambique had completed about two or three years of formal education (Walker et al., 2004).

It is also unfortunate that an already challenging task of reducing poverty has been made even harder by the high prevalence of HIV/AIDS (Dorward et al., 2004). It is estimated that in Mozambique, about 12 percent of the population is infected by HIV (CNCS, 2009), and AIDS was the main cause of death among teachers in 2002 (Collins, 2006). The loss of skills of the person with AIDS and loss of time for skill transfer to children can potentially contribute to severe labor shortages and knowledge loss, which would result in cropping shifts and declines in agricultural production (Topouzis and Guerny, 1999), with significant poverty implications.

This study evaluates poverty reduction options in rural Mozambique, with the goal of identifying synergies between economic growth, participation in nonfarm activities, and agricultural productivity growth. The study adds to the existent literature showing that a well-developed agricultural sector can support both economic growth and smallholder participation in nonfarm activities (Matsuyama, 1992; Benfica, 2006; Thurlow, 2008).

1.2 Literature review and identification of research gap

In Africa, a large part of the economic literature concerned with poverty has tended to focus on one of the following three research areas: the role of economic growth, the role of nonfarm activities, and the role of growth in agricultural productivity. The selection of the right combination of strategies depends on an accurate understanding of the main factors associated with poverty. It is therefore essential to review each strand of the economic literature on poverty, and identify the complementarities between the underlying theories, in order to address the multidimensional features of poverty (Ravallion, 1996; Bourguignon and Chakravarty, 2003).

The role that economic growth can play in reducing poverty is summarized in the neoliberal development theory. The theory behind neoliberalism is that macroeconomic stability and greater efficiency in resource allocation will favor economic growth, which should reduce poverty and inequality (Portes, 1997). This leads to an almost exclusive focus on the role that market forces can play in poverty reduction, while the government is assumed to be more effective at reducing poverty by stressing investment in human capital and infrastructure (Hulme and Shepherd, 2003). Typical examples of such policies include the structural adjustment program (SAP) and the poverty reduction strategy papers (PARPA). Due to high poverty levels and low density of infrastructure (including education), economic growth is still one of the development priorities in Mozambique, as expressed in various strategic documents to reduce poverty.

Using a sample of 92 countries, Dollar and Kraay (2002: p219) argue that “growth on average does benefit the poor as much as anyone else in society, and so standard growth-enhancing policies should be at the center of any effective poverty reduction strategy.” A

similar view is shared by Fischer (2003: p2) who argues that “as far as economics is concerned, the big challenge is poverty, and the surest route to sustained poverty reduction is economic growth.” Government and donors have therefore converged on the policy mantra that, at the economic level, growth provides the panacea for poverty reduction. As argued by Dollar and Kraay (2002: p218), macroeconomic policies associated with liberalization, such as reducing inflation, moderating the size of the government, trade liberalization, and establishing a sound financial system are good for both generating economic growth and reducing poverty.

Nevertheless, such a focus on ‘getting the prices right’ may not meet the needs of the different types of poor farmers (Sen, 1981; Hulme and Shephard, 2003). The neoliberal theory may encourage a focus on those poor whom the market can ‘liberate’ from poverty, but may neglect the needs of those who need different types of support or policy changes (Hulme and Shepherd, 2003; Boughton et al., 2007; Barrett, 2008). Indeed, Donaldson (2008) surveys cases where the income of the poor increased significantly less than was expected given economic growth. Cassie and Jensen (2009) take a similar approach and look at the time period in Burkina Faso where the correlation between economic growth and poverty reduction was strong. Likewise, Skarstein (2005) argues that the structural adjustment program has contributed in part to the stagnation of agriculture in Tanzania in the period from 1985 to 1998. McMillan et al. (2002) show that in Mozambique liberalization and privatization policies curtailed the development of the cashew sector, greatly raising unemployment due to the collapse of cashew processing factories.

Two other issues emerge when development policies have an excessive focus on ‘getting the prices right.’ First, as argued by Stiglitz (1998), such a focus does not recognize that the government had played an active role in successful development efforts in the United States and many other developed countries. Second, little is said about the distribution of the benefits of economic growth. It appears as if per capita GDP growth directly translates into improved standards of living, particularly of the poor (Blackmon, 2008). Yet, notwithstanding consistent rapid economic growth in Mozambique (and in Tanzania), poverty levels remained unchanged in the last decade (Arndt et al., 2010; MPD/DNEAP, 2010). This leads to focus on the plight of the rural poor. It also leads to considering other pathways out of poverty besides economic growth, and on how such alternatives might strengthen economic growth.

The second strand of the economic literature on poverty reduction relates to income diversification and the role of nonfarm employment. Income diversification is embedded in the portfolio theory, and consists of three dimensions. The first pertains to the reduction of the risk inherent to a rain fed agricultural production system, which leads to fluctuation in farm income (Reardon et al., 1998). This entails combining nonfarm portfolios of different risk profiles. It has also been summarized as an *ex ante* risk management behavior, and *ex post* coping with adverse shocks such as a drought (Barrett et al., 2001).

The second dimension of the portfolio theory concerns market failures in rural areas, particularly for credit and land (Reardon, 1997; Bryceson, 1999; Barrett et al., 2001; Thirtle et al., 2003a). Missing markets can encourage nonfarm diversification, such as when farmers own smaller landholdings and they are unable to rent in more land (Barrett et al., 2001). Nevertheless, missing markets can also hamper income diversification, such as when participation in nonfarm activities requires a substantial financial investment and farmers lack access to any credit (Barrett et al., 2001). Under these conditions, such investments can be facilitated by smallholders’ ownership of liquid assets, i.e., assets that can be easily turned into cash, such as livestock (Thirtle et al., 2003b; Walker et al., 2004).

The third dimension of the portfolio theory comprises the links between farm and nonfarm investments (Reardon, 1994; Mathenge and Tschirley, 2007; Oseni and Winters, 2009). On

the one hand, income gains from the use of improved technologies can be invested in nonfarm activities. On the other hand, nonfarm incomes can be used to purchase modern inputs, and therefore increase farm incomes through agricultural productivity growth. In addition, the diminishing or time-varying returns to labor or land can motivate household diversification into the nonfarm employment sector. These differences in the motivations to diversify manifest in differences in nonfarm incomes at the regional, household, and individual levels. At the regional level, such differences stem from differences in agroecology and infrastructure such as roads (Walker et al., 2004).

At the household level, once the decision to diversify is made, the nonfarm opportunities available usually differ across income groups (Reardon, 1997; Reardon et al., 2006; Cuinguara et al., 2011a). Poorer households are usually driven by 'push factors,' which are related to risk reduction, response to diminishing factor returns in any given use or smaller landholdings, and reaction to crisis or liquidity constraints (Barrett et al., 2001; Reardon et al., 2006). On the contrary, wealthier farmers are usually driven by 'pull factors,' mainly for accumulation purposes and strategic complementarities between activities, such as crop-livestock integration (Barrett et al., 2001; Reardon et al., 2006).

Within the household, due to child care-giving responsibilities and relatively limited access to education, women face higher entry barriers to employment in the formal sector (Haggblade et al., 2001). Thus, women tend to engage in informal activities that can be operated from the home (e.g., beer brewing), require low capital investments (e.g., collect firewood) and build on skills they already have (e.g., domestic worker) (Cuinguara et al., 2011a). Within female-headed households, a further distinction can be made between widow and non-widow headed households, given that widows are usually among the most economically disadvantaged households (Walker et al., 2004), and therefore relatively less capable of investing in nonfarm income generating activities.

Worth noting is that although participation in nonfarm activities has the potential to reduce poverty, one contentious issue remains: it can also increase income inequality. It has been shown that poorer households usually do not own enough cash to invest in nonfarm activities, lack access to credit, and have fewer liquid assets. This financial barrier will deter them from participating in nonfarm activities in general. Meanwhile, wealthier households systematically engage in the most lucrative nonfarm activities (Reardon, 1997; Reardon et al., 2006). As a result, wealthier households earn returns many times greater than do poorer households. Wealthier households are also more capable of investing in the use of improved agricultural technologies, and thus attain higher agricultural productivity levels.

The role of growth in agricultural productivity comprises the third strand of the poverty literature. It is frequently argued that growth in agricultural productivity is a fundamental prerequisite for widespread poverty reduction (Lipton, 1977; Timmer, 1997; Arndt et al., 2000; Irz et al., 2001; Mellor, 2001; Thirtle et al., 2003a; Dorward et al., 2004; Doss, 2006; Ravallion, 2009). Using data from Mozambique and Vietnam, Arndt et al. (2010: p8) show that "agricultural growth will have disproportionately large impacts on rural incomes". "This confirms", the study continues, "the strategic role that the agricultural sector can play in economic development and poverty reduction in Mozambique and indicates that the better performance of agriculture likely contributed to the more rapid reductions in poverty experienced in Vietnam." Furthermore, multipliers are usually greater in rural areas. This implies that agricultural productivity growth will also favor urban households, and forms part of the explanation why economic growth does not generate as much poverty reduction, particularly in a low-income economy with a large rural sector like Mozambique (Rahman and Westley, 2001; Arndt et al., 2010).

The importance of agriculture in Africa as a major source of employment, its contribution to the national income, and its multiplier effect on the rural economy has motivated several

studies on the impact of agricultural productivity growth. In some cases, as in de Janvry and Sadoulet (2002), the focus has been on estimating the impact of growth in agricultural productivity in reducing poverty. In others, as in Ravallion (2009), the focus has been in the identification of pre-conditions in which productivity growth in smallholder agriculture can reduce poverty in Africa. In both cases, it is implicitly assumed that improved technologies have a significant impact on household livelihoods. There are some profitability studies estimating the impact of adopting improved technologies (Oehmke and Crawford, 1996; Howard et al., 2003), but in most of these studies it is also implicitly assumed that users and non-users of improved technologies had similar productivity levels before the adoption took place.

The assumption that adoption of improved technologies or the receipt of agricultural services has a positive and significant effect on household incomes (or farm incomes) might not always hold when selection bias is accounted for. Different regions suffer from different weather shocks. Additionally, households are affected differently by labor shortage, and the adoption of improved technologies is correlated with other factors affecting productivity (Doss, 2006; Imbens and Wooldridge, 2009). Moreover, farmers or villages may be systematically selected by development agencies, based on some criteria or rule, leading to an endogenous program placement effect. Therefore, although improved technologies theoretically have the potential to reduce poverty, empirical evidence on the impact of their use, based on the analysis of households with similar characteristics, is still small (e.g., Mendola, 2007; Kassie et al., 2008).

Nevertheless, the agricultural productivity in Sub-Saharan Africa remains among the lowest in the world (Frisvold and Ingram, 1995; Savadogo et al., 1998). This is because in most of these countries smallholder farmers are provided with only limited technical and economic opportunities to which they can respond (Schultz, 1964). Most farmers lack the access to credit or cash, and lack information about improved technologies. In the specific case of Mozambique, at least 85 percent of farmers lack access to extension services, especially the poorest farmers (Mather, 2009). The receipt of extension services provides farmers with information about cropping practices and managerial skills, optimal input use, and high yield varieties (Birkhaeuser et al., 1991). Moreover, about 97 percent of farmers in Mozambique lack access to credit, making it harder to adopt improved technologies even if they have access to information about them through agricultural extension services.

African governments can minimize the constraints to agricultural productivity growth by increasing investments in key public goods such as roads, communication infrastructure, agricultural research, and improving the management of water resources (Rutan, 2002; Poulton et al., 2006b). There is also evidence that a guaranteed output market stimulates the adoption of improved technologies, which in turn contributes to agricultural productivity growth (Boughton et al., 2007; Barrett, 2008; Cunguara and Darnhofer, 2011).

In any case, as much as nonfarm incomes can be invested in improved agricultural technologies, or growth in agricultural productivity generates income that can be invested in nonfarm activities, there are some complementarities between the neoliberal theory, the portfolio theory, and the theory of technological change. For instance, Stern (1996) found a statistically significant relationship between economic growth and agricultural productivity growth. In addition, Stern (1996) applied the endogenous growth theory to the role of agriculture in economic development and found that agriculture will continue to be of central importance in many African countries. As a result, analyzing each strand of the literature separately is only a starting point, which should be complemented by an analysis of the relationship between each research area and the underlying development theory.

1.3 Research objectives

The three strands of the economic literature (economic growth, diversification into the nonfarm sector, and agricultural productivity growth) will guide the analysis presented throughout this study. Thus, the first objective is to assess the trends in household incomes, poverty, and food security, in the midst of a neoliberal development model adopted by Mozambique, which focuses heavily on economic growth. The second objective is to assess the role of nonfarm employment in reducing household vulnerability to drought, while exploring the recent advances in econometric modeling of censored regressions. The third objective is to evaluate the economic impact of interventions that can potentially enhance agricultural productivity, such as the use of improved technologies and the receipt of extension services, while exploring the recent advances in impact assessment analysis.

2 Theoretical concepts

This chapter reviews the theoretical concepts of the poverty literature. First, it presents the theoretical framework. This is followed by a brief review of the approaches used to understand the causes of rural poverty, and the justification of the approach used in this study. Finally, a conceptual framework is presented, while describing how its components are related to each other.

2.1 Theoretical framework

The notion of linking poverty reduction to a combination of development strategies emanates from the fact that poverty is a multidimensional concept (Ravallion, 1996; Bourguignon and Chakravarty, 2003). As such, broad-based poverty reduction strategies require exploring the complementarities of various mechanisms that can potentially reduce poverty. Three such mechanisms are prominent in the economic literature, namely: economic growth, household diversification into nonfarm activities, and agricultural productivity growth.

The neoliberal development theory posits that the benefits of economic growth would trickle down to the poor (Romer, 1990). Poverty reduction strategies adopted by the Government of Mozambique fit into this theoretical framework. It is implicitly assumed in PARPA that the development strategies are applicable to all types of smallholder farmers, and therefore not much emphasis is placed on tailor-made approaches. In a country as poor as Mozambique, economic growth has certainly multiple benefits. There are many possible links between economic growth and other sectors of the economy. For illustrative purposes, however, only a few are provided below, bearing in mind that this list of possible links is not exhaustive.

First, with economic growth, the government would be able to invest in road infrastructure, which would create more employment opportunities and thus reduce poverty. Second, government revenues could also be used to improve the infrastructure connecting the surplus agricultural areas in the north and center to food deficit regions in the south, and thus stimulating trade. These interventions would also have the potential to foster agricultural productivity growth because improved inputs would be more readily available, while at the same time marketing infrastructure would be improved. Third, the government could also create employment opportunities through credit and saving schemes. Fourth, investments in irrigation schemes would also trigger agricultural productivity growth, which in turn would generate sufficient cash to allow smallholder farmers to participate in the nonfarm employment sector.

Nevertheless, the adoption of a neoliberal development policy implied that the government would practically not intervene in the agricultural sector. Therefore, despite the potential complementarities between the numerous development policies, the government may have missed the opportunity to develop the agricultural sector. If that is the case, then the results should be reflected in household welfare given the importance of agriculture. That is, the benefit of economic growth might have by-passed the rural poor in several ways. This study explores the trends in selected welfare indicators, creation of nonfarm employment opportunities, the use of improved technologies, and many other indicators set forth in PARPA.

2.2 Review of approaches used to understand the causes of rural poverty

An important element in poverty studies is knowing who is poor or having an approach for determining who is poor. The literature provides three main approaches: a quantitative,

qualitative, and a multidimensional approach. The latter approach is a combination of the first two. The main difference between the three approaches lies on the welfare measure, how the poverty line is defined, and the analytical methods used to study poverty.

The quantitative approach uses a monetary measure as the welfare measure, such as household incomes or consumption levels. Households are deemed to be poor if their incomes or consumption levels are below a specified threshold, i.e., the poverty line. Three methods are used to set the poverty line: the food energy intake method, the cost of basic needs method, or the \$1/day criterion often used for international comparisons (Tarp et al., 2002). Methodological differences within the quantitative approach are known to yield different poverty measures. For instance, the second consumption expenditure survey conducted in Mozambique provides two alternative poverty estimates, depending on the method used to define the poverty line.

There are theoretical reasons why consumption is seen to be more accurate than income as the welfare measure. First, consumption tends to be less volatile than household incomes, and its use reduces the probability of misclassifying households as poor (or non-poor) (Gradin et al., 2004). Second, when using income as the welfare measure, the assumption is that a market exists for all goods, which is not the case in many developing countries. Third, there is no guarantee that households with income at or even above the poverty line would actually allocate their incomes so as to purchase the minimum basic needs bundle (Thorbecke, 2005). Fourth, income figures obtained through household surveys are more likely to be underreported than consumption expenditure (Alderman, 1992).

The qualitative approach uses a different welfare measure and poverty line. Here, the welfare measure can be asset endowment or the perceptions on whether consumptions of food, housing, and clothing were adequate for household needs (Pradhan and Ravallion, 2000). It can also be household's own perceptions about the current economic condition relative to a previous period (Walker et al., 2004). The welfare measure is relatively easier to obtain from simple surveys. However, setting the poverty line is quite challenging. The main desirable features of a poverty line are its consistency and specificity. Consistency is related to making equal classifications for households with the same living standard, but a household whose perception that the current economic condition has worsened can actually be better-off than someone with the opposite perception. Meanwhile, specificity is associated with its applicability to the communities under consideration, and household heterogeneity can make it harder to make comparisons within a given community.

Finally, the multidimensional approach to poverty measurement emerges as a recognition that household welfare depends on both monetary and non-monetary variables (Bourguignon and Chakravarty, 2003). Although higher incomes or consumption levels will likely generate higher welfare in the quantitative approach, it may be the case that markets for some qualitative attributes do not exist, such as with some public goods, or that these markets are highly imperfect (Bourguignon and Chakravarty, 2003). Therefore, the monetary approach as the sole welfare measure is often inappropriate. One popular example of a multidimensional welfare measure is the Human Development Index (HDI). The appealing feature of the HDI is its ability to summarize the standard of living, health indicators, and adult literacy in a single index.

An equally important element in poverty studies is how to analyze the determinants of poverty. In cases where the research focus is on a monetary measure, the determinants of poverty are usually modeled through an OLS regression, where the dependent variable is the total household income/consumption, after a logarithmic transformation, in order to ensure normality and to allow the coefficients to be interpreted as elasticities (see for example Walker et al., 2004; Datt and Jolliffe, 2005). Independent variables usually include a set of demographic variables (e.g., age, gender, and education of household head), access

to public services (e.g., the receipt of agricultural extension and membership to a farmers' association), access to financial services (e.g., credit), asset endowment (e.g., cropped area and livestock herd size), location dummies (e.g., agro-ecology or district dummies) and other variables. Some variables are included both in linear and quadratic forms to capture life cycle effects (e.g., age of household head) or diminishing returns (e.g., cropped area or livestock).

Nevertheless, monetary measures tend to be more subject to measurement error than stock variables such as durable assets, because they can only rarely be directly observed and verified (Barrett et al., 2006). Moreover, the stock of productive financial, physical, natural, social and human assets largely determines household income or consumption levels. Therefore, understanding the dynamics of assets is fundamental to understanding persistent poverty and longer-term socio-economic dynamics (Barrett et al., 2006). Unlike the monetary approach where the interest is often in finding who was poor at the time of the survey and which factors are associated with poverty, the asset-based approach often uses the stock of assets to predict who will be structurally poor (Carter and Barrett, 2006). Some studies have focused on understanding who among the poor is structurally positioned to take advantage of new economic opportunities when they become available (Adato et al., 2006). Other studies have focused on the identification of those who are more resilient to negative shocks such as the occurrence of natural calamities (Hoddinott, 2006).

The asset-based approach can also be used to determine asset thresholds separating the transitorily poor from those caught in a poverty trap (Adato et al., 2006). Similarly, the literature often distinguishes between policies to help the structurally poor to move out of poverty from those that directly reduce the risks that may drive non-poor into poverty or the transitorily poor into an escape from poverty (Barrett et al., 2006). This analysis usually requires panel data due to the need to track households over time. The stock of assets can also be used to calculate a welfare index. Some studies have used the principal components analysis to generate such indices (see for example, Filmer and Pritchett, 2001; Langyintuo and Mungoma, 2008). Then an arbitrary poverty line is used to generate a binary variable indicating the poverty status. This binary variable can be used as the dependent variable in a Probit or Logit model to estimate the factors associated with the poverty status.

2.3 Justification for the approach used

This study is mainly based on the quantitative approach, and household incomes were the main welfare measure, mainly due to data availability and the research questions addressed. Although consumption is believed to be a better welfare measure than household incomes, consumption data were not readily available. Moreover, when the research objective is to analyze the determinants of rural poverty and their implications for agricultural development, the analysis of data on consumption expenditure may not lead to specific, actionable conclusions. This is because data on the relevant agricultural variables may be missing from consumption surveys, or variation in data on consumption expenditure may be relatively small and more difficult to explain. Likewise, although the multidimensional approach to poverty is more appealing than the quantitative and qualitative approaches, the dearth of appropriate data conditioned the empirical approach. Nevertheless, the study used various other welfare measures, although not with the same analytical depth as it was in the case with household incomes.

2.4 Conceptual framework

Three mechanisms with the potential to reduce poverty were examined. These are the economic growth, participation in nonfarm activities, and agricultural productivity growth. The choice of these three mechanisms was guided by the fact that poverty is a multidimensional concept, and as such, its reduction requires a combination of different strategies. As discussed in the previous chapter, an exclusive focus on one poverty reducing mechanism is unlikely to result in a broad-based poverty reduction.

The analysis begins by exploring each of the three alternatives to reduce poverty. The role of economic growth in reducing poverty is covered in Cuinguara and Hanlon {2011} and in Cuinguara et al. {2011a}. In Cuinguara and Hanlon {2011}, the analysis pertains to changes in incomes and poverty. The economic condition of smallholder farmers is then correlated with changes (or lack of it) in farming. The analysis also looks at poverty traps, and provides a discussion of the implications of the neoliberal development policy imposed by the donors, while considering alternative policies that might raise agricultural productivity, reduce poverty, and improve food security.

Cuinguara et al. {2011a} proceeds by looking at trends in selected assets, food insecurity, and farmers' perception of their economic condition. This provides a basis for comparison of trends in different welfare indicators. The key assumption is that if economic growth reduces poverty, then a GDP growth should be positively correlated with changes in household incomes and food security. The study considers two main sources of changes in incomes and food security: agricultural productivity growth and participation in nonfarm activities.

Cuinguara et al. {2011b} examines the role of nonfarm income generating activities in reducing poverty. Earlier, the literature review section linked the participation in nonfarm activities to the reduction of smallholders' vulnerability to drought. This hypothesis is empirically tested among smallholder farmers in southern Mozambique, a region that is frequently affected by drought. The analysis also focuses on the factors associated with the decision to participate in different types of nonfarm activities as well as the incomes earned from each activity.

The third source of change, agricultural productivity growth, is covered in Cuinguara and Darnhofer {2011} and Cuinguara and Moder {2011}. Two potential sources of agricultural productivity growth are examined: the use of improved agricultural technologies {Cuinguara and Darnhofer, 2011} and the receipt of extension services {Cuinguara and Moder, 2011}. The technologies evaluated (improved maize seeds, animal traction, tractor mechanization, and improved granaries) were selected based on the expected impact on household income and on data availability. Besides the four technologies included in this analysis, the available data (TIA05) also included the use of chemical fertilizers and pesticides. However, since the survey did not collect data on the type and amount of agro-chemical used or on the crops on which they were applied, the available data was not meaningful enough to be included.

