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Changes in Rural Household Income Patterns in Mozambique, 1996-2002, and Implications for Agriculture's Contribution to Poverty Reduction

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Research Report No. 61E
December 2006

Republic of Mozambique

DIRECTORATE OF ECONOMICS

Research Paper Series

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ACKNOWLEDGEMENTS

The Directorate of Economics is undertaking collaborative research on food security with Michigan State University's Department of Agricultural Economics. We wish to acknowledge the financial and substantive support of the Ministry of Agriculture of Mozambique and the United States Agency for International Development (USAID) in Maputo to complete food security research in Mozambique. Research support from the Bureau of Economic Growth, Agriculture and Trade of USAID/Washington also made it possible for Michigan State University researchers to contribute to this research. This report does not reflect the official views or policy positions of the Government of the Republic of Mozambique nor of USAID. The authors also wish to acknowledge with gratitude the comments from colleagues in the Ministry of Plan and Development, and from the World Bank, on earlier drafts and presentations of the results in this report.

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Changes in Rural Household Income Patterns in Mozambique, 1996-2002, and Implications for Agriculture's Contribution to Poverty Reduction

EXECUTIVE SUMMARY

The challenge that faces Mozambique's government is to design poverty reduction and rural development strategies that deliver three-dimensional growth: *rapid* growth to reduce poverty incidence quickly, *sustainable* growth to ensure that people permanently escape poverty, and *broad-based* growth to ensure that as many families as possible benefit from it. The specific objectives of this paper are:

1. To compare the level, sources, and distribution of rural household incomes in 1995-96 and 2001-02. To achieve this objective, the paper answers questions such as how have rural incomes changed over the six year period; how much have the poorest of the poor benefited; and have rural incomes grown evenly over the whole country or have some areas grown faster than others?
2. To compare the level and composition of agricultural income in 1995-96 and 2001-02. The paper considers the importance of agriculture relative to non-farm activities as a source of rural income, and the mix of agricultural activities, for different income groups.
3. To identify priorities for enhancing agriculture's contribution to rural economic growth and poverty reduction in the medium term.

The national agricultural sample survey (*Trabalho do Inquerito Agrícola*) conducted in 2001-02, commonly referred to as TIA 02, provides a comprehensive data set on rural household income sources. It was designed and collected by the Statistics Department of the Economics Directorate of the former Ministry of Agriculture and Rural Development (MADER) with authority delegated by the National Statistics Institute (INE). The most recent national agricultural sample survey prior to TIA 02 was conducted in 1995-96 (TIA 96), only a few years after the signing of the peace accords in 1992 that formally ended the civil war. An understanding of how the rural economy has changed over the six years since TIA 96 will help guide investment priorities and implementation strategy to maximize the impact of public agricultural sector investment on rural poverty reduction.

Findings on Changes in Rural Household Income 1995-96 to 2001-02

Several key patterns of rural household income growth are identified. First, real mean rural household incomes per AE were 65% higher, and median incomes 30% higher, in 2001-02 compared to 1995-96. While households at all income levels saw their incomes rise, median incomes for the top 20% of households were more than double those of the next highest income quintile, and more than 15 times the income of the poorest 20%. With the exception of the top 20% of the population, rural household incomes remain very low, and remain critically low for the poorest 60% of the population. Encouragingly, regional disparities in rural household incomes have diminished since 1995-96, and ownership of goats and bicycles has increased among households at all income levels.

Second, increases in income for the highest income households have come primarily from off-farm skilled wage and self-employment opportunities. This route out of poverty will not be available to the majority of rural households in the near term because of limited projected employment growth in the public and NGO sectors, the high educational requirements for formal sector employment relative to current educational attainment of the rural population, and the concentration of high wage employment opportunities in the south of the country.

Third, participation in self-employment activities has increased across all income groups, but most of this increase has been in natural resource extraction activities. Some of these activities, such as firewood collection and charcoal production, are potentially problematical from the standpoint of environmental sustainability.