One equally important methodological issue concerned drawing causal relations. Although it is often assumed that the use of improved technologies can increase farm income and thus enhance household incomes, establishing a causal relationship requires dealing with a range of confounding factors, such as the selection bias and endogenous program placement. Sample selection bias may arise in practice for two reasons (Heckman, 1979). First, there may be self selection by smallholders to participate in nonfarm activities {Cuinguara et al., 2011b}, to use improved technologies {Cuinguara and Darnhofer, 2011} or to receive extension messages {Cuinguara and Moder, 2011}. Second, the data may be non-randomly selected because of deliberate placement of development projects. For instance, the coverage of extension services might be higher in the central and northern provinces due to the higher agricultural potential in those two regions.

A causal interpretation of the results is dependent on several assumptions, such as the overlap and unconfoundedness assumptions. The former postulates that the conditional distributions of the covariates of users and non-users (or participants and non-participants) overlap completely. On the other hand, the unconfoundedness assumption asserts that all variables that need to be adjusted for are observed and included in the model. In other words, beyond the observed covariates (modeled through the propensity score), there are no unobserved characteristics of the individual that are associated with both the potential outcome and the treatment. This is also referred to as selection on observables, exogeneity, or ignorability (Imbens and Wooldridge, 2009). Several diagnostic tests were used to assess the plausibility of these two assumptions {Cunguara and Darnhofer, 2011; Cunguara and Moder, 2011}.

Moreover, a causal interpretation of the results could also be affected by spillover effects such as the diffusion of knowledge. A key assumption is that the receipt of extension services or the use of improved technologies by one farmer does not affect outcomes for another farmer (Rubin, 1980). This assumption can be violated when there is interaction between farmers. For instance, farmers who received extension services can share the information on agricultural innovation with their peer neighbors. Details on how the analysis 'controlled' for spillover effects are provided in Cunguara and Moder {2011}.

3 Methods

This chapter describes the main data sources used to analyze households' livelihoods and incomes in rural Mozambique. It then discusses how different data sources were made comparable, followed by the econometric approaches used to analyze the data.

3.1 Data sources

The analysis is drawn from all available (seven) national agricultural surveys from Mozambique, commonly known as TIA (Portuguese acronym for *Trabalho de Inquérito Agrícola*). The surveys cover the period from 1996 to 2008, and were implemented by the Department of Statistics within the Directorate of Economics of the Ministry of Agriculture. With the exception of TIA96, the sampling frame for the remaining TIA surveys draws from the Census of Agriculture and Livestock of 1999-2000. The TIA samples were stratified at the provincial level and agro-ecological zone, making them nationally representative at both levels. The sample size varies between 3,891 households covered in TIA96, and 6,248 households in TIA06.

The surveys were designed to be comparable in order to allow the analysis of trends in several indicators, such as agricultural production, household incomes, the receipt of agricultural services, asset endowments, and the use of improved technologies. Nevertheless, they differ quite significantly. In particular, the survey instrument for the estimation of production of root crops (cassava and sweet potatoes) changed considerably from 1996 to 2002, and then again from 2003 onward (Boughton et al., 2006). For instance, in TIA96 the estimate of the total production of cassava was obtained using a single recall question, although the crop is harvested at several intervals throughout the agricultural season. These methodological changes dramatically affect the production estimates. Consequently, they also affect the estimates of total household incomes because farm income represents more than 60 percent of total incomes (Mather et al., 2008), and cassava is the second most important crop (after maize).

In addition to differences in the survey instrument, enumerators were most likely less trained in 1996. By then, the peace accord was only four years old, illiteracy rates were significantly higher, TIA96 was the first nationally representative survey in many years, and training of enumerators may have not been as thorough and rigorous as the remaining surveys (Boughton et al., 2006). In other words, it is possible that, for example, better-trained enumerators in 2002 prompted respondents with more questions about the various crops. As a result, TIA surveys show a significant increase on the average number of crops grown by each household from 1996 to 2002. Nevertheless, some of the increase may be attributed to an increase in cropped area.

Under the conditions described above, the most comparable TIA surveys are those conducted from 2002 to 2008, which include TIA02, TIA03, TIA05, TIA06, TIA07, and TIA08. Most of the analysis presented is therefore based on TIA surveys conducted in that period, while TIA96 data are used sparingly. TIA96 was only used in two papers {Cunguara and Hanlon, 2011; Cunguara et al., 2011b}, mostly with categorical variables, such as asset ownership and whether or not the household used improved technologies. These categorical variables are less problematic than continuous variables such as yield data.

While the analysis excluded TIA96 from most of the papers due to its unreliability, other TIA surveys were not included in some of the analysis, simply because the surveys did not collect the required data. For example, the analysis of trends in total household incomes {Cunguara and Hanlon, 2011}, food security {Cunguara et al., 2011b}, and determinants of nonfarm income {Cunguara et al., 2011a} was restricted to TIA02, TIA05, and TIA08, because data on incomes are not available from the other surveys.

The choice of the survey data for the analysis of the impact of the receipt of extension services {Cunguara and Moder, 2011} or the use of improved agricultural technologies {Cunguara and Darnhofer, 2011} was motivated in the same way. However, the analysis was restricted to TIA05 for two reasons. First, relative to all other TIA surveys, the receipt of extension services was highest in 2005, which is a desirable feature in impact assessment analysis to have a relatively larger sub-sample of beneficiaries. Secondly, because droughts are occurring more frequently (Joubert and Tyson, 1996; Usman and Reason, 2004), and 2005 was a drought year, the analysis of TIA05 is more illustrative of the risks associated with a rain fed agricultural system common to about 98 percent of smallholder farmers in Mozambique (Mather, 2009).

In addition to the availability and reliability of the data, the analysis also considered regional differences in terms of agricultural potential and infrastructure. The analysis of the role of nonfarm income generating activities in reducing poverty {Cunguara et al., 2011a} was therefore restricted to the southern provinces, which are characterized by erratic rainfall, but have better road infrastructure, more livestock and remittances, thus favoring diversification into nonfarm activities. Similarly, the analysis of the impact of animal traction {Cunguara and Darnhofer, 2011} is restricted to the southern provinces because its use is relatively low in central provinces and practically nonexistent in northern provinces. Furthermore, the analysis of the impact of tractor mechanization is also restricted to southern provinces, where 56 percent of all tractors are located, while the analysis on improved maize seeds and improved granaries is restricted to the central provinces, due to relatively higher potential for crop production and more households using these technologies {Cunguara and Darnhofer, 2011}.

Since nonfarm activities differ in terms of entry barriers (Reardon, 1997), nonfarm activities are further disaggregated into seven types: (i) unskilled agricultural wage on small or large farms; (ii) unskilled non-agricultural wage; (iii) skilled or specialized non-agricultural wage; (iv) extraction of flora and fauna products of low returns; (v) extraction of flora and fauna products of high returns; (vi) other self-employment activities of low returns; and (vii) other self-employment activities of high returns. The definition of these seven types of nonfarm activities builds on previous poverty research on Mozambique (Walker et al. 2004; Mather et al., 2008), and is based on the amount of financial investment needed to access them.

Finally, for consistency and comparability purposes, the inflators used to update the 2005 income levels to 2008 are similar to those described in detail in Mather et al. (2008). The 2002 income levels were inflated to reflect the prices in 2005, using data from the consumption expenditure survey of 2002/03 (IAF). IAF 2002/03 consumption quantities (flexible adjusted) from the food consumption basket of each IAF poverty region were used to update the incomes to 2005. These quantities were valued using 2002 retail prices from the Agricultural Market Information System (SIMA), then the basket was revalued with 2005 and 2008 SIMA prices to update the cost of an identical (fixed) consumption basket. The consumption quantities are therefore the weights for the commodity prices. The inflators are fixed because the weights are not allowed to change over time.

3.2 Econometric methods used

The main welfare indicators used in this study are total household income (and in some cases its components: cash incomes, farm and nonfarm incomes), asset endowments, and the perception of the economic condition. The analysis focused on changes for the whole population as well as quantiles of selected welfare indicators. In addition, Kernel density curves were used to evaluate changes in income distribution over time {Cunguara and Hanlon, 2010}. The study also examined the changes in the official poverty and inequality levels, which are based on consumption expenditure surveys.

A significant methodological challenge concerned choosing the food security measure. For this purpose, a measure of caloric acquisition was used. Food security was defined as the ability to obtain the required calories based on farmers' production and purchase of food. A food composition table was used to convert the physical quantities of food that were retained by the household for home consumption. Likewise, cash incomes were converted into caloric values using SIMA maize prices, while taking into account the share of food expenditure. Then, the estimated calories that could be purchased as food were added to calories from farmers' own production that was retained for home consumption. Median provincial prices were used to account for regional differences in prices.

Next, the factors associated with the food security status were modeled using a Probit model. The main goal of estimating a Probit model was to explore the correlations between food security, agricultural production, use of improved technologies, and participation in nonfarm income generating activities {Cunguara et al., 2011a; Cunguara and Darnhofer, 2011; Cunguara and Moder, 2011; Cunguara et al., 2011b}.

Another important methodological issue that the study had to deal with concerned the selection bias. This was relevant for the impact assessment papers {Cunguara and Darnhofer, 2011; Cunguara and Moder, 2011}, and for the paper on participation in nonfarm income generating activities {Cunguara et al., 2011a}. Two distinct methods were used to account for selection bias, and the choice of the method was guided by the nature of problem. In the impact assessment papers, the main objective was to estimate the average treatment effect of either the receipt of extension services {Cunguara and Moder, 2011} or the use of improved technologies {Cunguara and Darnhofer, 2011}. Meanwhile, the objective of modeling nonfarm activities was to analyze the factors associated with both the decision to participate, and the levels of incomes earned from each activity, while considering the correlation between the different types of nonfarm activities {Cunguara et al., 2011a}.

In the case of the impact assessment analysis, a two-stage estimation procedure was used to deal with sample selection bias. The first stage concerned estimating a propensity score model, where the dependent variable was a dummy variable indicating either the receipt of extension services {Cunguara and Moder, 2011} or the use of selected improved technologies {Cunguara and Darnhofer, 2011}. The propensity score is defined as the conditional probability of receiving treatment (Rosenbaum and Rubin, 1983). For ease of estimation, most applications have used a Logit model to estimate the propensity score (Dehejia and Wahba, 2002), and this study takes a similar approach. The propensity score was used to identify farmers with similar observable covariates, so that the difference in incomes could be attributed either to the use of improved technologies {Cunguara and Darnhofer, 2011} or the receipt of extension services {Cunguara and Moder, 2011}.

Accordingly, a series of diagnostic measures were used to ensure that users/non-users of improved technologies or beneficiaries/non-beneficiaries of the receipt of extension services had indeed similar covariates, i.e., the overlap assumption was satisfied. The diagnostic tests included the analysis of normalized differences and graphical illustration of the propensity score. In addition, placebo regressions and sensitivity tests to the propensity score model were used to assess the plausibility of the unconfoundedness assumption {Cunguara and Darnhofer, 2011; Cunguara and Moder, 2011}.

The sensitivity test consisted of comparing the results from the propensity score model, based on the original and a series of simulated data. The simulated data were drawn from the original TIA05 data. The concept behind this sensitivity test is that by drawing a large number of samples, the estimated parameters will be close to the "true" parameters. Also, if the parameters from the original and from the simulated data are comparable, then it is likely that the specification of the propensity score is correct and stable. Determining how many random samples should be drawn to be considered a 'large sample' is somewhat arbitrary.

For this study, 25,000 data sets were drawn for each of the four technologies {Cunguara and Darnhofer, 2011} or for the receipt of extension services {Cunguara and Moder, 2011}, each new data set being of the same size as the original TIA05 data. Once the diagnostic tests supported the unconfoundedness and overlap assumptions, a sub-sample of matches was used in the second stage of the estimation procedure.

The second stage concerned the estimation of an Ordinary Least Square (OLS) model on the whole sub-sample of matches (matching and regression) or on quintiles of the propensity score (sub-classification and regression). In addition to matching and regression, and sub-classification and regression, a third approach was used: the doubly robust estimator. The latter approach combines weighting and regression, which can lead to additional robustness by reducing the correlation between the omitted and the included covariates (Imbens and Wooldridge, 2009). The dependent variable in each of the three approaches is the income (farm income or total household income, depending on the research question) after logarithmic transformation. This ensures normality and allows the estimated coefficients to be interpreted as elasticities. Having estimated the average treatment effect, the results from matching and regression were used to simulate whether the receipt of extension services can help reduce poverty {Cunguara and Moder, 2011}.

Unlike the impact assessment methods discussed above, the analysis of the role of nonfarm income activities in reducing poverty {Cunguara et al., 2011a} used a different approach to deal with selection bias. Here, a multivariate sample selection model was used, following the model of Yen (2005), which is an extension of the Heckman approach, and a generalization of the Tobit model. The multivariate sample selection model accommodates censoring in the dependent variable and correlations among error terms across equations. The model avoids biased and inconsistent estimates of the standard errors for each type of nonfarm income generating activity that are caused by estimating the equations independently (a two-stage estimation procedure) and thus ignoring the correlation between types of nonfarm income activities (Greene, 2003).

Seven types of nonfarm activities were modeled. Therefore, a system of seven pairs of equations was estimated. Each pair consisted of a selection and level equations. The former concerned the estimation of the factors associated with the decision to participate (dummy variable) in each type of nonfarm activity. The level equations concerned the estimation of the factors associated with the returns earned (continuous variable) from each nonfarm activity. Therefore, a Probit model was used in the selection equations, whereas an OLS was used in the level equations. The system was estimated simultaneously, while imposing the error correlation between each pair of the selection and its corresponding level equation. Moreover, the error correlation matrix was used as a diagnostic test of sample selection bias. The test consisted of ascertaining whether the correlation of each pair of equations was significantly different from zero.

4 Results: summary of the papers

Earlier, three lines of poverty research were identified: the role of economic growth and neo-liberal development policies in reducing poverty, agricultural productivity growth, and participation into the nonfarm employment sector. The discussion below is guided by these three strands of the economic literature on poverty.

4.1 Economic growth as a pathway out of poverty in rural Mozambique

The first objective of this study was to assess the trends in household incomes, poverty, and food security {Cunguara and Hanlon, 2011; Cunguara et al., 2011b}, in the midst of the neoliberal development model adopted by Mozambique. The results suggest that in Mozambique poverty levels remained statistically unchanged in the last decade. Using data from the consumption expenditure surveys, official statistics indicate that in 2009 about 55 percent of the population lived below the national poverty line, compared to the previous poverty incidence figure of 54 percent in 2002 (Table 1).

Table 1 Poverty statistics in Mozambique by survey year and location

Description/ Survey year	Poverty headcount			Poverty gap			Squared Poverty gap		
	1996-97	2002-03	2008-09	1996-97	2002-03	2008-09	1996-97	2002-03	2008-09
National	69.4	54.1	54.7	29.3	20.5	21.2	15.6	10.3	11.0
Urban	62.0	51.5	49.6	26.7	19.7	19.1	14.6	9.6	9.6
Rural	71.3	55.3	56.9	29.9	20.9	22.2	15.9	10.7	11.6
Northern provinces	66.3	55.3	46.5	26.6	19.5	16.6	13.9	8.9	8.0
Central provinces	73.8	45.5	59.7	32.7	16.0	24.3	18.0	7.9	13.0
Southern provinces	65.8	66.5	56.9	26.8	29.1	22.1	13.9	16.0	11.4
Niassa	70.6	52.1	31.9	30.1	15.8	12.3	16.1	6.7	6.5
Cabo Delgado	57.4	63.2	37.4	19.8	21.6	11.5	9.1	9.5	4.8
Nampula	68.9	52.6	54.7	28.6	19.5	20.0	15.3	9.3	9.8
Zambézia	68.1	44.6	70.5	26.0	14.0	27.9	12.3	6.1	13.9
Tete	82.3	59.8	42.0	39.0	26.3	16.5	22.5	15.3	8.9
Manica	62.6	43.6	55.1	24.2	16.8	21.1	11.7	9.2	11.1
Sofala	87.9	36.1	58.0	49.2	10.7	27.0	32.1	4.3	17.1
Inhambane	82.6	80.7	57.9	38.6	42.2	20.9	21.4	26.0	10.1
Gaza	64.6	60.1	62.5	23.0	20.6	28.3	10.9	9.3	16.7
Maputo Province	65.6	69.3	67.5	27.8	31.1	25.6	14.7	17.2	12.5
Maputo City	47.8	53.6	36.2	16.5	20.9	11.8	7.7	10.3	5.2

Source: Third National Poverty Assessment (2010) – MPD/DNEAP.

Nampula and Zambézia provinces account for about half of the national population. These two provinces are predominantly agricultural-based. Poverty levels increased significantly there. Market segmentation and poor road infrastructure puts a major hurdle in the agricultural value chain (Tostão and Brorsen, 2005). Farmers in the central and the northern provinces are usually unable to sell their surplus to the deficit southern provinces, and if they do sell, it is usually soon after the harvesting season when prices are substantially lower.

Other welfare indicators were also examined. Households in 2008 perceived their economic conditions as significantly better than in 2005, but not as good as in 2002. This suggests that between 2002 and 2008 their economic condition worsened, which is consistent with trends both in household incomes from TIA and consumption expenditure surveys for the same period. This might seem paradoxical since ownership of some assets shows improvements. One explanation is that assets are unequally distributed in rural Mozambique. For instance, although on average the percentage of households with thatched roofs has declined, the change was greater among the top quintile of per capita cash income. Interestingly, thatched

roofs, often associated with low incomes, are common even among the wealthiest in rural Mozambique.

A similar pattern recurs with other assets. All quintiles experienced an increase in cropped area between 2002 and 2005, which is consistent with changes observed in household income between these two periods. However, in the period leading up to 2008 all quintiles experienced a decline in the cropped area, and the decline was relatively greater among the lowest quintiles of per capita cash income.

Regarding food security, the results show that food insecurity was lowest in 2002, but has been increasing ever since. About 43 percent of rural households were food insecure in 2002, which implies that they had to rely on food aid. Of note is that the definition of food security used in this study accounts for both produced and purchased food. Lowering food prices would therefore have a positive effect on food security. This can be accomplished by increased investment in agro-processing and storage in rural areas, especially in the regions with a high potential for crop production (Arndt et al., 2001).

In 2008 the percentage of food insecure households increased to about 48. The results also show that an overwhelming majority of households in the bottom three quintiles of cash income per capita are food insecure. Moreover, food insecurity decreases when moving from the bottom to the upper quintiles, but the change is noticeably greater from the fourth to the top quintile. This is because the median cash income per capita in the top quintile is about twice as high as the median among households in the fourth quintile, and maize production is about three times higher among those in the top quintile.

Food security can be enhanced either through market participation, agricultural productivity growth (through the use of improved technologies) or both. However, the use of improved technologies remains extremely low and access to agricultural services decreased in recent years, hence the yields also remain low. Agriculture continues to be one of the most important economic activities in Mozambique. Rapid economic growth wins high praise from the international community, and has been driven by growth in industrial production, mainly in 'mega projects.' However, the results of this study suggest that the benefits of economic growth have so far bypassed the poor.

Economic growth is concentrated in the industry, mostly located in peri-urban areas, with few linkages with the rest of the economy. The urban population is growing, so is the demand for food and the reliance on food imports, especially in the southern provinces. Yet investments in agriculture and rural areas tend to be disproportionately lower. Government's expenditures in the agricultural sector is less than the 10 percent of the total budget agreed by many African countries as part of the Comprehensive African Agriculture Development Program (CAADP) initiative. Similarly, the percentage of total international aid allocated to agriculture is low, relative to the other sectors. Furthermore, provinces of greater agricultural potential and population size tend to receive comparatively less government budget for agriculture.

4.2 Non-agricultural pathway out of poverty in rural Mozambique

The second objective of this study concerned the role of household diversification outside the agricultural sector in reducing drought vulnerability and poverty {Cunguara et al., 2011a}. This study applied recent developments in econometric modeling of censored regressions to untangle the relationship between drought, participation in nonfarm activities, and poverty. In general, participation in nonfarm activities increased for almost all activities between 2002 and the drought year 2005, but decreased in the period from 2005 to 2008.

Regarding household demographics, the low levels of educational attainment explain in part the low participation in 'skilled non-agricultural' activities, and the relatively higher participation in 'unskilled agricultural' and 'unskilled non-agricultural' activities. The relatively high share of female-headed households engaged in nonfarm activities in the southern provinces may reflect male outmigration, who may seek employment in urban centers or in the mining sector in neighboring South Africa. Therefore, remittances are higher in the south, which enables some smallholder farmers to participate in nonfarm activities that require some initial investment, such as 'skilled' and 'unskilled' non-agricultural activities of high return.

Overall, the effect of drought on the participation in nonfarm activities does not present a uniform pattern, neither in the proportion of households participating in a single type of nonfarm activity, nor in the per capita earning from each nonfarm income activity. However, when assessing the proportion of households who participated in more than a single type of nonfarm activity, there is a significant difference between the drought year 2005 and the two other years (2002 and 2008). This indicates that households tend to participate in more than one type of nonfarm activity in a year of drought, but the activities in which they engage in vary, depending on availability, accessibility or expected return {Cunguara et al., 2011a}.

The results of the multivariate sample selection models show that relatively poorer households are more likely to participate in nonfarm activities but often earn less than wealthier households. This can be related to the inability of poorer households to raise the money necessary to cover the initial investments. Such barriers to enter into high return activities can be eased through livestock ownership. Livestock promotion programs are thus likely to have a significant impact on poverty reduction. Alternatively, the government or any development agency could offer direct support, e.g., in the form of micro-credit or group savings schemes within farmers' associations.

Worth noting is that households in the bottom quintile of net income per capita participate in nonfarm activities mostly as a drought coping mechanism, whereas households in the top quintile engage in nonfarm activities as a permanent livelihood strategy {Cunguara et al., 2011a}. Income diversification through on-going participation in nonfarm activities can thus be a pathway out of poverty. This calls for policy interventions supporting participation in nonfarm activities, such as ensuring primary education for the rural population and improving road infrastructure to allow access to markets.

When designing these policies, however, equity issues should be taken into account, especially to ensure that the poorer and female-headed households will benefit directly from the interventions. Despite the challenges involved, policy makers should avoid designing interventions that relegate poor households to low-return activities such as 'unskilled agricultural and non-agricultural' wage labor. These serve primarily as short-term coping strategies, rather than being a pathway out of poverty.