Fourth, increases in crop income have played a dominant role for the bottom 60% of earners, and have been of equal importance to off-farm income growth for the next 20% (the fourth quintile). This increase in cropping income has been associated with substantial diversification of cropping patterns across all income groups, with the average number of crops grown increasing by about 75%.

Unfortunately, increased cropping income has been driven almost entirely by increased prices: production of most crops fell per hectare and per household (AE) member, but prices increased more than enough to compensate. This finding raises at least two troubling issues. First, the welfare improvement for households with increased crop income may be overstated, because much of this "income" is in the form of crop production retained on the farm for consumption; higher market prices for these foods do not make them more valuable in consumption to these households. Additionally, recent research shows that at least 61% of rural households in Mozambique are net buyers of maize, meaning that they purchase more maize (in the form of grain or meal) than they sell (Tschirley, Abdula, and Weber 2006). Higher food crop prices actually reduce the welfare of these households. Second, growth in agricultural productivity is a fundamental building block for sustained increases in rural incomes. Because most rural non-farm activities are depend on agriculture to generate effective demand for their goods and services, stagnant agricultural productivity will undermine the prospects for growth in the rural non-farm sector.

Because rainfall during the 2001-02 growing season was substantially worse across most areas of the country than in 1995-96, and because of the limitations in using household AEs as a proxy for labor allocation to agricultural activities, we cannot conclude from these two surveys that productivity is showing a medium-term downward *trend*. However, we have argued on the basis of complementary information, some in TIA and some from other sources, that agricultural productivity in Mozambique may well be stagnant.

Steps to Ensure Strong Agricultural Productivity Growth

For the majority of the rural poor, the fastest way to reduce poverty and improve food insecurity is by increasing the quantity and value of agricultural production, particularly crop production, combined with a gradual shift from unskilled low wage and self-employment in the natural resource extraction sector to skilled wage and value-added self-employment opportunities. As shown by the rapid growth of household incomes in Tete province, a high value cash crop like tobacco can be a powerful engine for rural economic growth, both through increased crop income and the resulting increased demand for additional locally produced goods and services.

In line with the findings of the earlier study of the determinants of rural household income in Mozambique (Walker et al. 2004), agricultural growth should be pursued through a twofold strategy of encouraging the emergence of a commercial smallholder group while strengthening the food security and cash earning opportunities for the majority of semi-subsistence smallholders. Semi-subsistence smallholders will benefit indirectly from the success of commercial smallholders through increased wage earning opportunities.

Commercial smallholders need assistance to expand cultivated areas through the use of animal traction, to increase high value horticultural crop production with small-scale irrigation, and to improve post-harvest storage and marketing. Studies on the costs and benefits of specific investment packages for different types of commercial smallholders are urgently needed.

The majority of semi-subsistence smallholders can expand their incomes rapidly through the introduction of higher yielding, drought tolerant, and disease resistant food crop varieties, and expanded access to cash crop opportunities. Studies of the costs and benefits of specific technologies and diffusion strategies are, again, urgently needed.

While difficulties in the estimation of cassava yields make it difficult to quantify the incidence and depth of food insecurity in 2001-02 compared to 1995-96 through the TIA surveys, additional research and extension appears necessary to strengthen food security for semi-subsistence farmers. In particular, households with limited land and/or labor need assistance to develop strategies for year-round balanced nutrition. Changing household demographics, such as decreasing household size and the increasing proportion of female-headed and widow-headed households, need to be taken into account in developing improved food security strategies. Work on long-term solutions to food insecurity has been neglected in recent years due to a focus on emergency food aid. Reduced incidence of malaria in the growing season through community-wide adoption of impregnated mosquito nets during the growing season could also help boost labor productivity for vulnerable families.

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ACRONYMS

AE	Adult Equivalent
AEU	Adult Equivalent Units
AP	Mozambique Early Warning Unit (*Aviso Prévio)*
HH	Household
IAF	National Household Consumption Survey (*Inquérito aos Agregados Familiares)*
IIAM	Institute of Agricultural Research of Mozambique
INE	National Statistics Institute
MADER	Ministry of Agriculture and Rural Development (now MINAG)
MAP	Ministry of Agriculture and Fisheries (*Ministério de Agricultura e Pescas*)
MINAG	Ministry of Agriculture (*Ministério de Agricultura*)
MPF	Ministry of Planning and Finance
MSE	Micro-small Enterprise
NGO	Non-governmental Organization
NRE	Natural Resource Extraction
PAEI	Agricultural Policy and Implementation Strategy (*Política Agrária e Estratégia de Implementação*)
PET	Potential Evapo-transpiration Rate
RQI	Rainfall Quality Index
SIMA	Market Information System (*Sistema de Informação de Mercados*)
TIA	National Agricultural Sample Survey (*Trabalho do Inquérito Agrícola)*

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by

Duncan Boughton, David Mather, David Tschirley, Tom Walker, Benedito Cunguara, and Ellen Payongayong

1. INTRODUCTION

This research report compares the level, composition, and distribution of rural household incomes in Mozambique in the agricultural calendar years 1995-96 and 2001-02. The analyses presented are relevant to national poverty reduction as well as agricultural and rural development strategies. The justification for a focus on the analysis of rural incomes is that rural households represent 65%-70% of Mozambique's population, and the incidence and depth of poverty is greater in rural areas (MPF 2004). The challenge that Mozambique's government faces is to design poverty reduction and rural development strategies that deliver three-dimensional growth: *rapid* growth to reduce poverty incidence quickly, *sustainable* growth to ensure that people permanently escape poverty, and *broad-based* growth to ensure that as many families as possible benefit from it. This is a tall order. To the extent that national and sectoral strategies can be grounded in facts about the rural economy and how it is evolving, the more successful those strategies are likely to be in achieving their stated objectives.

The national agricultural sample survey (*Trabalho do Inquerito Agrícola*) conducted in 2001-02, commonly referred to as TIA 02, provides a comprehensive data set on rural household income sources. It was designed and collected by the Statistics Department of the Economics Directorate of the former Ministry of Agriculture and Rural Development (MADER), with authority delegated by the National Statistics Institute (INE). This report is one of four research papers published by the Economics Directorate that analyze the TIA data to help inform agricultural and rural development strategies. The other three papers include an analysis of the determinants of rural incomes, poverty and perceived well-being (Walker et al. 2004), an analysis of the implications of adult illness and death among rural households (Mather et al. 2004), and an analysis of agricultural maize production and marketing by rural households (Tschirley, Abdula, and Weber 2006).

Analysis of the TIA data complements poverty analysis conducted by the former Ministry of Planning and Finance, using a household consumption expenditure data set (the *Inquerito do Agregado Familiar*, or IAF). It is generally accepted that household consumption expenditure surveys, like the IAF, provide more accurate estimates of poverty incidence and depth than income surveys because a household's consumption is generally less volatile than a household's earned income. Surveys that collect data on income sources are also more likely to underestimate well-being because of unobserved or undeclared income sources. Yet well collected income data correlates very well with expenditure data, both at the household level and over space. In addition, income data allow very detailed examination of the strategies that households pursue to ensure their food security and improve their well-being. Thus, analysis of the level and sources of household incomes provides valuable additional insights into rural household livelihood strategies that can help identify ways to increase and/or stabilize rural incomes in the future.