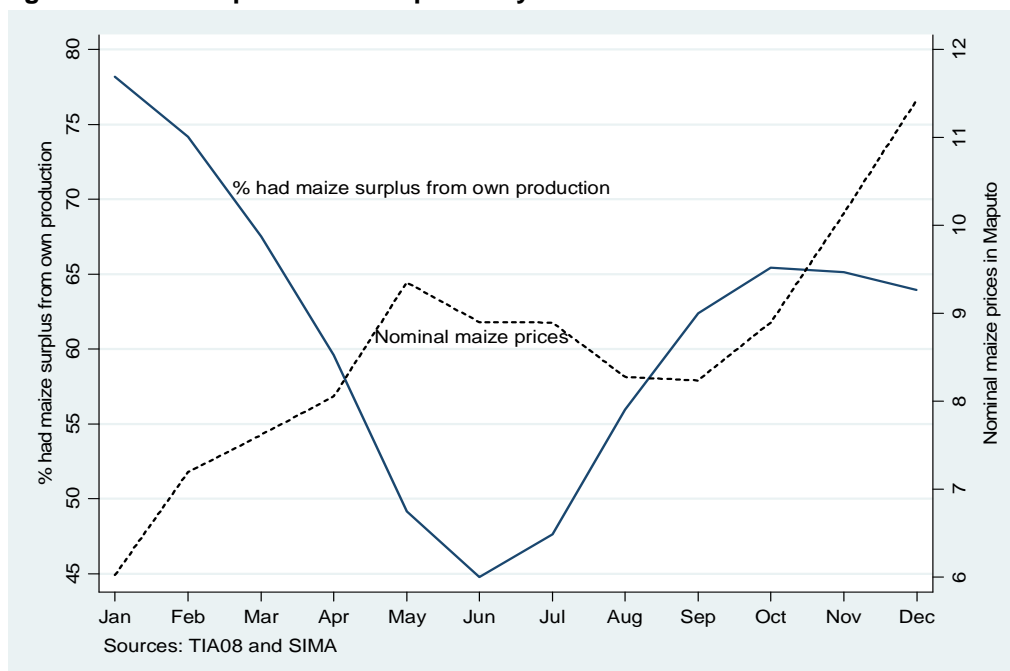
Breaking some of the barriers to participation in nonfarm activities of high return requires rather long term investments, such as in education. In the short run, however, it would be necessary to increase the profitability of activities that are predominant among the poor. These include milling and agro-processing activities, highlighting the synergy between agricultural and nonfarm activities. It will also be necessary to raise agricultural productivity and production. This would then stimulate the demand for non-agricultural goods, thus increasing nonfarm incomes.

4.3 Agricultural productivity growth as the route out of poverty

The third and last objective of this study was to assess the economic impact of interventions that can potentially enhance agricultural productivity growth, and hence reduce poverty {Cunguara and Moder, 2011; Cunguara and Darnhofer, 2011}. The results suggest that agricultural productivity did not improve. Maize is Mozambique's main staple crop, and its production levels have not changed in the past decade. Moreover, the poorest 20 percent of smallholder farmers produce only one percent of the country's maize, while the top 20 percent produces more than half. On average, farmers only produce enough food to feed their families adequately for less than eight months of the year, and this did not improve in recent years {Cunguara and Hanlon, 2011}.

As discussed in section 4.1, this implies that smallholders rely on food purchases. However, they participate in the market in relatively unfavorable conditions, usually selling the majority has maize surplus soon after the harvesting season. This is when prices are substantially lower, between January and May (see Figure 2). Then most farmers run out of maize by June, and they have to purchase maize. However, in June prices are usually very high, which has a negative welfare effect. Thus, policies to reduce the markup price, especially during the late dry season, would have a marked impact on food security and poverty.

Figure 2 Maize surplus vs maize prices by month in 2008



One reason for lack of improvement in agricultural productivity is that the use of improved technologies is extremely low in regions of higher agricultural potential. For instance, the use of chemical fertilizers is lowest in northern Mozambique: only 0.2 percent of farmers use chemical fertilizer on maize. In addition, the use of animal traction in the northern provinces is practically nonexistent due to the occurrence of the trypanosomiasis disease in cattle. Furthermore, the access to public services such as agricultural extension and commodity price information has declined in recent years, despite the evidence from some studies suggesting that the receipt of such services has a significant impact on farm income {Cunguara and Moder, 2011}.

In terms of the impact of the use of improved technologies, the results from matching and regression and the doubly robust estimator show that, in general, the adoption of improved agricultural technologies was surprisingly not statistically significant in enhancing household

incomes in rural Mozambique {Cunguara and Darnhofer, 2011}. However, the results from sub-classification and regression show that adoption of improved technologies has a positive and significant impact in increasing incomes for households with access to the markets, despite drought. The study also evaluated the impact of the receipt of extension services. The results consistently show that the impact of agricultural extension on farm income is positive and statistically significant. On average, the receipt of extension advice increases farm incomes by 12 percent.

Although the receipt of extension services increases farm incomes, extension visits alone may not have a significant impact on poverty reduction. Agricultural extension fails to develop technologies that require few off-farm resources. Moreover, the coverage of extension services is rather small to have a significant impact on poverty reduction. At the national level, extension services reached 15 percent of the rural population in 2005, but visited households are usually not the poorest ones. Additionally, extension services show a downward trend since 2005.

5 Discussion and conclusion

This chapter discusses the key results in light of the poverty reduction literature. These results are drawn from the papers included in Part B, which are referred to in curly brackets. Some methodological and theoretical implications are then drawn from those five papers. This is followed by policy implications and perspectives for future poverty reduction research.

5.1 Discussion of the key results in light of the literature

There is a growing recognition that past approaches, especially those predicated on simply getting the macro economy and prices 'right', which was the preoccupation of donor agencies in the 1980s and 1990s, did not generate the broadly based economic growth needed for sustainable poverty reduction (Stiglitz, 1998; Williamson, 2003; Killick et al. 2005; Barrett et al., 2006). The results presented in this study also suggest that poverty levels remained unchanged, and food security increased {Cunguara and Hanlon, 2011; Cunguara et al., 2011b}, which does not support previous poverty research on Mozambique. Nevertheless, the third national poverty assessment recognizes that not much progress has been made in reducing poverty in the last decade. The recognition that economic growth alone might not reduce poverty has in turn motivated a search for a better understanding of the micro-level constraints to poverty reduction (Barrett et al., 2006), and new developing strategies are emerging.

In 2009 the Government of Mozambique launched the National Program to Stimulate Food Production (hereafter PAPA). The program consists of stimulating the use of improved seeds and chemical fertilizers. In Africa, some studies have analyzed the impact of improved technologies in reducing poverty. These studies typically use the net present value or other profitability approaches, and in general, show a positive and significant impact of the adoption of improved technologies (Oehmke and Crawford, 1996; Simalenga and Longisa, 2000; Howard et al., 2003). This study, however, shows that in general, the use of improved technologies surprisingly do not have a significant impact in reducing poverty because of the poor market infrastructure in Mozambique and the cyclical occurrence of droughts {Cunguara and Darnhofer, 2011}. This finding does not support the usual perception that adoption of improved technologies will significantly increase household incomes (Panin, 1989; Oehmke and Crawford, 1996; Simalenga and Longisa, 2000).

The receipt of agricultural extension has a positive and significant impact on farm income {Cunguara and Moder, 2011}. Targeting the poorest households, however, results in lower farm incomes. This explains the insignificant impact of the receipt of extension services found in Walker et al. (2004), and more recently in Mather (2009). Neither study estimated the impact of agricultural extension based on household typology. Nevertheless, agricultural extension alone is unlikely to reduce poverty. This resonates with recent research suggesting that extension services fail to develop resource-poor technologies (Snapp et al., 2003; van den Berg and Jiggins, 2007). Farmers often do not have the resources to adopt and adapt the recommendations provided by the extension workers.

Participation in nonfarm income generating activities has the potential to reduce poverty in rural Mozambique {Cunguara et al., 2011a}. This result has long been acknowledged by other studies on Mozambique (see, for example, Walker et al., 2004; Benfica, 2006). The results also show that participation in nonfarm activities increases during a drought year, and the poorest households are more likely to engage in the nonfarm employment sector {Cunguara et al., 2011a}. Nevertheless, the access to nonfarm activities is significantly skewed, with the poorest households engaging in 'low return activities', while their wealthier counterparts have better access to 'high return' nonfarm income generating activities. This result is consistent with similar studies conducted in Africa (see for example, Reardon, 1997; Benfica, 2006; Debela et al., 2011).

5.2 Methodological implications

This study contributes to the understanding of poverty in several ways. First, the analysis of household income diversification {Cunguara et al., 2011a} was based on recent developments in econometric modeling of censored regressions. This allowed accounting for the correlations between the decisions to participate in various types of nonfarm activities and the incomes earned from such activities, while controlling for sample selection bias.

Second, the use of recent developments in the econometric analysis of impact assessment studies showed a rather surprising result. When properly accounting for sample selection bias and endogenous program placement, the use of improved technologies had no statistically significant impact on household incomes, unless the household had access to markets {Cunguara and Darnhofer, 2011}. This implies that impact assessment research should deal with sample selection whenever possible. This usually requires baseline data on probable adopters before the adoption takes place. Panel data, however, are rare in Mozambique, and this study used a cross-sectional approach which can be extended to other development projects where panel data are nonexistent.

Third, this study contributes to the debate of food security measurement by proposing a food security measure that captures food availability through farmers' own production, and access to food through purchases. The proposed food security measure showed a similar trend with that of household incomes, consumption, or poverty, thus lending support to its validity as a proxy of food security {Cunguara et al., 2011b}.

Fourth, the sensitivity analysis of the propensity score is challenging, as the literature provides little guidance on how it could be performed (Gibson-Davis and Foster, 2005; Gilligan and Hoddinott, 2007). This study contributes to the impact assessment literature by proposing a method to assess the plausibility of the unconfoundedness assumption, which consists on generating a 'large sample' of simulated data and comparing the estimated coefficients to those from the original data {Cunguara and Darnhofer, 2011; Cunguara and Moder, 2011}. The results showed no reason for concern, and hence the unconfoundedness assumption was reasonable.

Finally, the results from the papers included in this study suggest that poverty reduction strategies in rural Mozambique should be analyzed at the regional level. This result has been reported elsewhere (see Silva, 2007). For instance, some interventions are more suitable for the southern provinces (e.g., animal traction and participation in nonfarm activities) while others may be suitable for the central and northern provinces, provided that certain conditions are met.

5.3 Theoretical implications

This study analyzed three streams of the poverty literature: economic growth, participation in nonfarm activities, and agricultural productivity growth. In relation to these three strands of the literature, different perspectives and development theories have been discussed. Reducing poverty is very challenging, and development programs must account for the diversity of household characteristics, the agro-ecology, livelihood resources, access to the markets, among other variables. The results imply that none of the development theories is as effective in reducing poverty as a judicious combination of them. Therefore, development strategies should have an appropriate balance between the various theories. This balance, however, may be missing in the PARPA.

The results from the impact assessment papers {Cunguara and Darnhofer, 2011; Cunguara and Moder, 2011} suggest that technological change requires an enabling environment for

an effective and profitable adoption to occur. Most importantly, access to output markets proved to have a crucial role. Successful promotion of the use of improved technologies should be accomplished by investments in market infrastructure. Put differently, emphasis should not be placed on increasing production alone, but the whole agricultural system.

Finally, rapid economic growth may not be effective in reducing poverty if it is concurrent with population growth, especially in urban areas, with the stagnation of agriculture and with inflation. This result has long been highlighted in the literature (Kalechi, 1976; Bhaduri, 2006; Rakshit, 2009).

5.4 Policy implications

The theory behind liberalization common in most African countries was that state-owned boards were expensive and inefficient, and in a free market smallholder farmers would capture more of the surplus and prosper. Neoliberal development policies in Mozambique resulted in significant economic growth in the 15 years up to 2010. In addition, it is hard to dispute the importance of economic growth in a poor country like Mozambique. Yet the dawning recognition that poverty is not being reduced, at least not as quickly as previously thought, calls for some rethinking in poverty reduction strategies.

First, economic growth is a necessary but not sufficient instrument to generate a broad-based poverty reduction in Mozambique. Donors and the Government may need to stress not only the social areas (Millennium Development Goals 2-6), but also pay more attention to agriculture and creation of nonfarm employment opportunities (Millennium Development Goal 1). This is related to agricultural growth and income diversification, which in turn requires recognition that the government should play a proactive role in improving the market infrastructure.

Second, to reduce poverty, it may be more effective to devise regional strategies instead of a national PARPA. The current PARPA recognizes that there are significant regional differences in terms of poverty, food security, and agricultural potential. But this recognition is not translated into clear regional strategies to reduce poverty. Accordingly, Mozambique suffers from natural calamities almost every year – droughts or dry spells in the south, and floods in the center and north. Instead of simply acknowledging this problem, the strategies to reduce poverty should take the occurrence of droughts and floods into account. For instance, the promotion of nonfarm employment opportunities could be intensified in the southern provinces. In the meantime, significantly more investments in market infrastructure are required in the central and northern provinces, which would make the use of improved technologies profitable.

Third, the issue of poverty not being reduced is not only related to policies and vagaries of the weather, but also the government's role. The IMF and other donors allow protection for the sugar sector, where the plantations are owned by trans-national corporations who said their investment was dependent on protection, but not for other crops grown by smallholder farmers. Large tax breaks and other de facto subsidies are permitted for foreign investors, particularly in the mineral and energy sectors, but agricultural subsidies are practically not allowed for smallholder farmers. One of the world's largest tobacco companies has been given exclusive rights to control tobacco production in much of the country and set up what is, in effect, a marketing board, but the state is not allowed to create a similar system for other crops.

5.5 Perspectives for future research

The results from Cunguara et al. (2011a) are based on the assumption that the effect of a drought on the participation in nonfarm activities will take place within the same agricultural year. Although this is likely for many activities that are used as short-term coping strategies, long-term and strategic diversification behavior may not be adequately captured. Also, it is likely that engaging in any nonfarm activity will have a long-term effect, e.g., through learning and building social networks (Eriksen and Silva, 2009), which will affect subsequent participation in nonfarm activities. Furthermore, the behavior of households in a given year is likely to be affected by the quality of the previous agricultural year(s). Future studies on the determinants of participation in nonfarm activities based on panel data spanning longer period of time would provide valuable insights allowing for better understanding of these correlations.

Participation in nonfarm income proved to be one of the mechanisms to cope with the vagaries of the weather. However, other mechanisms should also be considered in future studies, both in drought and flood prone areas. Some of the alternatives include studying the potential impact of using water harvesting and conservation technologies. These studies should include a cost-benefit analysis. Additionally, whenever possible such technologies should be adapted and tailored to meet the socio-economic conditions of smallholder farmers.

So far the food security measure only captures two components of food security, namely food availability and access. Food utilization and farmers' resilience are not accounted for. In the future, it would be interesting to improve the food security measure to better reflect farmers' constraints to food security.

Regarding the survey instrument, improvements are likely to yield more accurate data and thus allow more nuanced analysis. For example, the timing of the use of improved technologies should be recorded. Sowing improved seeds in November will have a different impact than sowing in December. Likewise, plowing in November will likely have a different impact than plowing in late December. Furthermore, there are numerous extension methods that could be used by the extension workers, which in turn differ in terms of the effectiveness. These differences can affect the estimates of the impact of the receipt of extension services or the use of improved technologies. The survey instrument should therefore collect information on the type of extension method. Other important suggestions to improve the survey instrument are described in Doss (2006).

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The role of nonfarm income in coping with the effects of drought in southern Mozambique

Benedito Cunguara^{a,b,*}, Augustine Langyintuo^c, Ika Darnhofer^a

^a*Institute of Agricultural and Forestry Economics, University of Natural Resources and Life Sciences, Feistmantelstrasse 4, 1180 Vienna, Austria*

^b*Centre for Development Research, Gregor Mendel Strasse 33, 1180 Vienna, Austria*

^c*Alliance for a Green Revolution in Africa (AGRA), PO Box 66773, 00800 Westlands, Nairobi, Kenya*

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Abstract

To reduce their dependence on subsistence agriculture, farm households in rural Africa may diversify their income sources by participating in the nonfarm sector. In years of drought, nonfarm income can also be part of the coping strategies. A multivariate sample selection model was used to analyze three years of data from a nationally representative household survey in Mozambique. The analysis was guided by the following three questions. During a drought year: (1) Do households increase their participation in nonfarm activities? (2) Are poorer households as likely as others to participate in and benefit from nonfarm activities? and (3) Which factors are associated with higher nonfarm incomes? The results suggest that households are more likely to engage in at least one nonfarm income-generating activity during a drought year. Although poorer households are more likely to engage in nonfarm activities, they are less likely to participate in nonfarm activities of high return. The results suggest that policies reducing entry barriers (e.g., improved road infrastructure, micro-credit schemes, and livestock promotion programs) and increasing education levels can facilitate income diversification, thus allowing rural households to better cope with the effects of drought. When designing policies, care must be taken to avoid exacerbating income inequality by targeting measures toward poorer and female-headed households.

JEL Classification: I31, O16, Q01, R11

Keywords: Multivariate sample selection; Poverty; Coping strategies; Rural Mozambique

1. Introduction

Rural households in Africa, especially the poor, often lack access to key agricultural inputs and to the markets necessary to achieve an agricultural-led pathway out of poverty (Jayne et al., 2003; Lanjouw and Lanjouw, 2001). This is the case in southern Mozambique, where agriculture is almost entirely dominated by smallholder farmers. The average cultivated area per household is about 1.4 hectares (World Bank, 2006). Due to a high pressure on land, farm sizes cannot be expanded. In addition, smallholder farmers rarely have the means to invest

in improved technologies due to a lack of resources. The agricultural options are further restricted by the fact that frequent dry spells negatively affect yields (Joubert et al., 1996; Usman and Reason, 2004). Thus, two-thirds of the production is for home consumption (World Bank, 2006), and smallholders are unlikely to move out of poverty through crop production. Therefore, one option for farmers to complement subsistence farming is to engage in nonfarm income-generating activities (Reardon et al., 1998; Walker et al., 2004). Indeed, in Mozambique, the share of nonfarm income was about 22% in 2002 (a nondrought year) and 31% in 2005 (a drought year) (Mather et al., 2008).

The promotion of nonfarm income-generating activities among farming communities has the potential to reduce poverty through several mechanisms. First, combining nonfarm portfolios of different risk profiles can buffer the fluctuation in farm income inherent in rainfed agriculture (Reardon et al., 1998). Second, nonfarm income-generating activities can create positive spillover effects on agricultural activities, as they help overcome market failures, particularly for credit (Bryceson, 1999; Reardon, 1997; Thirtle et al., 2003). Third,

*Corresponding author. Tel.: +43 1 47654–3785; fax: +43 1 47654–3592; E-mail address: cunguara@gmail.com (B.A. Cunguara).

Data Appendix Available Online

A data appendix to replicate main results is available in the online version of this article. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.



Assessing the impact of improved agricultural technologies on household income in rural Mozambique

Benedito Cunguara^{a,b,*}, Ika Darnhofer^a

^a Institute of Agricultural and Forestry Economics, University of Natural Resources and Life Sciences, Feistmantelstrasse 4, 1180 Vienna, Austria

^b Centre for Development Research, University of Natural Resources and Life Sciences, Gregor Mendel Strasse 33, 1180 Vienna, Austria

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ABSTRACT

In many areas of Africa, rural livelihoods depend heavily on subsistence farming. Using improved agricultural technologies can increase productivity in smallholder agriculture and thus raise household income and reduce poverty. Data from a nationally representative rural household survey from 2005 is used to assess the impact of four technologies – improved maize seeds, improved granaries, tractor mechanization, and animal traction – on household income in Mozambique. To ensure the robustness of the results, three econometric approaches were used: the doubly-robust estimator, sub-classification and regression, and matching and regression. The results show that, overall, using an improved technology did not have a statistically significant impact on household income. This may be associated with a widespread drought that occurred in 2005. Despite drought, distinguishing between households based on propensity score quintiles revealed that using improved technologies, especially improved maize seeds and tractors, significantly increased the income of those households who had better market access. Thus, to allow households to benefit from the use of improved technologies, policy makers need to reduce structural impediments to market participation by ensuring adequate road infrastructure and enabling access to markets.

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Introduction

Agricultural productivity in Sub-Saharan Africa is among the lowest in the world (Savadoغو et al., 1998; Fulginiti et al., 2004). For example, in Mozambique the yield of the most important staple crop, maize, is estimated at 1.4 tons ha⁻¹, which is far below the potential yield of 5–6.5 tons ha⁻¹ (Howard et al., 2003). The low productivity can be linked to poor farmer health during the late dry season and the beginning of the cropping season (Abellana et al., 2008); the failure of agricultural commodity and credit markets (Mather, 2009); and the very limited use of improved agricultural technologies (Mather et al., 2008). To increase agricultural productivity, both the Government of Mozambique and Non-Governmental Organizations (NGO) are promoting the use of improved agricultural technologies in crop production (e.g. drought tolerant seeds, animal traction) as well as promoting the use of adequate storage facility for the harvested grain e.g., through improved granaries (Government of Mozambique, 2006).

The goal of promoting these improved technologies is to increase productivity so as to reduce food insecurity as well as produce a marketable surplus which contributes to household income. This approach has been summarized as the agricultural productivity pathway out of poverty and subsistence agriculture (Barrett, 2008). The first hurdle to be overcome is the adoption of the improved technology, which has been the subject of numerous studies (for a review see Feder et al., 1985; Sunding and Zilberman, 2001; Doss, 2006). Much less attention has been given to assess whether once a technology has been adopted, it has indeed fulfilled its promise of increasing household incomes.

Indeed, many studies focus on assessing the profitability of a technology. Some studies have used the net present value (see for example, Oehmke and Crawford, 1996; Howard et al., 2003). This approach implicitly assumes that users and non-users had the same productivity levels before the adoption took place, which may not be the case and may affect the validity of the results. Also, to assess the profitability for a wider population, baseline data on probable adopters would be needed before the adoption takes place. This may be possible in research trials or on a small scale, but is not feasible at the regional or national scale. Other studies estimate an Ordinary Least Squares (OLS) model and obtain the impact of the adoption by including a dummy variable indicating whether the farmer cultivated a certain crop (Walker et al., 2004).

* Corresponding author at: Institute of Agricultural and Forestry Economics, University of Natural Resources and Life Sciences, Feistmantelstrasse 4, 1180 Vienna, Austria. Tel.: +43 1 47654 3785; fax: +43 1 47654 3592.

E-mail address: benedito.cunguara@boku.ac.at (B. Cunguara).

Is agricultural extension helping the poor? Evidence from rural Mozambique

B. Cunguara and K. Moder

Journal of African Economies (in press).

Abstract

Mozambique remains predominantly poor. The official statistics show that poverty incidence barely changed from 54 percent in 2002-03 to 55 percent in 2008-09, which stands way above the government's target of 45 percent by the year 2009. This places the country off-target to cut hunger and poverty by half by 2015, despite an annual economic growth of about seven percent in the period 1994-2010. In rural areas, poverty levels have slightly increased, due to the underperformance of the agricultural sector. Extension services can have a significant impact on poverty reduction through stimulating growth in agricultural productivity. Based on a nationally representative household survey from Mozambique, this paper uses three econometric models, namely an OLS regression, the doubly robust estimator, and matching and regression to estimate the economic impact of receipt of extension. The results suggest that the receipt of extension increases farm incomes by 12 percent. However, rather than crafting resource-poor technologies, extension services tend to target wealthier households who are relatively more likely to adopt the existing technologies. This might increase income inequality. The impact of extension, and therefore its contribution to poverty reduction, can be enhanced through several mechanisms (e.g., programme design and the number of staff).

JEL Classification: O13, H34, I3.