The most recent national agricultural sample survey prior to TIA 02 was conducted in 1995-96 (TIA 96), only a few years after the signing of the peace accords in 1992 that formally ended the civil war. TIA 96 is an appropriate benchmark for comparison with TIA 02 for several reasons. First, TIA 96 coincided with the implementation of a new market-oriented agricultural strategy, commonly referred to as the PAEI (MAP 1995). Second, approval of the PAEI by the Council of Ministers was shortly followed by the preparation of new legislation governing land use rights, and the expansion of agricultural development efforts by donors and NGOs. Third, the inception of the national agricultural development program (Proagri) in December 1998 signaled the government's commitment to taking leadership of agricultural policy and the coordination of development activities in the agricultural sector. An understanding of how the rural economy has changed over the six years since TIA 96 is important as rural development strategy is reviewed, and the detailed design of a new phase of the national agricultural development program is contemplated. The specific objectives of this paper are:

1. To compare the level, sources, and distribution of rural household incomes in 1995-96 and 2001-02. To achieve this objective, we answer questions such as how have rural incomes changed over the six year period; how much have the poorest of the poor benefited; and have rural incomes grown evenly over the whole country or have some areas grown faster than others?
2. To compare the level and composition of agricultural income in 1995-96 and 2001-02. We consider the importance of agriculture relative to non-farm activities as a source of rural income, and the mix of agricultural activities, for different income groups.
3. To identify priorities for enhancing agriculture's contribution to rural economic growth and poverty reduction in the medium term.

Section 2 provides information on the methods used to ensure comparability between TIA 96 and TIA 02 data sets. Section 3 presents an empirical analysis of differences in the level and distribution of rural incomes between 1995-96 and 2001-02. Section 4 presents an analysis of the composition of rural household incomes, and looks more in-depth at how agriculture's contribution to income has changed between the two periods. The final section discusses the implications of the analyses presented in sections 3 and 4 for future agricultural and rural development strategy. Additional tables providing a provincial breakdown of some of the tables presented in sections 3 and 4 are provided as an Appendix. Unless otherwise stated, the sources of information for all tables are the TIA 96 and TIA 02 surveys.

2. DATA SOURCES AND METHODS

No two agricultural years are identical, and rarely are two surveys identical in their samples, questionnaire content, and definitions. In this section, we briefly discuss differences between TIA surveys in 1995-96 and 2001-02, the adjustments that we make to improve comparability, and remaining limitations imposed by the data and differences in seasonal rainfall patterns.

2.1. The Samples for TIA 96 and TIA 02

Both TIA 96 and TIA 02 samples were designed to be representative at the provincial and national levels. TIA 96 collected data from 3,889 households in 66 districts, while TIA 02 collected data from 4,908 households in 80 districts. The TIA 02 sample was drawn from the sampling frame prepared for the year 2000 agricultural "census" (covering approximately 22,000 households) with the intention that TIA 02 data could be analyzed at the provincial level and by agro-ecological zone. As a check on the possible effect of differences in sample design between TIA 96 and TIA 02, some of the analyses presented in subsequent sections of the paper were repeated using only the sub-sample of districts common to both surveys.[1] Differences in the results obtained using the sub-sample of districts common to both surveys do not materially change the conclusions.

2.2. Comparability of the Data for the Purpose of Comparing Household Income[2]

This paper uses the same concept of household income as Walker et al. (2004), namely net returns to family resources (land, labor, and other assets). Net income is summed across crop, livestock, small business, and wage earning activities. Remittances and seed costs are excluded from the income calculation of net income as this information was not collected by TIA 96. The value of own consumption of fruits, vegetables, and livestock products is also excluded, as this information was not collected by TIA 02. The value of livestock sales is used as a proxy for livestock income. Wages of household members living permanently outside the province are also excluded from the calculation since any income received by resident members of the household would effectively be in the form of remittances. Other adjustments that were made to ensure the highest degree of comparability between the two data sets are:

- non-standard units of crop production for both surveys are converted to standard units (kg) using the conversion factors estimated for TIA 02 since they were based on a more comprehensive set of product samples than was available for TIA 96;
- prices for valuing crop output are based on median household prices calculated at the district level where there are at least ten household price observations for a given crop, or at the provincial level where there are less than ten observations at the district level. Exceptions to this rule are field cash crops, for which the household-level

[1] Districts common to both TIA 96 and TIA 02 samples include approximately two-thirds of households in the TIA 96 data set and just over half those in TIA 02.

[2] The survey instruments used for TIA 96 and TIA 02 can be downloaded from the following website: http://www.aec.msu.edu/fs2/mozambique/survey/index.htm

reported price is used, and prices for horticultural crops in TIA 96 where mean prices (excluding the highest 20% and lowest 20% of observations) are used;[3]

- TIA 96 underestimated cassava production because the survey instrument attempted to recall a single annual total for a crop that is harvested at intervals. TIA 02 corrected this problem by using an instrument that captured quantity harvested in different time periods. We therefore assume that production of cassava per AE in 1995-96 was equal to that observed in TIA 02 for a given province and household income quintile. See Appendix A for information on the relationship between province, income quintile, and cassava production. For households in the TIA 02 sample with missing cassava production data, mainly in Nampula province, production was estimated using coefficients from a regression of cassava production on area cultivated and other household characteristics (Appendix B);
- TIA 96 collected detailed income data for small business activities in four provinces: Nampula, Zambêzia, Sofala, and Manica. In the remaining six provinces, TIA 96 collected information only on the number of household members with a small business and the total number of small business activities that the household had. Income for households with small business activities in these six provinces was therefore estimated using coefficients from a regression of small business income on the number of small business activities and other household characteristics (Appendix C). This imputation of small business income in 1996 affected 25% of households in these six provinces; 75% of households in those areas did not report operating any such business and therefore did not need any imputations. TIA 02 collected detailed income data for small business activities for all households in the sample.

2.3. Rainfall and Agricultural Production

The comparison of household income in 1995-96 and 2001-02 is complicated by the fact that the weather was quite different in the two years. In 1995-96, the weather was generally favorable for crop production. In contrast, crop production in southern Mozambique in 2001-02 was severely affected by the drought that hit a large part of the southern Africa region. Maize yields in southern Mozambique were particularly affected due to more than 40 days of drought stress (based on observed rainfall and a simple water balance model; see Appendix D). While the south was affected by drought, the north was affected by high levels of rainfall runoff. High levels of runoff can imply the need for multiple plantings, lower plant densities, and late weeding. In terms of weather, with the exception of central Mozambique, 1995-96 was in the best quartile of agricultural seasons looking over a 45-year period while 2001-02 was in the poorest.

While the difference in quality of the agricultural seasons complicates the comparison of household income in 1995-96 and 2001-02, it does not render the exercise futile. First, highly variable weather is a fact of life that rural Mozambican households must contend with. Analysis of income patterns in a difficult year, and the contribution made by different income sources, reveals how robust rural livelihoods are and what vulnerabilities remain. Differences in observed crop production and prices are discussed in more detail in section 4.

[3] We used individually reported prices for cash crops, such as cotton and tobacco, for two reasons. First, we judged that household recall of these prices would be better than for other crops, because the markets are formalized and farmers receive receipts for the transaction. Second, households paying back credit at the time of the sale reported receipts net of these credit repayments; applying median prices in these cases would have been incorrect. We did, however, replace individual prices in the top and bottom 20% of prices with medians.

2.4. Adjusting for Changes in Prices

Income is a measure of potential consumption and hence an indicator of well-being. To compare potential consumption from income generated at two different points in time, it is necessary to adjust for changes in the level of prices (inflation). We correct for inflation by using the same correction factors as those used for the Ministry of Plan and Finance poverty assessment based on IAF data in 1996 and 2002. This facilitates comparison of the income results from TIA with the observed consumption expenditure results from IAF (that reflect both current income and saving/dissaving decisions by households). The IAF-based poverty assessment report has two sets of inflation measures, one based on fixed consumption bundles and one based on flexible consumption bundles. Measures of inflation based on flexible consumption bundles are preferable because they recognize that households can increase their well-being from a given income level over time by taking advantage of relative price changes (i.e., where two products are equivalent, households consume more of the one that becomes less expensive over time and less of the one that becomes more expensive). As in the IAF report, we initially provide income results using both inflation measures, and then use measures based on flexible consumption measures for the remainder of the analyses. Unless otherwise stated, all values are expressed in 2002 constant "contos" (1 conto = 1,000 meticais).