Keywords: poverty reduction; impact assessment; targeting; Mozambique

Poverty is not being reduced in Mozambique

B. Cunguara and J. Hanlon

Manuscript resubmitted to *Development and Change*

Abstract

Despite rapid economic growth and massive inflows of aid, rural income in Mozambique is falling, poverty is not being reduced, and the gap between better off and poor widens. Rural poverty has not fallen because agricultural production and productivity have not increased. Use of chemical fertilisers and other modern technology is low and decreasing. The present development model emphasises that the government and donor role is to provide human capital and infrastructure, while the private sector is responsible for economic development and ending poverty. The most recent national agricultural survey and the consumption expenditure survey confirm what is being seen elsewhere in Africa, that this non-interventionist strategy does not raise agricultural productivity or reduce poverty. Officially, 70 per cent of Mozambique's population is rural, and the majority of rural Mozambicans are caught in the poverty trap. Their production is too small to sell significant amounts, and participate in the market mostly as buyers, usually in very unfavourable conditions. The policy failure is increasingly recognised, but donors and government have invested too much political capital in this policy to change easily.

INTRODUCTION

Mozambique has undergone significant structural changes in the last 50 years up to 2010. First, it suffered from nearly three decades of almost continuous war (Hanlon, 2010). Second, the implementation of the structural adjustment program in the mid 1980s and therefore a change from a socialist to a capitalism regime had marked macroeconomic effects on employment, economic growth, and inflation and exchange rates (MacMillan et al., 2003). Third, the peace agreement signed in 1992 tore down the divide between rural and urban areas, which would later encourage migration to cities and towns (Silva, 2007). More recently, the implementation of the poverty reduction strategy papers (hereafter PARPA) since 2001 adds to that list. But there is one thing that barely changed over the course of this period. Poverty reduction has always been the government overarching goal.

Mozambique has been consistently ranked among the poorest countries in the world for at least the last two decades (UNDP, 2009). Its population is predominantly rural and 80 per cent is engaged in agriculture, contributing about 20 per cent of the Gross Domestic Products (GDP) (INE, 2010). This suggests that labour productivity in the agricultural sector is significantly lower than in the non-agricultural sector, given that the former employs the majority of the population but the latter has the largest share of the GDP.

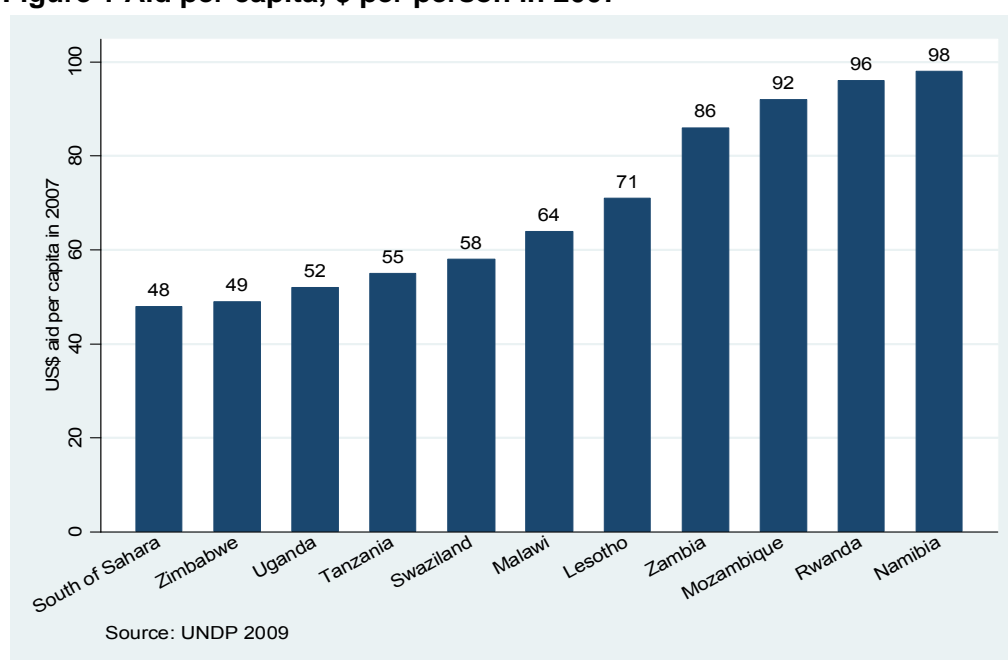
In 1996-97 the mean consumption per capita was actually below the absolute national poverty line, implying that even if the total consumption had been perfectly and equally distributed among Mozambicans in that period, all citizens would have lived in absolute poverty (Arndt et al., 2006). Economic growth was therefore identified as the prime mover in poverty reduction in the so-called 'Washington Consensus.' At the core of the 'Washington Consensus,' as reflected in the PARPA, are macroeconomic policies presumed to lead to economic growth, which in turn would trickle down to the poor (Dollar and Kraay, 2000; Shorrocks and Van der Hoeven, 2004).

In Mozambique, the official poverty statistics are derived from the consumption expenditure surveys. So far, there have been three surveys. The first survey showed that in 1996-97 an overwhelming 69 per cent of the population was poor. Nevertheless, significant improvement has been achieved, resulting in a sharp decline in poverty headcount to 54 per cent in 2002-03. This was made possible with the end of the war, and may reflect the expansion of cultivated area (Arndt et al., 2006; Virtanen and Ehrenpreis, 2007). Agricultural productivity is low, and there is no evidence of improvement between 1996 and 2002. Indeed, the production of most crops fell per hectare and per adult household member during this period (Boughton et al., 2006). Furthermore, caloric production per capita shows a decline in the subsequent period up to 2008 (MPD/DNEAP, 2010).

The third consumption expenditure survey showed that 55 per cent of Mozambicans were poor in 2008-09 (MPD/DNEAP, 2010). This is not only above the government's target of 45 per cent by 2009, but also suggests that at the national level there has not been much improvement in poverty reduction in the last decade. While empirical evidence exists on the relationship between economic growth and poverty reduction (Roemer and Gugerty, 1997; Dollar and Kraay, 2000; Fischer, 2003), this tends to be demonstrated in cross-country studies, using aggregate data which can conceal that in some countries such correlation may be weak. Even at the national level, aggregate statistics may mask successful cases of poverty reduction. Although in Mozambique poverty incidence remained virtually unchanged between 2002 and 2009, poverty incidence changed by 26 percentage points in both Cabo Delgado and Zambézia provinces, however with a decline in the former and an increase in the latter (MPD/DNEAP, 2010). It would therefore be of little consolation to the population in Zambézia to be told that on average poverty incidence remained unchanged.

The dawning recognition that poverty is worsening is puzzling for two reasons. First, the national accounts show an outstanding economic performance. Second, trying to recover from the war, Mozambique became a donor darling, and aid has been rising steadily for the past decade. Mozambique receives significantly more aid than neighbours at a similar level (Figure 1) – Malawi (GDP rank 172, HDI 160) and Tanzania (GDP 157, HDI 151) receive only 60 per cent per capita of the aid to Mozambique. This may be because Mozambique is one of the few countries to be loyally following a neo-liberal, free market development policy, and was apparently also reducing poverty (Hanlon and Smart 2008; De Renzio and Hanlon 2009). But the 45 per cent target has proved a hostage to fortune. Both donors and government staked their prestige on a continuing huge fall in poverty. However, both the National Agricultural Survey (TIA) and the consumption expenditure survey of 2008-09 indicate that far from declining, poverty is actually increasing, although not statistically significant.

Figure 1 Aid per capita, \$ per person in 2007



Three potential factors explain the weak correlation between rapid economic growth and poverty stagnation. First, Arndt et al. (2010) take on the examples of Tanzania and Mozambique, two countries with rapid economic growth but little change in poverty levels, and argue that differences in the methods and accuracy of national growth and poverty accounting may explain this paradox. Indeed, the official statistics show that on average the agricultural output is increasing by about six per cent a year in the last decade (INE, 2010), even in a year of widespread drought such as 2005. However, the third national poverty assessment blames the underperformance of the agricultural sector as one of the main reasons for the lack of progress in poverty reduction (MPD/DNEAP, 2010), raising doubts on the accuracy of the official statistics and the national accounts.

Second, the extent of the effect of economic growth on poverty reduction depends on the structural characteristics of the country, a feature often not accounted for in cross-country studies. Historically, Mozambique possesses two distinct poles of development, the relatively urban south and the predominantly rural areas in central and northern Mozambique (Silva, 2007). Most Portuguese settlers lived in the south where some urbanization took place, whereas agricultural production from the central and northern provinces was exported from the northern ports, leaving less incentives to connect the south to the north. Market segmentation contributes for the southern provinces to remain dependent on food imports,

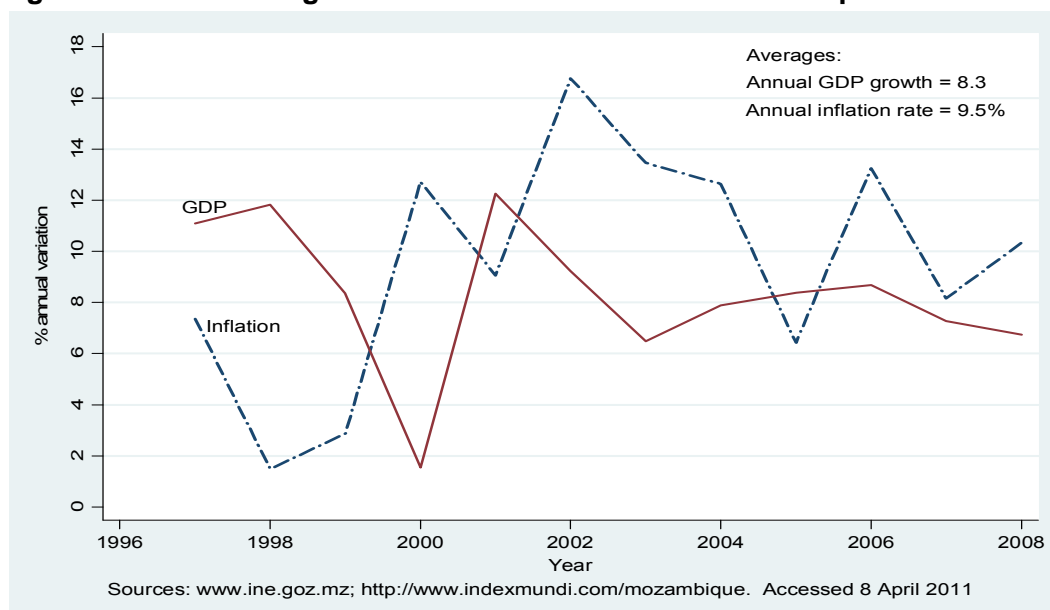
and vulnerable to price fluctuations in the international markets (Tostão and Brorsen, 2005). Additionally, as a result of socio-economic imbalances between the urban and the rural areas, the urban population is growing rapidly, especially in the food-deficit southern provinces (INE, 2010).

Economic growth and population growth (especially urban) with the stagnation of the agricultural sector may result in inflation of staple food prices, exacerbating poverty (Kalechi, 1976; Bhaduri, 2006; Rakshit, 2009). An increase in prices of staple food crops has a markedly negative impact on farmers' wellbeing because the demand for food is usually inelastic (Engel's law), and the majority of the population is net consumer of food (Boughton et al., 2007). For instance, Handa and Mlay (2006) found high (nearly unitary) income elasticity for basic staple foods (e.g., cassava) among poor households in rural Mozambique.

Price instability discourages investment in staple food production by surplus households in northern Mozambique that have the assets and the favourable conditions to produce much more (Poulton et al., 2006a). It also encourages deficit households in the southern provinces to devote scarce resources to staple food production to ensure their livelihoods, limiting diversification and the increased incomes that typically come with it (Tostão and Tschirley, 2010). Furthermore, it limits nonfarm investment in services such as input supply, provision of credit, and storage and processing, thus reinforcing behaviours that lead to continued price instability (Tostão and Tschirley, 2010).

Cirera and Nhate (2007) argue that changes in the exchange rate in neighbouring countries tend to be fully transmitted to consumer prices in the domestic market. Although available statistics show that the GDP has been increasing rapidly, inflation rates tend to be higher (Figure 2). This suggests a worsening cost of living, which disproportionately affects the poor, who spend most of their income on food. A robust GDP growth and lack of progress in poverty reduction in the last decade suggest that most of the benefits of economic growth accrue to wealthier households. As a result, inequality levels would increase over time. Nevertheless, the Gini coefficient remained almost the same between 2002-03 and 2008-09, prompting questions about who is really benefiting from the economic growth.

The third potential explanation for the weak correlation between rapid economic growth without significant changes in either poverty headcount or inequality is that the benefits of economic growth may accrue to foreign investors. Mozambique was quite successful in attracting foreign investment, such as the aluminium smelter (Mozal), a gas pipeline for export to South Africa, the mining of titanium in Chibuto and Moma, and coal mines in Tete (Arndt and Tarp, 2009). However, these 'mega projects' create few local jobs, have few local linkages, and have a small impact on poverty reduction (Thirtle et al., 2003a). They benefit from huge tax exemptions, rely heavily on imported goods, and only a very small fraction of their production is consumed locally (Virtanen and Ehrenpreis, 2007). For instance, in 2006 Mozal contributed about 56 per cent of total exports and seven per cent of the GDP (Sonne-Schmidt et al., 2009). However, the standard income tax of 32 per cent that Mozal foundry would be entitled to bear has been replaced by a fixed turnover tax of \$4 million, which is less than one per cent of Mozal's total export value in 2006 (Andersson, 2001; Sonne-Schmidt et al., 2009).

Figure 2 Annual GDP growth and inflation rates in Mozambique

Officially, 70 per cent of the Mozambican population is rural and agriculture is the predominant economic activity in Mozambique. The smallholder sector accounts for 99 per cent of all farms, which means that the further reduction in poverty called for in PARPA is dependent on enhancing farmers' incomes (Walker et al., 2004; Mather et al., 2008; Mather, 2009; Arndt et al., 2010; MPD/DNEAP, 2010). PARPA 'recognises' this and 'prioritises' agricultural development to increase rural incomes and reduce absolute poverty. PARPA calls for a transformation of agriculture through the promotion of agrarian services, and increased productivity and production. We argue here that this has not happened. In this paper, we first look at data and what they show about changes in poverty and the lack of changes in farming which contribute to the persistence of poverty, and then consider cash income and the poverty trap. In the final section we discuss the failure of the donor-led development model, look at Mozambique and other countries for alternative policies which might reduce poverty and raise agricultural production, and finally consider pressures for and against changing policy.

RURAL INCOME, POVERTY & TECHNOLOGY

We use data from the TIA of 2002, 2003, 2005, 2006, 2007, and 2008. The surveys were implemented by the Department of Statistics of the Ministry of Agriculture. Except for the TIA08 sample, which draws on the Population Census of 2007, the remaining TIA samples draw on the Census of Agriculture and Livestock of 1999–2000. The TIA samples were stratified by province and agro-ecological zone. All of the TIA surveys collected production and marketing data for each crop, ownership of livestock and the basic characteristics of members of each household. TIA02, TIA05, and TIA08 were the three most comprehensive surveys, with detailed information on household income components. Additionally, data on small and medium-sized farms were complemented by group interviews at the community level and field measurements. All the figures presented here are population weighted. Sample size was approximately 5000 in 2002 and 2003, and 6000 in subsequent years; coverage increased from 80 districts in 2002 to all 128 districts in 2008.

Mozambique is a large country with quite variable and differentiated climatic conditions – most years have droughts and floods somewhere – but 2005 had widespread droughts and thus poorer crops than normal, while 2006 was a better than average year (Table 1). Per

capita production of most staple crops declined between 2002 and 2008. Moreover, during the same period, agricultural productivity (measured as total calories produced per hectare) declined by 15 percentage points.

Table 1 Food production trends (2002- 2008) in Mozambique

Crop/year	2002	2003	2005	2006	2007	2008	Δ 2002-08
Production per person							
Maize	90.0	92.9	67.3	101.7	80.7	80.7	-10.4
Rice	7.5	9.2	4.6	7.1	7.3	5.8	-22.5
Sorghum	11.2	15.0	8.2	14.7	11.9	8.4	-24.8
Millet	1.0	1.7	1.1	1.6	1.8	1.0	-1.5
Groundnuts – large husks	3.0	3.4	2.0	1.8	2.2	2.1	-32.1
Groundnuts – small husks	5.2	3.4	4.2	4.4	5.0	4.7	-8.7
Butter bean	2.9	3.2	3.6	3.6	3.9	3.5	21.0
Cowpea	4.3	5.0	3.5	5.2	4.4	4.1	-5.0
Bambara groundnut	1.8	1.4	0.6	0.8	1.4	0.8	-53.9
ChickPea	2.6	3.4	2.6	4.5	5.1	4.3	65.9
Cassava	278.2	376.1	341.7	399.5	353.0	269.4	-3.2
Sweet Potato	36.8	48.0	36.4	49.4	61.4	40.5	10.0
Caloric aggregate measures							
Total production index	100	124.2	111.3	140.9	128.6	113.8	13.8
Productivity (kcal/ha)	2,307	2,643	1,935	2,424	2,189	1,961	-15
Productivity index	100	114.6	83.9	105.1	94.9	85	-15
Calories per person/ day	2,135	2,583	2103	2717	2422	2000	-6.3

Source: Adapted from the Third National Poverty Assessment (2010), using TIA data.

Table 1 focuses on food production because on average food crop income accounts for over 90 per cent of the median crop income (in 2002), and the share is even higher among smallholder farmers in the lowest income quintiles (Mather et al., 2008). Furthermore, between 2002 and 2005 participation in higher-value farm activities declined, as only a third of households had sold some high-value crops in 2005, and a quarter had sales of livestock products (Mather et al., 2008). Given subsistence requirement, risk management, and entry barriers to income activities, some households either do not have access to cash cropping or choose to focus their attention on meeting subsistence food requirements (Mather et al., 2008).

For income, we use data from the TIA of 2002, 2005 and 2008 which included household income questions. The income analysis is restricted to cash income, that is, total household income is not reported. This is because the bulk of food eaten in rural areas is produced by peasant farmers for their own consumption, and the value of crop production can be misleading. Income may be higher in the drought year of 2005 because the farm gate prices of food consumed were higher in that shortage year – so higher imputed income does not necessarily mean greater welfare or more food eaten. Cash income includes all cash received by households.

Two broadly based social surveys are also compared. The Demographic and Health Survey 2003 (IDS, Inquérito Demográfico e de Saúde), recalculated using as base the 2006 WHO standard population, was compared to the Multiple Indicator Cluster Survey 2008 (MICS). Additionally, we look at the third national poverty assessment report, which is based on the consumption expenditure surveys. Finally, we draw on four studies done as part of the

donor–government evaluation of PARPA II (Cunguara and Kelly, 2009a and 2009b; Grupo de Estudo, 2009; Kelly, 2009).

Worsening rural poverty

The third consumption expenditure survey shows no improvement in poverty headcount (MPD/DNEAP, 2010). At the national level, poverty incidence barely changed from 54.1 per cent in 2002-03 to 54.7 per cent in 2008-09 (Table 2). The increase was not statistically significant. Similar results had been reported a year earlier, in Cunguara and Kelly (2009a,b) using TIA data. Rural poverty has worsened, especially in Zambézia and Sofala provinces. These two provinces receive far less agricultural budget than Gaza and Inhambane, despite their agricultural potential and population size (Zavale et al., 2009). Coincidentally, the ruling party usually does not win the elections in Zambézia and Sofala, but it is in Gaza and Inhambane where they win an overwhelming majority of votes. Zavale et al. (2009) argue that ‘government budget allocation to various sectors reflects policy and development priorities on one hand and political compromises on the other hand.’

The rising cost of living has sparked a series of riots throughout the country, especially in urban areas (Hanlon, 2010). This led the government to readjust some development policies. First, in 2008 subsidies were introduced for diesel, wheat, water, electricity, and others. These measures proved to be financially unsustainable, and in 2011 some of the subsidies are either due to expire (e.g., diesel subsidies) or will be replaced by cheaper measures (e.g., food vouchers to be given to households below a certain salary threshold). But these measures are usually urban biased, and the urban population is growing faster than the rural population while agriculture is stagnant and the demand for food is increasing.

The poverty gap and the squared poverty gap results suggest that the distribution of incomes worsened as the inequality increased, however not significantly. Similar to the trend in poverty incidence, the change in the depth and severity of poverty was higher in rural areas. In general, poverty levels have worsened in the central provinces, despite relatively high crop potential in that region. Further discussion is provided in the next section, where we look at trends on the use of selected agricultural technologies.

Nutrition also shows that poverty levels are not changing very much. Nationally, chronic malnutrition (low height for age or stunting) for children under five years old fell from 48 per cent in 2003 to 44 per cent in 2008, but this is still considered ‘very high’ by the World Health Organisation (Grupo de Estudo, 2009). Stunting is a good indicator for the well being of a population. If young children are exposed to sub-optimal nutrition at early stages in their development, they are unable to reach their full potential height and mental development, and this opportunity is irreversibly lost; it cannot be regained, even if nutrition improves and a child gains weight. And Ministry of Health figures show that low birth weight rates are not improving; they were 10.9 per cent of births in 2006 to 11.3 per cent in 2008, a difference which is not statistically significant, but it is also not better.

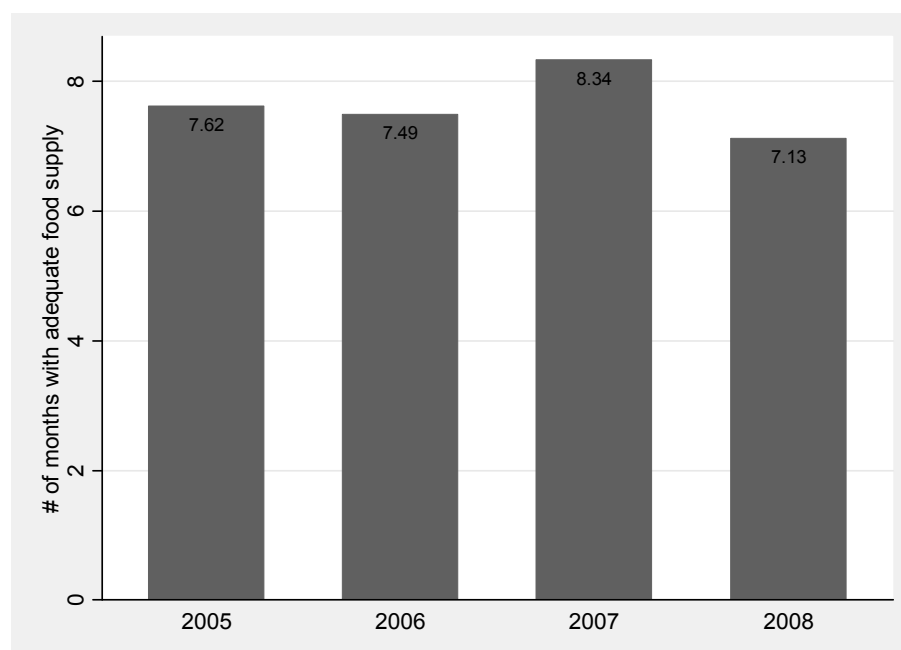
Table 2 Poverty statistics in Mozambique by survey year and location

Description/ Survey year	Poverty headcount			Poverty gap			Squared Poverty gap		
	1996-97	2002-03	2008-09	1996-97	2002-03	2008-09	1996-97	2002-03	2008-09
National	69.4	54.1	54.7	29.3	20.5	21.2	15.6	10.3	11.0
Urban	62.0	51.5	49.6	26.7	19.7	19.1	14.6	9.6	9.6
Rural	71.3	55.3	56.9	29.9	20.9	22.2	15.9	10.7	11.6
Northern provinces	66.3	55.3	46.5	26.6	19.5	16.6	13.9	8.9	8.0
Central provinces	73.8	45.5	59.7	32.7	16.0	24.3	18.0	7.9	13.0
Southern provinces	65.8	66.5	56.9	26.8	29.1	22.1	13.9	16.0	11.4
Niassa	70.6	52.1	31.9	30.1	15.8	12.3	16.1	6.7	6.5
Cabo Delgado	57.4	63.2	37.4	19.8	21.6	11.5	9.1	9.5	4.8
Nampula	68.9	52.6	54.7	28.6	19.5	20.0	15.3	9.3	9.8
Zambézia	68.1	44.6	70.5	26.0	14.0	27.9	12.3	6.1	13.9
Tete	82.3	59.8	42.0	39.0	26.3	16.5	22.5	15.3	8.9
Manica	62.6	43.6	55.1	24.2	16.8	21.1	11.7	9.2	11.1
Sofala	87.9	36.1	58.0	49.2	10.7	27.0	32.1	4.3	17.1
Inhambane	82.6	80.7	57.9	38.6	42.2	20.9	21.4	26.0	10.1
Gaza	64.6	60.1	62.5	23.0	20.6	28.3	10.9	9.3	16.7
Maputo Province	65.6	69.3	67.5	27.8	31.1	25.6	14.7	17.2	12.5
Maputo City	47.8	53.6	36.2	16.5	20.9	11.8	7.7	10.3	5.2

Source: Third National Poverty Assessment (2010) – MPD/DNEAP.