2.5. Adjusting for Household Composition

Household members vary in their consumption needs, and therefore in the income necessary to provide for those needs. For example, it typically costs less to provide for the basic needs of children than for their parents. To correct for differences in household composition over time and space, we present income in terms of Adult Equivalent Units (AEU). To calculate the AEUs in a given household, adults of either sex receive a weight of 1.0, children age 0-4 years receive a weight of 0.4, and children 5-14 receive a weight of 0.5 (Deaton 1997).

3. COMPARISON OF THE LEVEL AND DISTRIBUTION OF RURAL HOUSEHOLD INCOMES IN 1996 AND 2002

In this section we first present information on rural household income levels in 1995-96 and 2001-02, and then consider spatial and distributional patterns of income change. To help interpret differences in household income levels and distribution between the two TIA survey periods we analyze changes in household demographics and asset levels between them.

3.1. Comparison of Mean and Median Household Income

Table 1 presents mean household income per adult AE by province and for the country as a whole in 2002, and the percent difference in real income per AE compared with 1996 using the fixed and flexible inflators discussed in section 2.4. Note that these figures represent earned income and do not include remittances.

Table 1. Mean Household Income per AE by Province in 2002 and Percent Change Since 1996

	Total Net HH Income/AE (2002 contos)		Fixed Deflator	Flexible Adjusted Deflator
Province	Mean	S.E.	Percent Change 1996-2002	
Niassa	1,921	230	114	152
Cabo Delgado	1,355	81	6	25
Nampula	1,330	146	-17	-10
Zambezia	1,432	196	64	102
Tete	2,396	318	329	419
Manica	1,597	100	27	53
Sofala	1,511	133	88	133
Inhambane	2,229	289	80	77
Gaza	1,542	189	95	92
Maputo	3,112	306	143	131
Total	1,641	71	48	65

S.E. = Standard Error (of Mean)

Mean household income per AE at the national level in 2002 was 1,641 contos or 1.6 million meticais, equivalent to a little over $70 at the prevailing exchange rate. This represents an increase in real income at the national level of 48% compared to 1995-96 using the fixed consumption basket inflator, and 65% using an inflator that allows people to vary the mix of products they consume to take advantage of those that have become cheaper over time. These differences are greater in the center and north of the country than in the south.

Maputo province had the highest average income per AE in 2001-02, followed by Tete, Inhambane, and Niassa. The provinces of Nampula, Cabo Delgado, and Zambezia had the lowest mean income per AE, while Manica, Sofala, and Gaza are a little below the mean.

Differences in mean household income per AE in 2001-02 compared to 1995-96 vary greatly from one province to another. Tete province has the highest increase, more than trebling since 1995-96. The provinces of Niassa, Maputo, and Sofala all more than doubled compared to 1995-96 as measured by the flexible inflator, while Zambezia, Gaza, and

Inhambane show increases of 75% to almost 100%. Increases of less than 50% were observed in Manica and Cabo Delgado, while Nampula was the only province where a decline in real average income per AE was measured.

Despite major differences in their survey samples, there are notable similarities between TIA and IAF results. For example, the four provinces outside of Maputo with the highest positive percent change in income measured by TIA are the same four with the highest rates of poverty reduction as measured by IAF. In Cabo Delgado province, where poverty increased as measured by IAF, the change in rural income measured by TIA was negligible. Anticipating results discussed in detail in the next section, we note that provinces with high rates of positive income change are those with increases in *both* agricultural and non-agricultural income sources. In provinces with only limited proportional change in income, agriculture is lagging as a contributor.