Figure 3 shows one reason for the very high levels of chronic malnutrition in Mozambique – the average farmer produces enough food to feed their family adequately for less than eight months of the year, and this is not changing. Moreover, the poorest families only produce enough to provide adequate food for half the year. This means that most smallholder farmers are deficit producers of food, selling some quantities soon after the harvest, and buying more food later in the agricultural season (Boughton et al., 2007). These households rely either on food aid or on cash income for their subsistence. However, participation in nonfarm income activities is usually used as a coping strategy, and the poor usually engages in activities of low return (Cunguara et al., 2011).

Although income and nutrition are not improving, the 2008 Multiple Indicator Cluster Survey indicates considerable improvements in human capital, notably education and health. Although it remains extremely high, the under-five mortality rate was reduced from 153 deaths per 1,000 live births in 2003 to 138 in 2008. Positive trends were also observed with respect to literacy rates and primary school enrolment and attendance rates, however the absolute numbers remain low when compared to international standards. The United Nations has enacted eight Millennium Development Goals (MDGs) to be reached by the year 2015. For example, it is expected that Mozambique cuts hunger and poverty by half, which implies reducing poverty incidence to levels from 55 percent in 2009 to below 35 per cent in just four years. At the present rate of improvement, however, Mozambique will not meet several MDGs (Cunguara and Kelly, 2009a and b; Grupo de Estudo, 2009).

Figure 3 Months with an adequate food supply from farmers own production

Source: Authors' calculations based on TIA data

Child poverty, as measured through the deprivations-based approach⁴, was reduced significantly from 2003 to 2008, from 59 per cent to 48 per cent. This measure responds more quickly to resource allocation, compared to consumption or income-based indicators of poverty. Therefore, increased funds for the rapid expansion of immunisation programmes had an immediate and direct impact on child poverty under the deprivations-based measure. Nevertheless, the evidence suggests that while Mozambique has been expanding and improving basic services to its citizens, it has been far less successful in promoting the agricultural sector, employment opportunities and the incomes of the rural population.

Low technology & little change

PARPA II stressed reducing poverty through increased agricultural productivity and production, but this is not happening. Maize is Mozambique's main staple crop. Table 1, which showed the bad year of 2005 and the unusually good year of 2006, also makes clear that maize production levels have not changed in the past decade. Table 3 shows the poverty implications – the poorest 20 per cent of rural people produces only 1 per cent of the country's maize, while the top 20 per cent produces more than half.

⁴ A household is identified as poor if, and only if, it is deprived in some combination of indicators whose weighted sum exceeds a certain threshold. Indicators include health, education, and standard of living.

Table 3 Percent distribution of total maize production by quintile and year

Year	Bottom quintile	Quintile 2	Mid quintile	Quintile 4	Top quintile
1996	2	5	10	20	63
2002	1	6	11	22	59
2003	1	5	12	22	60
2005	0	4	11	23	63
2006	1	6	11	23	59
2007	1	5	11	22	60
2008	1	5	12	20	61

Source: Authors' calculations based on TIA data

Low productivity results from low and declining use of equipment and inputs, as shown in Table 4. More detailed data from the TIAs shows that improved technology is only used where there are special conditions. Northern Mozambique has the highest agricultural potential but, with a few exceptions, the lowest use of modern technology. For example, only three per cent of Mozambican farmers use chemical fertilisers, and that is largely on tobacco where it is supplied on credit by an international tobacco company, and on a few other cash crops. But in the north, where expensive fertiliser can only be purchased in towns, only 0.2 per cent of farmers use fertiliser on maize (compared to a majority of farmers in neighbouring Malawi). Only 2 per cent of farmers use tractors and 11 per cent use animal traction, and most are in the south, even though the most productive land is in the north. One reason is trypanosomiasis disease in cattle, which does not occur in the south but is widespread in the north; lack of experience, training and veterinary services combine to create an insurmountable hurdle to the use of oxen in the north.

Table 4 Characteristics of agriculture production (2002-2008) in Mozambique

Description	2002	2003	2005	2006	2007	2008	Δ 2002-08
Cultivated area ('000 hectares)	4,185	4,535	5,552	5,612	5,672	5,602	33.9
No. small and medium sized farms ('000)	3,127	3,210	3,333	3,396	3,619	3,725	19.1
Average farm size (ha.)	1.3	1.4	1.7	1.7	1.6	1.5	12.4
Household size (average)	5.0	5.0	5.3	5.1	4.9	5.1	2.0
Rural population (millions) [adjusted]	12.4	12.7	14.0	13.7	14.0	15.1	21.5
Household heads with 4 th grade education (%)	31.1	32.9	36.4	36.2	36.6	42.3	36.0
Receipt of extension info. (% farms)	13.5	13.3	14.8	12.0	10.1	8.3	-38.5
Use of chemical fertiliser (% farms)	3.8	2.6	3.9	4.7	4.1	4.1	7.9
Use of pesticides (% farms)	6.8	5.3	5.6	5.5	4.2	3.8	-44.1
Use of irrigation (% farms)	10.9	6.1	6.0	8.4	9.9	8.8	-19.3
Receipt of credit (% farms)	-	2.9	3.5	2.9	4.7	2.6	-10.3

Source: Adapted from the Third National Poverty Assessment, using TIA data.

And Table 4 shows that use of irrigation, chemical fertilisers and pesticides are all falling – in part due to higher input prices caused by higher fuel prices. Similarly, high fuel prices sharply cut the number of visits by agricultural extensionists. In the case of pesticides, the decline may be related to a shift from cotton production to other cash crops (less demanding in terms of pesticides) like sesame. In Mozambique, inputs are not, in general, subsidised, and the very low use creates a vicious cycle, with low sales causing low import volumes and thus higher prices.

The Ministry of Agriculture has not intervened sufficiently in rural areas. Many extensionists are on annual contracts, thus encouraging productive agents to seek jobs (sometimes non-agriculture related) with NGOs and the private sector (Eicher, 2002). This further reduces the number of staff. The overall institutional weakness of the Ministry of Agriculture is also reflected in the number of publications. Between 2000 and 2005, the Directorate of Economics published 24 research reports and 27 policy briefs. In the subsequent period to 2010, the number of publications dropped to 12 research reports, and 13 policy briefs. Due to high cost of living, many employees of the Ministry of Agriculture search for better jobs in other places. For example, the Department of Policy Analysis, once a very functional unit of more than 15 analysts, at one point was reduced to two staff only – the head and its deputy.

Table 5 looks at chemical use by income; as expected, better off farmers are more likely to use chemicals, but the drop in even their use is noticeable. Better off farmers produce most of the maize, but they do it by farming more land, not by increasing productivity. Thus it appears that not only have none of the PARPA II targets to increase irrigation, extension, and use of improved seeds and fertiliser been met, but that the trend is actually the opposite, with a decrease.

Table 5 The use of improved technologies and hired labour, and membership to farmers' association

Income quintile	Chemical fertilisers (%)			Pesticides (%)			Member of association (%)			Hired seasonal labour (%)		
	2002	2005	2008	2002	2005	2008	2002	2005	2008	2002	2005	2008
Bottom	2	2	0	3	3	1	2	5	4	4	7	6
2	2	3	2	5	4	2	3	7	8	7	9	12
3	4	5	3	7	6	3	4	9	7	13	14	15
4	6	5	6	9	9	5	5	10	9	22	22	23
Top	10	10	7	13	10	5	9	13	10	35	39	38
Total	5	5	4	7	6	3	5	9	8	16	18	19

Source: Authors' calculations based on TIA data

Cash & the poverty trap

Cash income in rural Mozambique is low and hugely skewed, as shown by Table 6. The median cash income per capita in 2008 was about \$25 per year, just \$0.07 per day. This must be used to buy clothing, school books, cooking oil, medicines, and food in the lean season. And incomes are hugely skewed, with the top 20 per cent earning on average \$174 per person per year – not a lot of money by global standards, but relatively wealthy by Mozambican standards. Cash income is derived from small crop sales, typically a few kilograms at a time, and is matched by small sales of charcoal or other forest products or locally produced beer. Some carry out some day labour on neighbours' fields. Total cash income per capita was significantly less in 2008 than in 2002.

Table 6 Annual per capita cash income by quintile of total maize production and year

Quintile of total maize production	Median per capita cash income (US\$)			Mean per capita cash income (US\$)		
	2002	2005	2008	2002	2005	2008
Bottom quintile	9.61	22.41	21.15	72.85	94.27	100.22
2	10.60	26.19	18.94	66.23	113.40	75.05
Middle quintile	13.18	28.30	21.67	81.61	104.18	88.78
4	22.88	36.09	31.37	99.82	118.28	90.12
Top quintile	41.48	86.87	58.46	152.01	200.16	174.50
Total	16.30	34.44	25.38	90.89	123.47	102.71

Source: Authors' calculations based on TIA data

Notes: Unofficial exchange rate in 2008: \$1 = 26 Meticais;

All figures were converted into 2008 US\$.

The bottom 60 per cent (based on cash income) has barely any food surplus, and constitutes an invisible majority in Mozambique. They are caught in what is known as the 'poverty trap' – that you cannot pull yourself up by your bootstraps if you have no boots. They are basically too poor to sell their produce, although they participate in the market as buyers. For the very poor with very little money, everything is more expensive (Addison, 2008). Buying in small quantities (usually when prices are high late in the season) is always more expensive than buying in bulk; selling maize by the 'lata' (a large can used as a measure) always earns less per kilo than selling by the sack or the lorry-load.

Transport to the nearest town, as well as clothing, medicines, and school books, cost a larger share of income. Risk is the biggest issue– the poorest have no savings, and must be conservative and reduce risk. Thus to use scarce cash to buy fertiliser is a huge risk when the investment may be lost due to poor or excessive rains or low prices. The poverty trap works at community level too. When no one has money to buy, it makes no sense to produce more to sell on the local market. Even those who do trade are likely to sell only small quantities, and thus earn little for their day sitting in the market or by the roadside – as can be seen by the tiny average cash incomes of the poorest.

The top 40 per cent earn more in cash than the value of what they produce for self-consumption. The large non-cash component means they are more productive farmers, even for their own consumption. As Table 5 shows, these are also the farmers using chemical fertilisers and pesticides, and they are more likely to be in associations. In effect, many are commercial farmers producing a cash crop. But it is off-farm income, both wage labour and self-employment, that lifts them into the upper income group (Cunguara et al., 2011). Incomes are volatile, but the best off in this group are better off than they were in 2002.

FAILURE OF THE DONOR MODEL

For the past two decades, Mozambique has followed a development model largely set by the international community, and which argues that donors and government should stress human capital (health and education) and infrastructure (roads, electrification, and telecommunication), and, more recently, 'governance'. Economic growth and poverty reduction were to be left to the private sector. The Millennium Development Goals (MDGs) have become an integral part of this policy, with emphasis put on MDG two to six – education, gender, and health. The bias toward human capital has been pushed by the donors. For instance, aid to the social and governance sectors in Mozambique doubled in just six years, from \$477 million in 2003 to \$990 million in 2008. Budget support jumped from \$172 million to \$452 million between 2003 and 2008, and that also largely goes to social

sectors (OECD Stat). A mark of the unquestioning promotion of this model was the 2005 statement by a visiting Norwegian aid official that 'everyone knows' that poverty is fought through investment in health, education, water and roads (Castel-Branco, 2007).

The MDG one (to end poverty and hunger) has largely been ignored, and left to the private sector and foreign investment. Goal one has three targets: halve the proportion of people whose income is less than \$1 a day, achieve full and productive employment and decent work for all, and halve the proportion of people who suffer from hunger. Mozambique seems not to be moving toward the Goal one targets (See Tables 1 through 4, and Figure 3), yet both the government and donors treat the economic sectors as areas outside their concern.

There has been substantial foreign investment in Mozambique, but it has been primarily in mineral and energy 'mega-projects'. Rapid economic growth with GDP rising by more than six per cent a year for the past decade wins high praise from the international community, but has been driven by these 'mega-projects', which create few jobs and have few local linkages. Over the next decade, mineral and energy exports will provide an increasing share of government revenue, but this is not a development strategy. Mozambique remains predominantly rural, and in the short and medium term, agriculture must remain a central component of development and poverty reduction (Walker et al., 2004; Mather, 2009; Arndt et al., 2010; MPD/DNEAP, 2010). Import substitution industrialisation may never compete with China, but specialised agriculture and agro-industry can sell to the Asian market, creating jobs and raising incomes, and can grow in parallel with increased food production (see, for example, Kaplinsky, 2006). This is already happening in a small way, notably in Nampula, where some smallholders have increased the production of sesame which is exported to Asian and European markets.

The government talks much about the 'green revolution' which is supposed to end rural poverty. But it is not happening (Mosca, 2011). Half of Mozambicans are peasant farmers using only a hoe and no modern inputs, farming as their great grandparents did. The Chr Michelsen Institute (CMI) of Norway is doing a long term study of poverty funded by the UK Department for International Development (DfID), which should shake up the donor community. 'Our surveys confirm national data on improvements in education and health. However, we also show that people are in the process of losing faith in education as a vehicle for upward social mobility.' They continue: 'Above all, the surveys have confirmed the importance attached to employment, income and fair prices for agricultural products for alleviating poverty' (CMI Brief 8.1, Apr 2009; Tvedten et al., 2009). This result is also supported by Virtanen and Ehrenpreis (2007) and Cunguara et al. (2011).

Two decades of a donor-led, liberal, free-market rural development strategy have failed not just in Mozambique, but across Africa (Skarstein, 2005; Blackmon, 2008; Donaldson, 2008; Casse and Jensen, 2009). Countries were pushed to privatise what were previously state services and close marketing boards in the belief that if a truly free market was established, farmers would respond to price signals to produce the most profitable crops and pull themselves out of poverty. But the opposite happened, as production and productivity stagnated (see Table 1) and the poorest peasants dropped back into subsistence production. Mozambique's case is just one among dozens. Hesselbein (2010a) points to the lack of change in agricultural productivity across Africa. She notes that two of Mozambique's neighbours, Tanzania and Zambia, developed visions similar to Mozambique's 'green revolution,' based on market liberalisation and the private sector. As in Mozambique, the strategy failed; farmers are too poor to purchase seeds and fertiliser or invest in irrigation (Hesselbein, 2010b).

A new study published by OECD on fragile and post-war states notes that 'donor assistance to the development of the capacity of fragile states to manage the economy has been limited largely to programmes to improve macroeconomic management. The lack of attention to the

productive sectors is especially important in relation to agriculture. Markets left entirely to their own devices are unlikely to underpin new growth trajectories, particularly in the risky environments found in most fragile states'. So, after 17 years, the OECD notices that the policy imposed on Mozambique after its war (and on other African countries) was 'unlikely' to work. And it did not (Hanlon 2010a).

The ahistorical nature of neo-liberal policies and their failures in Africa have led writers to look both at history and at the actions of other, more successful, countries (Stiglitz, 1998). Hesselbein (2010a) argues that 'the initial conditions in Europe, before industrialisation, were very similar to those found in contemporary Sub-Saharan Africa.' There were complaints in mid-19th century Europe about lazy peasants; economists came to realise that the physical labour of a subsistence farmer was so hard that 'when working longer hours of arduous work only increases the yield insignificantly, the work will not be done, or only be done at the threat of one's own starvation'. Agricultural stagnation was only overcome when farmers were given inputs, such as fertiliser and machines, that made the work less back-breaking, plus consumer goods which made their lives less hard. And this tended to involve the active intervention of the state, particularly directing investment but also using tax policy to curb unproductive elite consumption and shift the money to investment. The state needs to be actively involved in the shift from subsistence to a market rural economy.

Development economists such as Ha-Joon Chang (2008) are looking back at both 19th century Europe and the Asian Tigers of the late 20th century. South Korea is often cited, because it had been colonised (by Japan) and then went through a war, and was similar in many ways to African countries in the late 20th century. A study by the US Congressional Budget Office (CBO, 1997) looked at what it saw as the success of aid to South Korea. (Non-military aid to South Korea in the 1970s was, in real per capita terms, double the aid to Mozambique now.) 'The South Korean government largely initiated, directed, and organised development by setting goals, establishing priorities, and backing them up with resources. Large, highly profitable private companies were clearly subordinate to the government, in part because the government controlled domestic credit as well as the right to borrow abroad.' The government also put in place a number of incentives such as subsidies and access to subsidised credit. The CBO notes that perhaps the most important role of aid was that it 'increased the pool of available investment capital.'

The CBO report pointed out that foreign aid was particularly important in upgrading South Korean agriculture, where it was used for research and agricultural extension, and to promote the use of fertiliser. US aid helped Korea build five fertiliser plants. Yet for the subsequent two decades, the international community prohibited exactly those successful policies in Africa, and in particular in Mozambique, which was forced to close its marketing board, dismantle agricultural research, and end state support for production of modern seeds. All protection and support, except for foreign multinational companies, was stopped. Subsidy was not allowed.

An alternative: reducing risk

Fertiliser subsidies are proving to be important in Africa as well (Hesselbein, 2010b). In contrast to many other African counties, Rwanda has a highly interventionist policy. A fertiliser subsidy pushed fertiliser use from two per cent to 62 per cent in just two years. Government guarantees credit to farmers. And it promotes farmer marketing associations and agribusiness, including companies that do peasant contract farming under which peasants grow an agreed crop and the company guarantees to buy, as with tobacco in Mozambique (Hanlon and Smart, 2008; Hesselbein, 2010b).

In Malawi, a fertiliser subsidy turned the country from being dependent on food aid to being a maize exporter in just two years. In the 2004 election, all the leading candidates promised government support for small holder agriculture and fertiliser subsidies to end food insecurity. Donors were opposed and during the campaign warned that debt relief under the Heavily Indebted Poor Countries (HIPC) Initiative would be delayed if a fertiliser subsidy was introduced. Bingo Wa Mutharika was elected in May 2004, but in the face of such fierce donor opposition, he delayed until he then came under heavy parliamentary pressure, and finally announced a broadly based fertiliser subsidy in June 2005, funded entirely from the government budget. Each household receives coupons allowing the purchase of two 50 kg bags of subsidised fertiliser, seed and storage pesticides; by the 2006/2007 season the programme reached 1.7 million families (70 per cent of farm households). Partly helped by good rains, maize yields doubled and production jumped dramatically; in 2007 Malawi exported 300,000 tonnes of maize to Zimbabwe (Chinsanga, 2007; Chinsanga and O'Brien, 2008; Denning et al., 2009).

In Mozambique, a similar programme was implemented in 2009-10 and 2010-11 agricultural seasons. Following the riots in 2008, the government launched the Action Plan to boost Food Production (PAPA), and introduced a fertiliser subsidy in collaboration with some NGOs. Farmers receive coupons allowing the purchase of two 50 kg bags of Urea and NPK (12-24-12), and 12.5 kg of improved maize seeds of either OPV or PAN-67 varieties. This subsidised package costs \$27 in Manica province, and about \$38 in Nampula province. Although this corresponds to about 30% of the real price, many farmers are unable to purchase the subsidised package because they have little cash. Additionally, it is not clear how the subsidised package is enforced. Input dealers and farmers' associations that receive fertilisers to sell in their communities usually speculate and increase the price. Furthermore, high bureaucracy in signing the contracts to distribute the subsidised package can cause some delays, and fertilisers reach farmers late in the season.

Fertiliser prices are linked to oil prices, and in 2008 fertiliser prices were double that of 2006, while by early 2010 prices had fallen back close to 2006 levels. International maize prices, in turn, partly follow oil prices. The Millennium Villages Project estimated that it cost \$82 in 2006 and \$135 in 2008 in fertiliser and seed to produce an extra tonne of maize (Denning et al., 2009). UNCTAD figures show the global price of maize ranging from \$160 per tonne in late 2006 to a peak of \$250 in 2008. Retail maize prices in Malawi and northern Mozambique are similar, and ranged from \$150 to \$300 in the same period (Zavale et al., 2009). So, subsidy is roughly half the value of the extra production. 'The subsidies do all good and no harm' concluded an FAO study (Buffie and Atolia, 2009). 'Input subsidies are highly effective in reducing smallholder poverty. ... They buy a substantial increase (17-41 per cent) in the smallholder income along with a small but significant rise (2-5 per cent) in the real unskilled wage.'

Faced with the obvious success of the subsidy, donors could not impose any sanctions. But many remain opposed. Some argue that subsidies create market distortions while others argue that the money would be better spent on infrastructure. The IMF had been one of the most vociferous opponents, but the April 2010 issues of IMF Survey Magazine had unexpected high praise for the fertiliser subsidy. 'Malawi's recent robust economic growth has enabled one of Africa's poorest countries to make real strides in reducing chronic food insecurity and progress toward poverty reduction.' This is partly because of 'several bumper harvests for tobacco, the principal cash crop, and maize, stemming from good rainfall and the distribution of subsidised fertilizer.'

Two important interventions in Mozambique show what can be done with a coordinated approach. The cashew nut sector's destruction by World Bank enforced liberalisation in 1995 became notorious (MacMillan et al., 2003), which created space for a quiet reversal of policy in the 2000s. A state agency, INCAJU, reintroduced protection (in direct and explicit violation

of the World Bank rules) and discreetly worked with a domestic development agency and a handful of sympathetic donors to build the entire value chain – peasant production, state spraying and plant protection, marketing, new shelling and processing factories, and coordinated export – to create thousands of jobs and record production in the 2009–2010 season. Tobacco is the other success. It has become Mozambique's most important export crop and has done more than any single intervention to reduce poverty. A single transnational corporation (TNC), the US-based Universal Leaf Tobacco (ULT), has been given exclusive rights over tobacco production in much of the country. More than 150,000 peasant families participate in its outgrower schemes, in which seeds, fertiliser and training are provided on credit, and there is a guaranteed market, but the tobacco must be sold to the company.

Net profits for better farmers are over \$730 per year (Benfica, 2006). The company has now built a tobacco processing factory, which created 1,600 jobs. ULT has created something similar to the old marketing boards, but no foreign investor has suggested similar schemes for other crops (Hanlon and Smart, 2008: ch 5, 6). The theory behind liberalisation and the abolition of marketing boards common in most African countries was that state owned boards were expensive and inefficient, and in a totally free market peasants would capture more of the surplus and prosper. But this nice theory failed to take into account a central issue of risk in agriculture throughout the world. In exchange for potentially higher prices, peasants also had to accept all the risk of weather, pests, and fluctuating markets.

And the poverty trap came into play – fertilisers and extension services supplied by marketing boards may have been more expensive, but farmers did not have to pay up front – the cost was deducted from the payment for the crop. Most peasants have too little money to pay for inputs, even if they do cost less, and the marketing boards effectively provided insurance because if there was a generalised crop failure the input costs were not repaid. What we are observing, yet again, is that peasants are prepared to accept significantly lower profits in exchange for credit, insurance and a guaranteed market. Hesselbein (2010b) identifies lack of markets as the biggest constraint in both Tanzania and Zambia. This result is also supported by Cunguara and Darnhofer (2011). The CMI study says that in Mozambique 'publicly supported local and adapted alternatives to the previous "marketing boards" should be considered' (CMI Brief 8.2, June 2009; Rosário et al, 2009).

The core demands identified by CMI – income, jobs, and fair and assured market – are broadly agreed, so shared risk, guaranteed markets and subsidised technology will be central to reducing rural poverty. UNCTAD (2006) argues that domestic demand is the largest contributor to economic growth, but that generalised and persistent poverty means that demand is small, which inhibits growth. This is obvious from rural markets where women with small piles of onions or tomatoes chat to each other because there are no customers. For this majority of rural people, the need is more cash which will trigger an upward spiral as people buy from each other. That means helping people to grow more by taking away the risk – especially by guaranteeing markets for the staples such as maize that people already grow for family consumption – and by providing subsidised inputs on credit.

Cunguara and Darnhofer (2011) argue that, despite drought in 2005, the use of improved technologies in Mozambique was only significant in increasing household incomes among smallholder farmers who had better access to the market, either those close to a tarred road or in villages bordering other countries. Jobs, even temporary day labour, should be created. It may also require cash transfers such as a child benefit or non-contributory pension (Hanlon et al., 2010). Most important is to identify activities usually engaged in by the poor, and raise their profitability since participation in high-return activities is conditioned by entry barriers that require long-term investments, such as in education. Cunguara et al. (2011) argue that agro-processing and milling activities are usually carried out by female-headed households,

which have systematically been ranked as poor. Raising the profitability of these activities is likely to generate pro-poor growth in the short-run.

There is a need to raise technological levels to the point where working harder brings significant gains, so as to improve their own food production. Extension services could play a key role in fostering the adoption of improved technologies, provided markets exist. Cunguara and Moder (2011) estimate that in Mozambique the receipt of extension increases farm incomes by 12 percent. Nevertheless, rather than crafting resource-poor technologies, extension services tend to target wealthier households (Gêmo and Rivera, 2001; Mather, 2009; Cunguara and Moder, 2011). This can increase income inequality in rural areas.

Resource-poor technologies include smaller packages of improved seeds and chemical fertilisers, which could be provided on a shared-risk basis, under which they are given on credit and the money is deducted from sales at the end of the season and does not need to be repaid if the crop fails. Seed packages should also include both early and late varieties to provide farmers with more flexibility in terms of when to plant, depending on the rainfall pattern in a given cropping season. Since rain-fed agriculture is predominant in rural Mozambique, improved seeds should be selected for drought tolerance, especially in the (semi-) arid zones such as the southern provinces.

This points to a regional dimension (Silva, 2007; Mather, 2009). Packages of support should be tailored to the agricultural potential of different parts of Mozambique. The overwhelming majority of Mozambican farmers still use only a hand hoe, which means tillage and the amount of back pain a farmer can suffer is a key constraint. Animal traction and other tilling methods would allow the cropped area to be expanded, and fertile land is available in the north. But this would require investment, especially the construction or rehabilitation of dip tanks and expansion of veterinary services in central and northern Mozambique. An alternative is small tractors, but that would require the establishment of machinery servicing and hiring networks appropriate for small farmers.

Farmers will require more and higher level technical support; government will need to promote machinery hire companies that can rent out tractors and harvesters to farmers too small to own their own. Machinery hire companies should in turn guarantee a provision of timely services, and ensure that the peasant farmers have priority in accessing such services, considering that poverty reduction will be faster if the benefits of growth in agricultural production and productivity are biased toward the poor. Long term credit and technical support for up to seven years will be needed for the development of tree crops including nuts, mangoes and citrus fruit, and for farmer association owned marketing companies such as Ikuru in Nampula province (Hanlon and Smart, 2008).

Mozambicans speak out

The dawning recognition that poverty is not being reduced is forcing some rethinking, but it is proving very slow. Prominent establishment Mozambicans are speaking out. Young people rioted in the capital Maputo on 5 February 2008 against the rising cost of living; five people were killed and more than 100 injured, many shot by police. Rogério Siteo, editor-in-chief of the government owned daily, *Noticias*, wrote a remarkable column arguing that the root cause is 'the religious way we applaud and accept the prescriptions of the World Bank and International Monetary Fund', when these are really 'poison prescriptions'.

They have destroyed jobs (MacMillan et al., 2003) and failed to promote agricultural development (Mosca, 2011), which has 'contributed greatly to the impoverishment of the countryside and forced a migration to the cities (Silva, 2007), particularly of the youth.' The

government needs its own development policy and needs to stop treating World Bank and IMF statements as if they were ‘bible verses’ (*Notícias*, Maputo, 15 Feb 2008). Later that year, Professor Firmino Mucavele, formerly Chief Executive of NEPAD, argued that Mozambique’s much talked-about ‘green revolution’ cannot be simply providing a few inputs. Instead, it requires radical changes to the entire agricultural value chain, new ways of thinking about rural development, a hugely increased role for the state, and large amounts of money. He stressed that in previous green revolutions, the entire food production chain – choice of crops, inputs, extension, production systems and marketing – went through a revolution which was totally externally financed. The state would need to provide vastly expanded extension services, step up research particularly on pests and diseases, and would have to be buyer of last resort to guarantee a market (*Notícias*, 15 Sept 2008).

Then in early 2009 open criticism of the development model was voiced by the Mozambican Forum of the Peer Review Mechanism of the African Union. In a self evaluation report for the peer review, the Forum said that ‘the most credible indicators point to an increase in absolute terms in the number of people below the minimum subsistence level.’ The report is caustic about economic policy, pointing to the ‘notorious way the economic programme ignored the question of income distribution, which means that the principle beneficiaries of growth are concentrated in tiny groups and restricted social strata.’ It goes on to cite ‘the failure to prioritise job creation in economic programmes’ and says that the high levels of ‘unemployment result from the application of neo-liberal economic programmes, which has a constraining effect leaving many families without the minimum level of subsistence’ (Fórum Nacional do MARP, 2009: 50,82). The Forum consists of the Mozambican establishment; it has 58 members from civil society and the private sector, with three provincial governors, the governor of the central bank, and representatives of eight parliamentary commissions. The review was chaired by Lourenço do Rosário, rector of the largest private university, *A Politécnica*.

On 17 May 2010 in a speech in Maputo, the Executive Secretary of the Southern African Development Community (SADC) and former Mozambican Finance Minister, Tomás Salomão, said western institutions have been telling African governments ‘do what I say and not what I do’. Developing countries had thus been obliged ‘to comply with the recipes from structural adjustment programmes, often with heavy social costs and little impact on our socio-economic development’. The risk now was that attempts would be made ‘to patch up the model of “structural adjustment” which has proven to be obsolete and outdated, and does not respond to the challenges that developing countries must overcome’. Salomão feared that Africa would be faced ‘with the question: do you want aid? Then do what it says on this menu. Take it or leave it. A menu which often has nothing to do with us, or is produced by intellectuals who have recently come out of banks and universities, and don’t know that Africa is a continent with more than 50 countries of differing socio-cultural realities’ (AIM News, Maputo, 18 May 2010).

Is such a policy change possible?

The obvious question is why, with the establishment behind it, the Mozambican government does not simply stand up to the donors, as the government in Malawi did? Both donors and government have invested huge political capital in the current failed model and change will be hard. The glib answer is provided by Table 1. Malawi stood up to the donors over fertiliser and still has a marketing board; Tanzania stood up to the donors in the early 1990s, and it now has an Independent Monitoring Group for aid (Harrison et al, 2009). Malawi and Tanzania received only 60 per cent as much aid as Mozambique, per capita, which in 2008 was worth nearly \$800 million to Mozambique. A 2005 evaluation of aid to Mozambique by the respected British economist Tony Killick and others, ironically titled ‘Perfect Partners’,

said boldly: 'aid dependency does not have to entail subservience' (Killick et al, 2005: 50). But most Mozambican leaders disagree, and think Salomão rather than Killick is right; looking over the border at Malawi and Tanzania, they conclude the subservience pays extremely well.

Frelimo's dealings with the international community reflect a long history in which the 'West' was not sympathetic to it. This was shaped by the Cold War. First NATO backed Portugal's attempt to prevent independence and decolonisation. Then Mozambique became a Cold War battlefield, and in the 1982–92 proxy war, more than one million Mozambicans died; inevitably, many in the leadership see this as an extraordinarily high price that was paid for having an independent development policy. Then at the end of the Cold War, the victors in Washington used the Bretton Woods Institutions to impose harsh neoliberal policies on post-socialist governments which were still not trusted (Hanlon, 2010a and b). Aid was used to impose these policies. During the 1980s there were two donor strikes, in which food aid was withheld first to force Mozambique to sign an agreement with the IMF and World Bank, and then to force it to agree a structural adjustment programme (Hanlon & Smart, 2008: 10).

The next confrontation came in 1995, when the World Bank imposed an unprecedented set of 'necessary conditions' on its programme to Mozambique. If the 'necessary conditions' were not satisfied, the programme would stop, and since all aid at that time was conditional on having a World Bank programme, violation of those conditions would end all aid. Two of those conditions were particularly controversial – privatisation of state banks to consortia known to be corrupt (which bankrupted the banks and created high level corruption which still plagues Mozambique) and a liberalisation of the cashew sector (which destroyed the sector, MacMillan et al., 2003). In a debate on cashew on 24 November 1997, Prime Minister Pascoal Mocumbi told parliament that when Mozambique asks money 'from the World Bank, the Bank imposes its conditions. Sometimes we have to accept things which are not in our interest, because there is no other way out' (Hanlon, 2000).

Faced with an international community that is seen to demand an inordinate level of obsequiousness while often not acting in Mozambique's interest, the government is careful to avoid frontal confrontations with the donors. It chooses its battles carefully, and then acts as discreetly and invisibly as possible. There have been three confrontations. The first, described above, was over cashew, where over a decade government intervention in direct violation of World Bank policy rebuilt the sector, creating thousands of industrial jobs and an important peasant cash crop (Hanlon & Smart, 2008: ch 5). It seems precisely a model agricultural development, but cannot be widely applied because it was carried out without publicity and tolerated by some donors because of the embarrassment caused by the international scandal created by the World Bank destruction of the sector.

The second confrontation was over a campaign pledge by Armando Guebuza in 2004 to create a Mozambican development bank. In a response similar to that in Malawi in the same year, donors said they would not allow government to create such a bank — even though Mozambique was one of few countries without a development bank, and many donors have their own development bank. The newly elected government decided not to confront the donors, and instead quietly inserted a budget line to give about \$250,000 to each district per year as a development fund. Donors were angry, at least partly because they simply did not notice until the budget was passed by parliament. Their response was to insist on a change in the agreement between the budget support donors and government, in which the donors would see not only the final budget, but all preliminary drafts – to insure that nothing they did not agree with was ever again snuck into the budget.

The third and most complex confrontation is the on-going struggle over 'governance'. Here Frelimo's interests are complex. At one level, some in the Frelimo elite stole large amounts of money from the privatised banks, and part of this money was used to fund the party

(Hanlon and Mosse, 2009); prosecuting such people in response to donor demands would destabilise the Frelimo party. But at another level, 'good governance' is now seen as opening Mozambique to transnational corporations and to prevent the support of domestic capital which has been important in all successful national developments, such as the Asian Tigers, and which Mozambique is now doing. Again Frelimo is trying to avoid a frontal confrontation. Instead, each year it promises actions which are never actually carried out.

In 2004, one of us wrote an article entitled 'Do donors promote corruption?: the case of Mozambique', in which we argued that there was an implicit compromise to maintain the myth of the Mozambican success story, in which both sides claim poverty reduction, Mozambique accepts imposed neo-liberal policy prescriptions and the stress on social services, and the donors turn a blind eye to corruption and state capture (Hanlon, 2004). That deal seems to still be in place, because at the 19 May 2010 annual review of budget support, Kari Alanko, Finnish ambassador and head of the budget support group, said that although government performance on governance was 'unsatisfactory', that its overall performance was 'satisfactory' because of expansion of services, economic growth and inflation control (Alanko, 2010).

For two decades, donors have been deeply divided on agriculture and rural development policy; their attitudes have changed rapidly and there have been divisions within agencies. But the one constant has been to keep government out of the economy and agriculture. Thus they forced the closure to the marketing board and seed production and curbed agricultural research. In 1999 the World Bank actually blocked the government from hiring more agricultural extension workers, even though the total number was only one-tenth that recommended by the FAO (Hanlon & Smart, 2008: 168). The issue is not the policies, but the government role. Thus the IMF and other donors allow protection for the sugar sector, with plantations owned by transnational companies which claimed that their investment was dependent on protection, but not for the cashew sector owned by local business.

Huge tax breaks and other *de facto* subsidies are permitted for foreign investors, particularly in the mineral energy sector. One of the world's largest tobacco companies can be given exclusive rights to control tobacco production in much of the country and set up what is, in effect, a marketing board, but the state is not allowed to create a similar system for other crops. The desire to avoid public confrontations with the donors combined with the emphasis that the donors have put on keeping the state out of agriculture makes it impossible for Mozambique to introduce a fertiliser subsidy on credit.

Another key to the puzzle is that Frelimo lacks a coherent agriculture and rural development strategy, and has not been able to have a broad public debate. There are two reasons why Frelimo cannot think outside the box and openly debate alternatives. First, the tradition is that policy issues should be debated first inside the party and in secret, but Frelimo has been unable to build that kind of internal debate. The second is that the budget support process means that donors are deeply embedded inside all the key ministries, and thus intervene actively in all policy discussions, which makes it impossible to even consider options that donors would oppose (de Renzio & Hanlon, 2009). But the final key rests inside the Frelimo Leadership.

Frelimo has always stressed big farms (Mosca, 2011). States farms in the socialist era, and now trying to encourage foreign companies to invest in big farms (often the old state farms). There has always been distrust of the better off peasants who could be commercial farmers – dismissed as 'kulaks' in the socialist era, their role is still not accepted. In this, there is a curious alignment of interest between Frelimo and the donors – both want big foreign owned plantations as a development strategy and to help 'subsistence' peasant farmers (the poorest of the poor) almost as a form of social welfare. The final piece of the jigsaw is that throughout the 'greed is good' 1990s, donors promoted the idea that by getting rich, the elite

was promoting development. Indeed, as recently as 2006 the IMF called for ‘an agricultural and rural strategy to enhance the trickling down of growth to the poorest segments of the population’ (IMF, 2006). And who in the elite will argue against ‘trickle down’ to help the poor, when the elite gain so much from the present policy?

Donors have pushed this development model very hard, and even used the budget support process to ensure that their officials are part of drafting key Mozambican documents such as the PARPA. But the Mozambican leadership has also accepted the donor line. Thus there seems no enthusiasm on either side for a change in policy. Mozambique has been a donor darling because of a combination of two factors – subservience to donor policy combined with apparently dramatic falls in poverty. If poverty is not falling, will that force a rethink on both sides? Can Mozambique and its donors pay more attention to Millennium Development Goal 1 – food, income and jobs? That is related to agricultural growth and the ‘green revolution’, which in turn requires a recognition that markets do not spring up by magic, but instead are created by the state. Will the government try to promote markets and the introduction of subsidised new technology (preferably on credit) which would allow peasants to reduce their back-breaking work while producing more and raising their living standards?

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Trends in food security in rural Mozambique, 1996/2008

B. Cunguara, A. Mabiso and J. Hanlon

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1 Introduction

In 1992 about 83 percent of Mozambicans subsisted on food aid, largely because of war and drought (Tschirley et al., 1996). Since then nearly two decades have elapsed and a series of floods and droughts that occurred in the 2000s have left many rural households continuing to subsist on grain imports and food aid. This has caused Mozambique to be one of the largest recipients of global food aid flows (Abdulai et al., 2004). The worldwide food crises of 2007 and 2008 did not help the situation either, particularly in the southern provinces of Mozambique, a region dependent on grain imports due to lower crop potential (Arndt, et al., 2008; Tschirley and Jayne, 2010).

At the national level, it is estimated that an overwhelming 34 percent of the population is facing chronic hunger (WFP, 2010). There is, however, some evidence of glimmers of hope. To enable food purchases and dampen volatility in grain prices, the Mozambican government recently constructed silos with 50,000 metric ton capacity for grain storage in Tete province and there are plans to expand silo capacity to 143,000 metric tons by 2011 (Tschirley and Abdula, 2007; Tostão and Tschirley, 2010). In addition, there are some improvements in marketing infrastructure such as the bridge in Caia district, linking surplus agricultural production areas in the north to food markets in food deficit areas of the south (Tschirley and Jayne, 2010).

The government of Mozambique has developed a poverty reduction strategy paper (hereafter referred to by its Portuguese acronym PARPA, *Plano de Acção para a Redução da Pobreza Absoluta*), that has the potential to enhance food security through various mechanisms. For example, plans for more investments in irrigation, market infrastructure, extension services, commodity price information, animal traction, and other improved technologies are likely to increase crop yields (Mather, 2009). Also, investments in road infrastructure and education could reduce transaction costs in agricultural marketing and increase household cash incomes through the creation of rural non-farm employment.

While food security is a widely used concept that needs to be addressed in rural Mozambique, there is a longstanding debate on its measurement. Many indicators have been proposed, such as the dietary diversity index, coping strategies index, household caloric acquisition and individual intakes, among others (Maxwell and Frankenberger, 1992; Riley and Moock, 1995; Barrett, 2002). This is because food security entails multiple features such as the availability, access, and utilization of food that cannot easily be captured by a single measure, (Webb et al., 2006; Barrett, 2010). In this paper, food security is primarily measured by the amount of calories available to households in rural Mozambique, based on the dietary needs of each household member.

Two sources of caloric acquisition are considered, namely household own food production and household food purchases. The former has been shown to be negatively affected by low levels of farm productivity (Howard et al., 2003; Fulginiti et al., 2004). For instance, maize yield (the most important staple crop in Mozambique) is estimated to be 1.4 tons ha⁻¹; far below the potential yield of 5.5-6.0 tons ha⁻¹ (Howard et al., 2003). This low level of productivity is intertwined with various factors, such as poor farmer health during the late dry season and at the beginning of the cropping season and HIV/AIDS related prime-age mortality (Abellana et al., 2008; Jayne et al., 2010); market failures in agricultural commodity and credit markets (Mather, 2009); very limited use of improved agricultural technologies

(Mather et al., 2008); and the occurrence of cyclical floods and droughts (Joubert and Tyson, 1996; Usman and Reason, 2004).

The second source of caloric acquisition that is considered in this manuscript is the amount of calories obtained through food purchases and this significantly depends on cash income available to the rural households, which in turn depends mainly on access to non-farm employment opportunities (Cunguara and Hanlon, 2010). Such opportunities have been shown to differ by geographical region, with households in the southern provinces having better access to non-farm activities due to better road infrastructure, relatively higher remittances, which can be invested in some non-farm activities (Walker et al., 2004), and better education levels (Government of Mozambique, 2006). Meanwhile, households in the central and northern provinces rely more on agricultural production, partly because of greater agricultural potential in these areas. Differences in geophysical, social, natural, and human capital in these areas are reflected in the differences in food security levels and poverty (Heltberg and Tarp, 2002; Donovan and Tostão, 2010).

The objective of this paper is twofold. First, using the national agricultural surveys from rural Mozambique, described in more detail in section two, the paper evaluates if PARPA has been effective in enhancing agricultural production and creating non-farm employment opportunities to address food security challenges in rural Mozambique. The focus is on PARPA II, which covers the period between 2006 and 2009, although the data used refer to a longer period (1996/2008) to better identify trends.

The evaluation starts in section three by tracking some of the agriculture-related targets set forth in PARPA, and relates these targets to food insecurity in rural Mozambique. The relevance of market participation both as a source of caloric acquisition through food purchases and as a potential source of income through farm output sales, justifies the discussion in section four on the priority agenda of output market participation. Given that the amount of calories acquired through food purchases often constitutes a greater proportion of total caloric intake and is highly dependent on cash income, section five addresses the relationship between cash incomes and other poverty measures that affect food security, while concluding the evaluation of PARPA with a heretical commentary on its success.

The second objective of this manuscript is covered in section six, and entails an econometric analysis of factors associated with food insecurity in rural Mozambique. This section first provides details on how the food security measure was constructed, while discussing its strengths and recognizing its weaknesses, then presents a Probit model estimated for each region (south, central, and north). The analysis is further disaggregated based on select household characteristics. Finally, section seven concludes with policy recommendations that are relevant for PARPA III, which will cover the period 2010-2014.

2 Data description and sources

The data analyzed were drawn from all available national agricultural surveys in Mozambique, commonly known as TIA, which is the Portuguese acronym for *Trabalho do Inquérito Agrícola*⁵. The surveys were conducted by the Department of Statistics within the Directorate of Economics of the Ministry of Agriculture. The TIA samples are stratified by province and agro-ecological zone, making them representative at both levels. Therefore, all results presented in this paper are population-weighted to account for the stratified sampling. Sample size varies between 3891 households in 1996 and 6248 households in 2006. The surveys differ slightly in terms of the questions that were asked. For example, the data on use of improved seeds and access to credit were only collected starting in 2005. Also, specification of the crops that received fertilizer application was only recorded in the latest round of surveys, TIA08.

Worth noting is that TIA96 had serious methodological drawbacks. Most importantly, the data on cassava production, the second most important crop in Mozambique, were collected using a single recall question. This is inadequate for a crop that is harvested several times throughout the year. Therefore, TIA96 data are used sparingly in this study. TIA02, TIA05, and TIA08 are the three most comprehensive surveys. They combine the annual household demographic and agricultural and livestock production components with detailed data on household income components. Total household incomes are obtained from five sources, namely livestock sales, remittances and pensions, wages, self-employment earnings, and crop production. Meanwhile, cash income refers to all cash received by the household (e.g. salaries in cash, crop and livestock cash sales, net revenues in cash from small businesses, and cash transfers).

TIA02, TIA05, and TIA08 also provide data on non-farm activities. These include (i) unskilled agricultural wage on small or large farms; (ii) unskilled non-agricultural wage (e.g. domestic worker); (iii) skilled or specialized non-agricultural wage (teaching, management positions, government clerk, trained non-agricultural workers with at least 10 years of schooling, and mining); (iv) extraction of flora and fauna products of low returns, which includes cutting firewood, sticks, grass and palm tree leaves, collecting honey and bush fruits, and hunting; (v) extraction of flora and fauna products of high returns, which comprises charcoal production and fishing; (vi) other self-employment activities of low returns, which includes handcrafting, carpentry, cloth making, bicycle and radio repairing, blacksmith, and brick production; and (vii) other self-employment activities of high returns, such as production and sale of home-made beverages, trading in food and non-food products, trading in livestock, agro-processing and milling activities.

All income data were inflated to 2008 prices and for consistency and comparability purposes, the inflators used to adjust the 2005 income levels to 2008 prices are similar to those described in Mather et al. (2008), where 2002 income levels were inflated to reflect the prices in 2005. Household consumption quantities, defined in terms of the food basket in the region-specific consumption expenditure surveys (IAF), were also used in adjusting incomes. These consumption quantities were valued using 2002 Agricultural Market Information Systems (SIMA) retail prices, then the basket was revalued with 2005 and 2008 SIMA prices to update the cost of an identical (fixed) consumption basket. The consumption quantities are therefore weights for the commodity prices. Thus the inflators were fixed because the weights were not allowed to change over time.

⁵ A brief description of the TIA surveys can be found at the following website address: <http://www.aec.msu.edu/fs2/mozambique/survey/index.htm>

3 Tracking PARPA's achievements on agriculture-related targets

Descriptive analysis of the TIA data show that between 2005 and 2008, the coverage of extension services in rural Mozambique steadily declined (Table 1). This was partly because extension workers did not have fuel for their motorbikes. Similarly, the market information system recently experienced a decline in funding available to pay for radio broadcasts (Mather, 2009), which resulted in a decline in the percentage of households receiving price information. This suggests that PARPA did not provide adequate support for public market information services, which farmers and rural traders could have taken advantage of to improve their incomes and food security.

Table 1 Evolution of some of the agriculture-related indicators set in PARPA

	TIA96	TIA02	TIA03	TIA05	TIA06	TIA07	TIA08
Received extension visits (%)	NA	13.53	13.52	14.77	11.97	10.15	8.27
Farmers' association (%)	NA	3.67	4.45	6.39	6.50	8.25	7.22
Received price info (%)	NA	34.52	47.15	40.32	36.27	33.12	34.19
Hired seasonal labour (%)	NA	15.51	15.32	17.60	23.81	20.76	19.57
Used chemical fertilisers (%)	1.26	3.72	2.46	3.76	4.58	3.63	3.02
Used chemical pesticides (%)	NA	6.76	5.12	5.41	5.29	6.51	2.60
Used poultry vaccine (%)	NA	1.92	3.22	3.00	4.12	NA	4.39
Used animal traction (%)	6.55	11.22	10.90	9.29	12.38	11.48	10.92

Source: Authors' calculations based on all available TIAs

Notes: NA – Not available

Statistics on land tilling methods show a slight decline in the use of animal traction in recent years. Due to the occurrence of trypanosomiasis disease, animal traction is limited to the southern provinces and few villages in central provinces. Dipping services are sparse because many dip tanks were destroyed during the war and have not been rehabilitated. In addition, there is a shortage of staff (i.e., dip tank attendants) and a lack of accessible water to operate the dip tanks (Alfredo et al., 2005). Little effort has been made to address trypanosomiasis disease and expand the use of animal traction in high agricultural potential zones. It is revealing that animal traction is not mentioned at all in PARPA II, despite its potential to increase crop production (Pingali et al., 1987; Mather, 2009). An effective measure of dealing with trypanosomiasis could be the combination of dipping services, application of vaccines in endemically unstable conditions, and the use of tick-resistant breeds of cattle (Norval et al., 1992). The use of tractor mechanization is another alternative, but only two percent of farmers currently use tractors in rural Mozambique and mostly in areas of lower agricultural production potential.

Statistics from the TIA data also show that agricultural production is unevenly distributed. In the case of maize, the bottom quintile accounted for less than two percent of total production, while the top quintile accounted for more than half the total production. This pattern barely changed between 1996 and 2008. Overall, total maize production was five percent higher in 2008, relative to 2002, but a trend could not be discerned because of high fluctuation in production (Table 2).

On the one hand, households in higher quintiles achieved higher production levels because they cultivated larger areas of land (i.e., technical efficiency). On the other hand, they also had higher productivity levels because their production increased at a faster rate than the increase in cropped area when moving from a lower quintile to the upper quintiles (i.e., allocative efficiency). For example, total maize production in the top quintile in 2008 was approximately 44 times greater than that in the bottom quintile (Table 2), but total cropped area (of maize and all other crops) was roughly two times greater (last column of Table 3).

Table 2 Share of maize production by farm size and year (percentage of total maize grown)

Year	Quintiles (%)					Total production (Tons)
	Bottom	2	Mid	4	Top	
1996	1.78	5.29	9.51	20.06	63.36	919,644
2002	1.23	5.62	11.49	22.45	59.21	1,155,538
2003	0.97	5.16	11.83	22.24	59.81	1,145,303
2005	0.14	3.90	10.54	22.60	62.82	945,831
2006	1.39	5.71	11.26	22.85	58.78	1,469,087
2007	0.86	5.22	11.35	22.29	60.29	1,133,306
2008	1.39	5.49	12.30	20.17	60.65	1,214,255

Source: Authors' calculations based on all available TIAs

Notes: Farms have been ranked in quintiles by the total amount of maize produced

Both the mean and median per capita cash income increased significantly between 2002 and 2005, which is in line with the increase observed in household incomes during the same period (Mather et al., 2008; Cunguara and Kajisa, 2009; Cunguara, 2009), but decreased in the following period. The results also show a large variation in cash income both across time and quintiles of maize production (see Table 3). Moreover, there is a considerable disparity between the mean and the median, which reflects a high degree of skewness in the distribution of per capita cash income among rural households.

Table 3 Annual per capita cash income by quintile of total maize production and year

Quintile of total maize production	Median per capita cash income in 2008 US\$			Mean per capita cash income in 2008 US\$			Mean cropped area in 2008
	2002	2005	2008	2002	2005	2008	
Bottom quintile	9.61	22.41	21.15	72.85	94.27	100.22	1.29
2	10.60	26.19	18.94	66.23	113.40	75.05	1.45
Middle quintile	13.18	28.30	21.67	81.61	104.18	88.78	1.63
4	22.88	36.09	31.37	99.82	118.28	90.12	2.05
Top quintile	41.48	86.87	58.46	152.01	200.16	174.50	3.15
Total	16.30	34.44	25.38	90.89	123.47	102.71	1.83

Source: Authors' calculations based on TIA08

Notes: Unofficial exchange rate \$1 = 26 Meticaïs;

Among the top quintile households, productivity levels increased because households engaged in non-farm income generating activities more often, and hence had cash to purchase improved farm inputs. Households in the top quintile also used fertilizers about 14 times more frequently than their counterparts in the bottom quintile. In addition, households in the top quintile were found to employ a considerable amount of non-family labor, suggesting that they also helped other households to move out of poverty (Table 4). Ellis and Freeman (2004) have argued that the success of poverty reduction strategy plans such as PARPA in reducing poverty in Africa is related to their ability to stimulate creation of employment opportunities and generating creative solutions for technical extension and market infrastructure development.

Table 4 The use of improved technologies, hired labour, and access to public services by farm size in 2008

Quintile of total maize production	Percentage of households					
	Improved maize seeds	Chemical fertilisers	Animal traction	Receipt of extension	Receipt of price info	Hired seasonal labour
Bottom quintile	8.20	0.75	15.25	4.93	28.93	11.48
2	8.21	1.42	16.60	6.51	34.27	17.83
Middle quintile	9.29	2.63	12.99	9.03	36.65	17.91
4	11.43	7.37	14.24	9.49	39.01	25.78
Top quintile	12.74	10.25	19.86	12.20	44.20	34.47
Total	9.74	4.00	15.62	8.11	35.93	20.41

Source: Authors' calculations based on TIA08

Notes: Analysis restricted to maize growers, 78% percent of the total sample

Farms have been ranked in quintiles by the total amount of maize produced

4 Participation in the output market

Most smallholder farmers were found to be net buyers of food but participated in food markets as both buyers and sellers, depending on the season. Usually smallholder farmers sell their produce right after harvesting season (between May and July) at prices that are significantly lower than the food prices they pay when they participate as buyers during the dry season (Stephens and Barrett, 2008). Profitable participation in the output market has been linked to participation in input markets and the use of storage and post-harvest marketing services. For example, Howard et al. (2003) show that in Mozambique farmers using improved maize seeds earn 24 percent more than non-users if they are able to delay their maize sales until November.

The type of crops as well as the amount sold varied significantly by farmer's income. The poorest farmers, defined as those in the lowest quintile of per capita cash income, tended to sell staple crops such as maize, whereas wealthier farmers sold cash crops in addition to staple crops (see Table 5). Of note is that once the farmer was able to sell, the poorest would sell extremely low quantities compared to wealthier farmers. It is also interesting to note that farmers in the top quintile did not sell cotton (a traditional cash crop in Mozambique) as frequently as those in the other quintiles, except the bottom quintile. This finding lends support to previous results in Pitoro et al. (2009), where non-cotton growers were found to be wealthier than cotton growers. Conversely, farmers in the bottom quintile rarely cultivated tobacco or sesame, and thus could not sell tobacco in 2008.

There are also regional differences in output market participation. Maize and cotton were sold more frequently in the northern provinces, whereas sales of tobacco, sesame, and tomatoes⁶ was predominant in the central provinces. However, farmers in the central provinces had the largest volumes of sales, including sales of maize and cotton. The quantity of tobacco sold in the southern provinces (reported in Table 5) can be misleading because a closer look at the data shows that there were only three large sellers, and all of them were located in Maputo province. The relatively lower quantities of maize sold in the northern provinces, despite its agricultural potential, could be associated with poor road infrastructure and low market access. Indeed, the development of rural markets is identified by the government as one of the main challenges in promoting rural development (Government of Mozambique, 2006: p70).

⁶ Tobacco and sesame are two of the most important cash crops in Mozambique, while tomatoes are the most widely sold horticultural crop.

Table 5 Output market participation by quintile of per capita cash income, region and crop in 2008

Quintile/ region	% of households who sold the following crops*					Mean quantity sold in kilograms per household				
	Maize	Cotton	Tobacco	Sesame	Tomatoes	Maize	Cotton	Tobacco	Sesame	Tomatoes
Bottom	5.01	0.46	0.00	0.44	1.13	59.89	42.45	-	18.73	197.20
2	17.65	4.87	0.39	5.35	2.57	132.96	213.12	44.74	51.23	309.24
Mid	20.38	6.54	2.20	7.38	4.50	192.60	448.85	198.73	83.35	520.15
4	19.64	4.54	4.25	9.02	5.87	301.38	658.27	369.64	112.66	1,471.00
Top	18.87	2.38	4.89	7.74	5.23	952.20	1,041	986.04	407.43	2,088.28
North	20.45	5.01	2.20	6.12	2.85	228.54	416.87	409.40	131.98	585.07
Centre	14.05	3.53	3.72	9.49	6.50	802.42	730.17	745.75	197.54	1,806.01
South	4.88	0.17	0.11	0.00	3.07	182.77	33.90	1,412	-	827.23
Total	16.21	3.82	2.21	5.88	3.77	346.79	484.13	555.22	157.63	1,129.19

Source: Authors' calculations based on TIA08

Notes: * The percentages are based in the whole sample, including those who did not cultivate the crop. If non-growers were excluded from the analysis, there wouldn't be any variation, i.e., the percentages would be similar across quintiles. For instance, 159 farmers sold tobacco out of 167 growers;

Farms have been ranked in quintiles by the per capita household income.

Rural development and food security would benefit from policies and programs that address missing rural financial markets and other limiting factors, such as access to animal traction (Boughton et al., 2007). Unfortunately, analysis of the TIA data shows a statistically significant decline in rural households' access to credit, from 2.9 percent in 2006 to 2.6 percent in 2008. The limited access to credit is also highly skewed, with the poorest households having no access at all. While government has been providing funds for investment into local credit initiatives at the district level, the selection criteria used to allocate these funds is unclear and its impact on beneficiaries is still unknown.

Rural development programs should also include investments in road infrastructure and market information, which are necessary but not sufficient conditions for increasing crop market participation at this early stage of Mozambique's smallholder agricultural development (Boughton et al., 2007). This is consistent with the result found in Cunguara and Darnhofer (2010), where road infrastructure played a crucial role in the profitability of the use of improved technologies. However, the relationship between market infrastructure and the adoption of improved technologies is barely explored in PARPA. Instead, the government expects the private sector to co-participate in the investment of market infrastructure through what is called "the development of public-private partnerships" (Government of Mozambique, 2006: p126).

Since not all smallholders are likely to be commercially viable in the short to medium term, households that cannot build the necessary asset portfolios may fail to escape poverty through output market participation. Therefore, there will be a need for policies and programs that enable more remunerative participation of such households in non-farm labor markets and entrepreneurial opportunities (Boughton et al., 2007). Since poor households are often confined to low return non-farm activities, breaking barriers to entry in high return non-farm activities will be critical. This may require substantial investments in education (Reardon, 1997), which can only be accomplished in the medium to long-term.

Rural markets could also take advantage of the current rapid changes in communication technologies and the rapid spread of mobile phones. There is an opportunity in the market information system to develop innovative services that rapidly and efficiently deliver information to farmers (see for an example, Aker, 2008 for the case of Niger). Sadly, as evinced by the results in the previous section, government investment in the market

information system has recently declined, perhaps because of government's belief that the private sector has enough incentives to co-participate.

5 Cash income, assets, and farmers' perceptions of economic conditions

As much as it is challenging to improve food security, measuring it is an equally difficult task. The results presented so far suggest that household incomes did not improve between 2002 and 2008. During the same period, official poverty estimates for rural areas suggest an increase in poverty headcount from 55 percent to 58 percent. Although both the TIA surveys and the official poverty estimates show no improvements, it is important to look at other welfare measures to determine if a similar pattern exists. One such measure is the household's perception of the present economic condition, relative to that of three years before. In 2008, households were asked whether their economic condition had improved since 2005, and in 2005 the same question had been asked, relative to 2002, and so on. Figure 1 illustrates the results on these perceptions. In 2005 there were significantly more households that perceived a worsening economic condition, relative to 2002. This result may be explained by the excessive drought of 2005. Mozambique frequently suffers from both floods and droughts in the same agricultural year, but in 2005 the drought was much more severe (especially in the southern provinces).

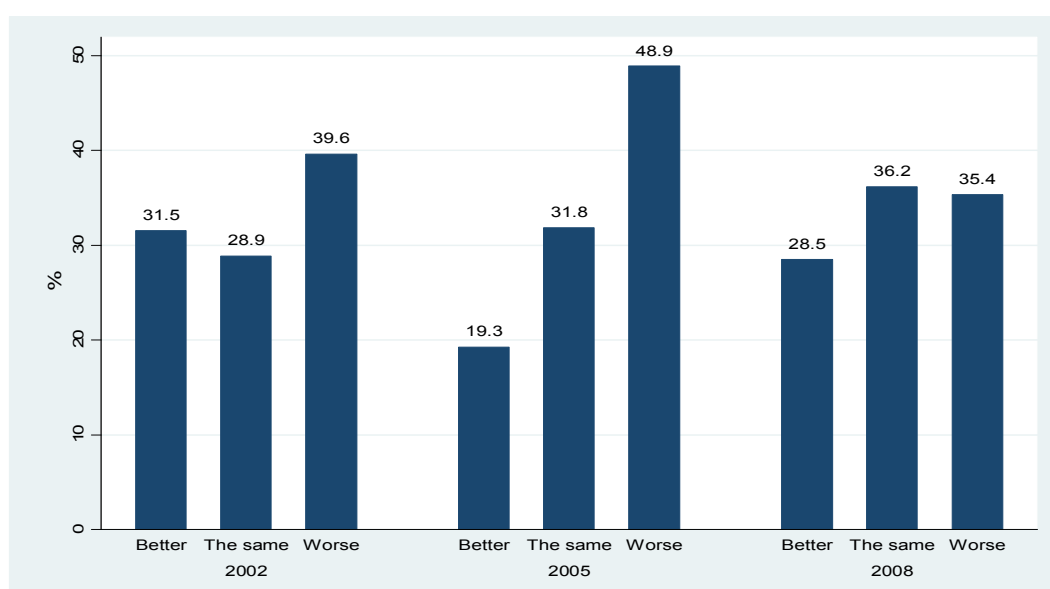


Figure 1 Household perception of the economic condition, relative to three years before

In 2008 households perceived their economic conditions as significantly better than in 2005, but not as good as in 2002. This suggests that overall, between 2002 and 2008, their economic condition had worsened. Results on perceptions are consistent with household welfare trends. However, they may seem paradoxical since data on asset ownership (e.g. bicycles) show improvements (Figure 2). Researchers have asked the question whether the increase in bicycle ownership is really indicative of poverty reduction and concluded that it is not necessarily the case (Hanlon and Smart, 2008). A prominent explanation has to do with asset distribution.

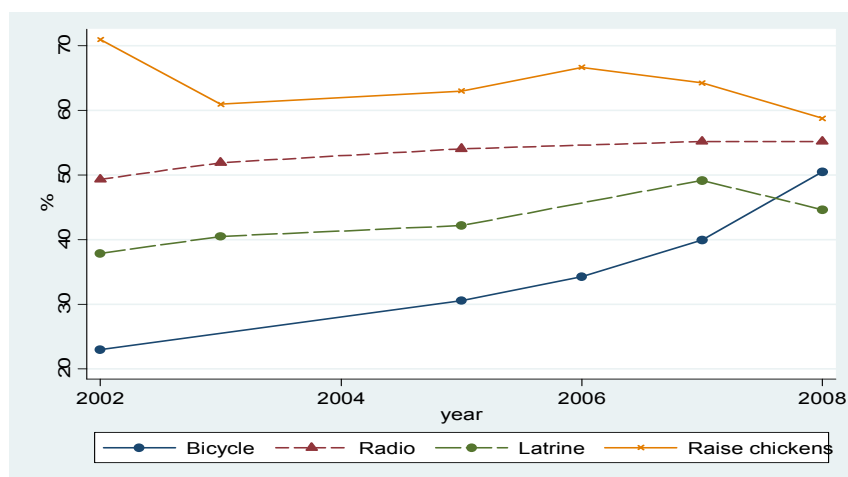


Figure 2 Percentage of ownership of selected assets by year

Other assets were equally considered, such as cropped area, type of housing, and ownership of chickens (Table 6). The percentage of households raising chickens has declined, especially among the lowest three quintiles of per capita cash income. While the top two quintiles experienced a decline between 2002 and 2005, in 2008 there were more households raising chickens among these two groups, relative to 2005. One reason for the decline in the number of households raising chickens could be the occurrence of Newcastle disease. A study conducted in 11 villages in the southern province of Gaza found that “unvaccinated chickens are approximately five times more at risk to die of Newcastle disease” (Harrison and Alders, 2010). However, in 2008 only four percent of farmers vaccinated their chickens (see Table 1).

In terms of cropped area, all quintiles experienced an increase between 2002 and 2005, which is consistent with changes observed in household incomes between these two periods. However, in the period 2005 to 2008 all quintiles experienced a decline in the cropped area, and the decline was relatively greater among the lowest quintiles of per capita cash income. A similar pattern recurs for the type of housing in rural Mozambique. Although on average the percentage of households with thatched roofs has declined, the change was greater among the top quintile.

Table 6 Asset ownership by quintiles of per capita cash income and year

Quintiles of per capita cash income by year	% HH raising chickens			Mean cropped area (hectares)			% HH with thatched roof		
	2002	2005	2008	2002	2005	2008	2002	2005	2008
Bottom quintile	60.80	58.23	50.37	1.14	1.60	1.42	87.04	88.27	82.99
2	72.10	65.63	58.77	1.17	1.80	1.63	93.19	88.98	89.49
Mid quintile	75.95	66.10	59.03	1.33	1.98	1.83	91.97	87.40	83.61
4	77.10	63.10	64.02	1.54	2.04	1.93	88.95	79.92	77.90
Top quintile	68.57	61.77	62.53	1.59	2.32	2.20	74.90	68.34	55.28
Total	70.97	63.02	58.76	1.34	1.92	1.77	87.87	83.54	78.82

Source: Authors' calculations based on TIA08

Some assets show a positive trend (type of houses, bicycle and radio ownership), but most of the improvements are concentrated among the relatively wealthy households. Looking at household incomes, asset ownership, and household's own perception of the economic condition based on TIA data, and the official poverty estimates, a similar pattern can be

identified. Between 2002 and 2008, the interventions set forth in PARPA did not significantly enhance household incomes, consumption, and asset accumulation among the poor.

6 Measuring food security

The use of caloric acquisition as a measure of food security has been criticized for two main reasons. First, it is not possible to uncover intra-household allocations of food (Hoddinott, 1999). Second, by focusing on macronutrient such as the caloric sufficiency, micronutrient deprivation is ignored, although it is just as serious an issue (Barrett, 2002). Nevertheless, in a country where 44 percent of the population suffers from chronic malnutrition (low height for age or stunting) and about a third faces chronic hunger (Grupo de Estudio, 2009; WFP, 2010), the lack of macronutrients is likely to be a reasonable indicator of food security.

Rural households can be defined as food secure if they are able to obtain the required calories either from their own production or purchase of food, although other food sources may exist, such as food aid. In this paper, the focus is on the first two food sources assuming that food aid is only made available when farmers are food insecure and unable to obtain the required calories either from agricultural production or purchase of food. Thus, the following equation is estimated, indicating whether or not a household is food insecure ($food^s = 1$ if food secure, and 0 otherwise):

$$food^s = D * [(Q_r + fs * \frac{Y_{cash}}{P_{retail}}) \geq Cal_{req}] \quad (1)$$

where fs is the share of food expenditure, and varies between 0.7 in Maputo province to 0.8 in Tete and Manica provinces, depending on the household location (MPF/UEM/PU, 2004: p37). D is a dummy variable taking on the value of one if the left hand side of the inequality is unsatisfied, and zero otherwise. Q_r & Cal_{req} represent the amount of calories produced and retained for home consumption, and household caloric requirements, respectively. Y_{cash} is the total cash income, and P_{retail} is the maize retail price from SIMA.

The above proposed measure of food security captures two aspects, namely the availability and access to food. Some households are likely to obtain most of their caloric requirement through purchase (e.g., tobacco producers and households whose head is relatively more educated) either because they allocate relatively smaller portions of their land to crop production or due to their greater participation in non-farm income generating activities. Others are likely to meet their caloric needs exclusively from own crop production (and food aid) because they are completely subsistence farmers without any cash income.

A food composition table was used to convert the physical quantities of food that were retained by the household for home consumption. The crops used in this computation included: grains (maize, rice, sorghum, and millet); pulses (peanuts, cowpeas, common beans, pigeon peas, green beans, mung beans, and earth peas); and roots and tubers (sweet potatoes and cassava). These crops represent the overwhelming majority of Mozambican peasant production⁷. Likewise, cash incomes were converted into caloric values using SIMA maize prices, and added to the retained calories from farmers' own production. Median provincial prices were used to account for regional differences in prices. The analysis was restricted to TIA02, TIA05, and TIA08 because other TIAs did not collect information on cash income sources, with the exception of TIA96, which was excluded

⁷ Horticultural crops were not included in the computation of caloric availability because horticultural yield data are not collected by the agricultural surveys used in this paper.

because the data on cassava production are not reliable, as previously explained in section 2.

Table 7 shows that food insecurity was lowest in 2002, but has been increasing ever since. About 43 percent of rural households were food insecure in 2002, which implies that they had to rely on food aid. In 2008 the percentage of households in need of food aid had increased to approximately 48 percent. These results resonate well with the official poverty incidence estimates in rural Mozambique, which show an increase from 55 percent in 2002 to 57 percent in 2008 (MPD, 2010).

The results also show that an overwhelming majority of households in the bottom three quintiles were food insecure. As expected food insecurity decreases, as one moves from the bottom quintile to the upper quintiles, but the change is noticeably greater from the fourth to the top quintile. This is because the median per capita cash income in the top quintile is about twice as high as the median among households in the fourth quintile (See Table 3), and maize production is about three times higher among those in the top quintile (Table 2). Therefore, food security strategies are likely to differ between households in the top quintile and those in the bottom four quintiles.

Table 7 Percentage of food insecure households by year

Quintiles of total maize production	Percentage of food insecure households			Food security gap per capita/day in 2008 US\$		
	2002	2005	2008	2002	2005	2008
Bottom quintile	55.81	61.09	60.38	0.10	0.11	0.11
2	52.96	56.55	59.63	0.08	0.09	0.09
Middle quintile	46.43	48.47	51.35	0.07	0.09	0.08
4	37.33	42.24	41.32	0.05	0.07	0.05
Top quintile	12.18	14.43	16.39	0.04	0.05	0.04
Total	42.93	45.44	47.79	0.08	0.09	0.08

Source: Authors' calculations based on TIA08

Notes: Farms have been ranked in quintiles by the amount of maize produced.

In order to close the food security gap, each Mozambican in rural areas needs an average of \$0.08 per day. This might seem very low at first glance, but is actually greater than the median per capita cash income per day in 2008 (See Table 3: $\$25.38/365\text{days}=\0.07), and is also roughly about a quarter or a fifth of the official poverty line, depending on the region in the country. For those in the bottom quintile, adoption of improved technologies alone might not be sufficient to close this gap. A family of five, the average household size in rural Mozambique, would have to adopt an improved technology that increases their incomes by about \$241 per year, almost 10 times the median cash income in 2008, which seems difficult. In addition to the adoption of improved technologies, farmers in the bottom quintile would have to expand their cropped areas, while seeking employment opportunities outside the agricultural sector. In turn, those in the top quintile can either adopt improved technologies or engage in non-farm income activities. This is because food insecure households in this group lie perilously below the 'food insecurity line,' and thus require relatively smaller changes in either agricultural production or cash income.

A closer look at the results presented in Table 7 reveals that the food security gap slightly increased among those in the lowest quintile of maize production. While the Food Security and Nutrition National Strategy described in PARPA II aims at increasing food availability from farmers' own production and improving farmers' ability to purchase food, the results shown indicate that this is not happening. On the contrary, food insecurity is increasing, consistent with the results obtained from other welfare measures. Whether the measure is per capita cash income, consumption expenditure, or the food security measure presented in

this paper, the receipt of public services (e.g., extension services or price information), poultry production, or the use of improved agricultural technologies such as chemical fertilizers and animal traction, the results consistently show that PARPA II has not reduced food security and has not been effective in achieving its goals.

6.1 Probability estimation of household food insecurity

A Probit model was used to assess the factors associated with the likelihood of being food insecure. The dependent variable is thus binary; whether or not the household was able to obtain sufficient calories, either from own production or purchases from the market, to meet the dietary requirements of all members. The analysis was conducted for each region in the country because there are substantial systematic differences in terms of agricultural potential and livelihood strategies, with households in the southern provinces relying relatively less frequently on crop production. In addition, separate models were estimated for households in the top income quintile of maize production because their food security strategies are likely to differ from those in the bottom four quintiles. The analysis discussed below is based primarily on TIA08 because the data provide more recent details on some of the key agricultural-related variables, which were not collected in the previous household income surveys (e.g., access to credit was not collected in TIA02 and TIA05; the use of improved seeds was not collected in TIA02). Nevertheless, a pooled model was also estimated using the variables that are common to the three TIA surveys and a trend variable denoting the survey period was included in this model. TIA02 was set as the baseline year.

The vector of independent variables includes household demographics, participation in non-farm income generating activities, asset ownership, agricultural technology variables, and access to public services. Pertaining to demographic characteristics, the education level of the household head has been shown to influence cash income earned by the household (Reardon, 1997; Garrett and Ruel, 1999). The coefficient was thus expected to be negative, implying that more educated households are less likely to be food insecure because they are able to purchase food. A variable on gender of household head was included based on other poverty studies in Mozambique showing that female-headed households tend to be worse-off than their male counterparts (Walker et al., 2004; Boughton et al., 2006; Boughton et al., 2007; Mather et al., 2008). Household size, expressed in terms of the adult equivalent scale (Deaton, 1997), was included as a proxy for labor availability, both for agricultural and non-agricultural activities. Cunguara et al. (2010) show that increasing the household size by adding one adult member usually results in lower outcomes because the marginal gain in net income per capita is smaller than the average net income per capita. Thus, the coefficient on household size was expected to be positive. Finally, the age of household head was expected to have an impact on labor supply for food production, and the ability to seek and obtain non-farm employment opportunities (Babatunde et al., 2007).

A second set of independent variables comprised of participation in non-farm activities by the household head. Here two proxies were used, namely whether the household head was engaged in salaried or self-employment activities. Previous work has revealed that household head's participation in non-farm activities increases farmers' ability to purchase food (Garrett and Ruel, 1999; Babatunde et al., 2007). Therefore, the coefficient was expected to be negative, implying that households with such sources of income are less likely to be food insecure. The magnitude of the coefficient, however, was likely to differ noticeably by region and quintile of maize production.

A third set of independent variables consisted of household asset ownership. Here, two proxies were also used: cropped area and livestock ownership. Households cultivating larger fields were expected to be more food secure (Tschirley and Weber, 1994), and thus the sign of the coefficient would be expected to be negative while its magnitude would most likely

vary by region, reflecting differences in agricultural potential. A squared term was included for the variable on cropped area to capture potential diminishing marginal returns from land. In terms of livestock, three animal species were included. Cattle are relatively predominant in the southern provinces, goats are found more frequently in the central provinces, particularly in Tete, and chickens are widespread throughout the country. The coefficient on each of these three variables was expected to be negative, implying that households can sell some of their animals to purchase food, invest in agricultural activities through purchase of improved inputs, or invest in small-businesses and hence increase their cash incomes (Reardon and Taylor, 1996; Dercon, 1998).

With regard to agricultural technology, animal traction was included as an independent variable in the models for the southern and central regions, but excluded from the northern provinces due to the occurrence of tse-tse fly disease on cattle. Mather (2009) estimates that the use of animal traction increases crop income by 33 percent in the central provinces. In central provinces the gains from animal traction use are related to increases in both agricultural productivity and expansion of area cropped, whereas in the southern provinces its impact is only related to area cropped (Mather, 2009). The coefficient was thus expected to be negative. The use of improved seeds and chemical fertilizers was also expected to have a negative sign, suggesting that households adopting these technologies would be less likely to suffer from food insecurity. A variable on the use of hired labor was included to capture the heterogeneity of family and hired labor (Deolalikar and Vijverberg, 1987).

The last set of independent variables pertained to access to public services, such as the receipt of credit, extension services, price information, and household membership to a farmers' association. Generally, these variables were expected to have a negative sign, implying that access positively influences either agricultural production or participation in non-farm income generating activities. In addition, district dummies were included to control for differences in agricultural potential and access to non-farm activities.

The results of the Probit estimation for TIA08 are presented in the appendix section, Tables A1 and A2. The model seems to fit the data fairly well, especially among the top 20 percent of the households, with a pseudo R^2 of 0.80, and about 91 percent of households predicted correctly. Most of the signs of the estimated coefficients were also in agreement with the literature. In what follows, a discussion is provided emphasizing the differences between the top 20 percent of households and the bottom 80 percent, while also looking at regional differences. A discussion of the results from the pooled model is also provided, and the discussion emphasizes the trends in food insecurity.

In the northern provinces the use of improved technologies (improved maize seeds and chemical fertilizers) was not significant for the bottom 80 percent of households, but was found to be significant for the top 20 percent. A similar pattern was observed in the southern provinces. One possible explanation for this result is that households in the bottom 80 percent cultivate smaller parcels of land, and most of the times in intercropping systems. The average impact of adopting these technologies was therefore small, and households in this category should expand their cropped area first to realize significant gains to technical change. Indeed, the coefficient in cropped area is significant for the northern provinces and the bottom 80 percent of households, but statistically insignificant for the top 20 percent of households in the same region. The results on the effect of animal traction are slightly different, suggesting that all households in the southern provinces would benefit from its adoption. Use of animal traction, however, was not statistically significant for the central provinces, probably due to lower variation in the data.

In terms of livestock, goats and cattle were significant factors enhancing food security among the top 20 percent, but not significant among the bottom 80 percent, perhaps because the latter do not own them (see the means presented in Tables A1 and A2). For the

poor, at present chickens are the most important livestock in all three regions. However, cattle herd size was also significant among the bottom 80 percent in the central provinces, although the magnitude of the coefficient was small, relative to that among the top 20 percent in the same region. At present, chicken sales among the bottom 80 percent are unable to raise the required cash to either purchase sufficient food or invest in the agriculture so as to increase the agricultural productivity and production to ensure food security.

The statistically significant coefficient on whether the head is engaged in non-farm activities signals the importance of non-farm cash income in ensuring food security. For the bottom 80 percent of households, the magnitude of the coefficient on self-employment (and head's education) was larger for the southern provinces, which reflects the lower agricultural potential in that region, and non-farm employment should be a long term strategy for coping with food insecurity and poverty (Cunguara et al., 2010).

Finally, with the exception of the receipt of credit in the central provinces, access to public services was not statistically significant among the bottom 80 percent. With regard to the receipt of extension, the lack of statistical significance might be related to the farmers' inability to adopt the technical recommendations provided by the extension workers (Walker et al., 2004; Mather, 2009; Cunguara and Moder, 2010). Low variation in the data could also explain the lack of effect of credit (in the northern and southern provinces only 2% received credit and the impact was not significant, compared to 7% in the central provinces, where the impact was significant). The result on the receipt of price information was somewhat surprising, and contradicted the results found by Mather (2009), who estimated that its receipt increases crop income by 23 percent and 31 percent in the central and southern provinces, respectively. For the top 20 percent of households, the receipt of credit and extension was statistically significant both in the northern and central provinces.

Results of the Probit estimation for the pooled model are presented in the appendix section, Tables A3 and A4. The results are consistent with those obtained in the Probit model for TIA08 and the descriptive statistics presented earlier. For example, food insecurity in 2008 was significantly worse than in 2002 and 2005. Similarly, chickens were more effective in enhancing food security among the bottom 80 percent of household ranked by the amount of maize produced, while goats were more effective among the top quintile.

7 Conclusions and policy implications

Using a set of seven nationally representative household surveys from rural Mozambique, the objective of this paper was twofold. The first goal was to evaluate whether or not PARPA, the poverty reduction strategy in Mozambique, has been effective in enhancing agricultural production and creating rural non-farm employment opportunities to address food security challenges in rural Mozambique. The results consistently show that this did not happen and findings are robust to the welfare indicator used. Whether it is cash income, consumption expenditure, asset endowments, receipt of public services, agricultural production or food security, results suggest that PARPA missed its goals, and food insecurity increased between 2002 and 2008.

The second objective was to analyze the factors associated with food insecurity in rural Mozambique. Results differed noticeably by quintile of total maize production and region. In the short run, adoption of improved technologies should be promoted more rigorously, especially among households in the top quintile of maize production. This recommendation stems from the finding that top quintile households were more likely to adopt improved technologies and be less food insecure while at the same time employing those in the bottom quintiles. Because the food security gap is relatively large among households in the

bottom quintile, non-farm employment opportunities would be beneficial in addition to the adoption of improved technologies.

Likewise, the main strategy to reduce food insecurity in the southern provinces should be creation of non-farm activities for all quintile categories of households. Nevertheless, the use of some improved technologies also proves to be of great importance. In particular, animal traction and/or mechanization are likely to enhance food security among those in the top quintile of maize production because they cultivate relatively larger fields. Meanwhile, the use of animal traction was not significant among the poorest households partly because they farm smaller fields and land area is the binding constraint for these households. Therefore, if the poor in the south are to realize significant gains from adoption of improved technologies they will need to first expand their cropped area.

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Appendix

Table A1 Probit model results for the bottom 80% by region in 2008

	North: bottom 80%			Centre: bottom 80%			South: bottom 80%		
	Coeff.	Sig.	Mean	Coeff.	Sig.	Mean	Coeff.	Sig.	Mean
Head's gender (1=male)	-0.32	**	0.80	-0.18		0.75	-0.05		0.61
Head's years of completed education	-0.07	***	2.74	-0.05	**	3.05	-0.10	***	2.79
Head's age (years completed)	0.00		40.03	0.02		43.10	-0.01		48.49
Head's age (squared term)	0.00		1786	0.00		2072	0.00		2589
HH size in adult equivalent scale (AE)	1.31	***	2.84	0.42	***	3.27	0.23	***	3.57
HH size in AE (squared term)	-0.12	***	9.02	-0.03		12.69	-0.01	**	16.72
Head is engaged in salaried act. (1=yes)	-0.22	**	0.24	-0.39	***	0.36	-0.51	***	0.34
Head is self-employed	-0.37	***	0.42	-0.44	***	0.36	-0.63	***	0.29
Cropped area in hectares	-0.45	***	1.61	-0.25	**	1.94	0.08		1.50
Cropped area in hectares (squared term)	0.03	***	3.74	0.04	***	5.80	-0.01		3.96
Cattle herd size	-0.03		0.03	-0.04	*	0.51	0.00		0.77
Number of goats owned by the HH	0.00		0.63	-0.01		2.37	0.00		1.32
Number of chickens owned by the HH	-0.03	***	3.09	-0.01	**	6.89	-0.02	**	5.35
HH used improved maize seeds (1=yes)	0.13		0.05	-0.02		0.18	-0.01		0.09
HH used animal traction (1=yes)			0.00	-0.02		0.11	-0.22	*	0.44
HH used fertilisers (1=yes)	0.11		0.02	-0.08		0.04	-0.14		0.02
HH hired permanent labour (1=yes)			0.01	-0.57		0.04	-0.39		0.03
HH hired seasonal labour (1=yes)	-0.47	***	0.18	-0.59	***	0.17	-0.53	***	0.20
HH received extension services (1=yes)	-0.05		0.08	-0.02		0.10	-0.01		0.05
HH received price information	-0.12		0.34	-0.08		0.39	-0.16		0.32
Member of a farmers' association (1=yes)	0.10		0.08	-0.06		0.05	0.25		0.09
HH received credit (1=yes)	-0.49		0.02	-0.43	*	0.03	0.07		0.02
Constant	-1.11	*		-0.53			1.49	**	
Number of observations	1581			1106			1330		
Wald chi2	306			179			211		
Prob>chi2	0			0			0		
Pseudo R2	0.21			0.18			0.17		
Percent predicted correctly	72.87			70.71			69.85		

Source: Authors' calculations based on TIA08

Notes: District dummies are included but not reported to save space

***, **, and * denotes significance at 1%, 5%, and 10%, respectively.

Table A2 Probit model results for the top 20% by region in 2008

	North: bottom 80%			Centre: bottom 80%			South: bottom 80%		
	Coeff.	Sig.	Mean	Coeff.	Sig.	Mean	Coeff.	Sig.	Mean
Head's gender (1=male)	1.71	**	0.90	-0.88	**	0.91	1.14	**	0.75
Head's years of completed education	0.16		3.32	-0.04		4.01	-0.19	**	2.73
Head's age (years completed)	0.78	***	42.27	0.04		42.58	0.10		50.52
Head's age (squared term)	-0.01	***	1943	0.00		1985	0.00		2721
HH size in adult equivalent scale (AE)	14.84	***	3.39	1.60	***	3.73	0.46	**	5.17
HH size in AE (squared term)	-1.66	***	13.16	-0.09	***	16.16	-0.02		33.55
Head is engaged in salaried act. (1=yes)	-3.55	***	0.19	-0.95	***	0.28	-0.84	*	0.28
Head is self-employed	-1.65	***	0.43	-0.92	***	0.39	-0.01		0.31
Cropped area in hectares	-0.73		3.10	-0.41	***	3.46	-0.31	**	2.80
Cropped area in hectares (squared term)	-0.05		13.98	0.01	***	21.48	0.01	**	12.43
Cattle herd size	0.65	***	0.11	-0.07	*	1.38	-0.02		3.50
Number of goats owned by the HH	-0.38	***	1.37	-0.07	***	3.67	0.01		3.31
Number of chickens owned by the HH	-0.06	*	6.33	-0.01		11.11	-0.10	***	13.53
HH used improved maize seeds (1=yes)	-2.06	*	0.10	0.75	*	0.18	-2.28	***	0.11
HH used animal traction (1=yes)			0.01	0.05		0.24	-1.06	**	0.66
HH used fertilisers (1=yes)	-3.65	***	0.07	-0.57		0.13			0.05
HH hired permanent labour (1=yes)			0.09	1.20	**	0.11	-0.51		0.09
HH hired seasonal labour (1=yes)			0.32	-0.99	***	0.36	-0.89	**	0.45
HH received extension services (1=yes)	-2.74	***	0.11	-0.84	*	0.13	1.51	***	0.08
HH received price information	-0.93		0.31	0.12		0.53	-0.54		0.36
Member of a farmers' association (1=yes)	3.34	***	0.11	0.75	*	0.09	-0.85		0.19
HH received credit (1=yes)	-2.67	**	0.05	-1.28	*	0.06			0.02
Constant	-54.23	***		1.00			-1.24		
Number of observations	219			433			164		
Wald chi2	126.56			156.53			83.66		
Prob>chi2	0			0			0		
Pseudo R2	0.80			0.50			0.53		
Percent predicted correctly	90.87			88.22			80.49		

Source: Authors' calculations based on TIA08

Notes: District dummies are included but not reported to save space

***, **, and * denotes significance at 1%, 5%, and 10%, respectively.

Table A3 Pooled Probit model results for the bottom 80% by region

	North: bottom 80%		Centre: bottom 80%		South: bottom 80%	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Head's gender (1=male)	-0.12	*	-0.08		-0.01	
Head's years of completed education	-0.06	***	-0.05	***	-0.08	***
Head's age (years completed)	0.00		0.02	**	-0.01	
Head's age (squared term)	0.00		0.00	**	0.00	
HH size in adult equivalent scale (AE)	0.83	***	0.30	***	0.22	***
HH size in AE (squared term)	-0.06	***	-0.01	***	-0.01	***
Head is engaged in salaried act. (1=yes)	-0.38	***	-0.37	***	-0.64	***
Head is self-employed	-0.35	***	-0.41	***	-0.50	***
Cropped area in hectares	-0.32	***	-0.11	***	-0.04	
Cropped area in hectares (squared term)	0.02	***	0.01	***	0.00	**
Cattle herd size	-0.03		-0.02	*	-0.02	***
Number of goats owned by the HH	-0.01		-0.01	*	0.00	
Number of chickens owned by the HH	-0.02	***	-0.01	***	-0.01	**
HH used animal traction (1=yes)	0.52		-0.25	**	0.01	
HH used fertilisers (1=yes)	0.07		-0.43	***	-0.26	
HH hired permanent labour (1=yes)	-0.72	**	-0.56	**	-0.24	*
HH hired seasonal labour (1=yes)	-0.42	***	-0.57	***	-0.49	***
HH received extension services (1=yes)	-0.16	**	0.03		-0.09	
HH received price information	-0.11	**	-0.13	*	-0.15	**
Member of a farmers' association (1=yes)	-0.09		-0.04		0.06	
Dummy for year=2005	0.22	***	0.10		-0.03	
Dummy for year=2008	0.31	***	0.14	*	0.26	***
Constant	-1.04	**	-0.75		1.02	*
Number of observations	4779		3270		4405	
Wald chi2	701.72		436.54		454.95	
Prob>chi2	0.00		0.00		0.00	
Pseudo R2	0.15		0.17		0.15	
Percent predicted correctly	69.09		70.67		68.63	

Source: Authors' calculations based on TIA02, TIA05, and TIA08

Notes: District dummies are included but not reported to save space

***, **, and * denotes significance at 1%, 5%, and 10%, respectively.

Table A4 Pooled Probit model results for the top 20% by region

	North: bottom 80%		Centre: bottom 80%		South: bottom 80%	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Head's gender (1=male)	-0.26		-0.20		0.22	
Head's years of completed education	-0.01		-0.04		-0.13	**
Head's age (years completed)	0.13	***	0.06	*	-0.06	
Head's age (squared term)	0.00	***	0.00	*	0.00	
HH size in adult equivalent scale (AE)	1.60	***	0.63	***	0.34	***
HH size in AE (squared term)	-0.13	***	-0.02	***	-0.01	*
Head is engaged in salaried act. (1=yes)	-0.67	**	-0.60	***	-0.47	*
Head is self-employed	-0.67	***	-0.19		-1.08	***
Cropped area in hectares	-0.38	***	-0.12	**	-0.09	
Cropped area in hectares (squared term)	0.02		0.00		0.00	
Cattle herd size	-0.06		-0.01		0.01	
Number of goats owned by the HH	-0.02		-0.02	**	-0.04	**
Number of chickens owned by the HH	0.00		-0.01		-0.03	**
HH used animal traction (1=yes)			-0.17		-0.54	*
HH used fertilisers (1=yes)	-0.94	**	-0.58	**	-1.48	***
HH hired permanent labour (1=yes)			0.32		-0.62	*
HH hired seasonal labour (1=yes)	-0.61	***	-0.85	***	-0.24	
HH received extension services (1=yes)	-0.12		-0.19		0.74	**
HH received price information	-0.22		-0.10		-0.44	
Member of a farmers' association (1=yes)	0.59	**	0.37	*	-0.36	
Dummy for year=2005	0.84	***	-0.09		0.27	
Dummy for year=2008	0.98	***	0.09		1.00	***
Constant	-13.70	***	-1.81	*	2.34	*
Number of observations	789		1495		511	
Wald chi2	214.11		245.66		129.35	
Prob>chi2	0.00		0.00		0.00	
Pseudo R2	0.34		0.30		0.35	
Percent predicted correctly	88.21		86.89		82.19	

Source: Authors' calculations based on TIA02, TIA05, and TIA08

Notes: District dummies are included but not reported to save space

***, **, and * denotes significance at 1%, 5%, and 10%, respectively.