Table 2 compares changes in the mean and median incomes by province and at the national level using the flexible inflator (Figure 1 presents the same information in graphical form). While the mean sums all household income per AE across households and divides by the number of households, the median reports the income per AE of the middle household in a given group when ranged from highest to lowest. The median is useful for poverty analysis because it tells us that 50% of the observations are at or below that value.

Table 2. Mean and Median Household Income per AE by Province in 2002 and Percent Change Since 1996

Province	Mean Total Net HH Income/AE (2002 contos)	Percent Change 1996-2002	Median Total Net HH Income/AE (2002 contos)	Percent Change 1996-2002
Niassa	1,921	152	1,154	153
Cabo Delgado	1,355	25	816	4
Nampula	1,330	-10	800	-31
Zambezia	1,432	102	803	63
Tete	2,396	419	1,161	273
Manica	1,597	53	930	69
Sofala	1,511	133	877	111
Inhambane	2,229	77	1,121	39
Gaza	1,542	92	654	22
Maputo	3,112	131	1,761	104
Total	1,641	65	867	30

Figure 1. Mean and Median Total Net Household Income per AE, 2002 contos

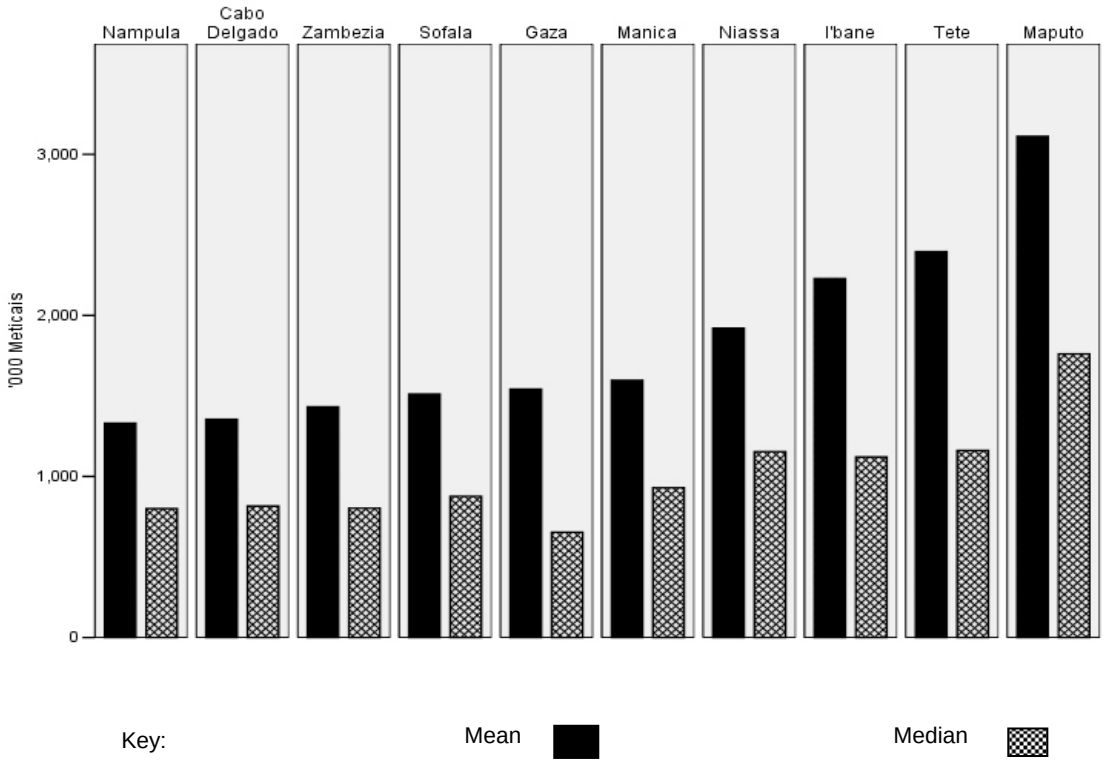
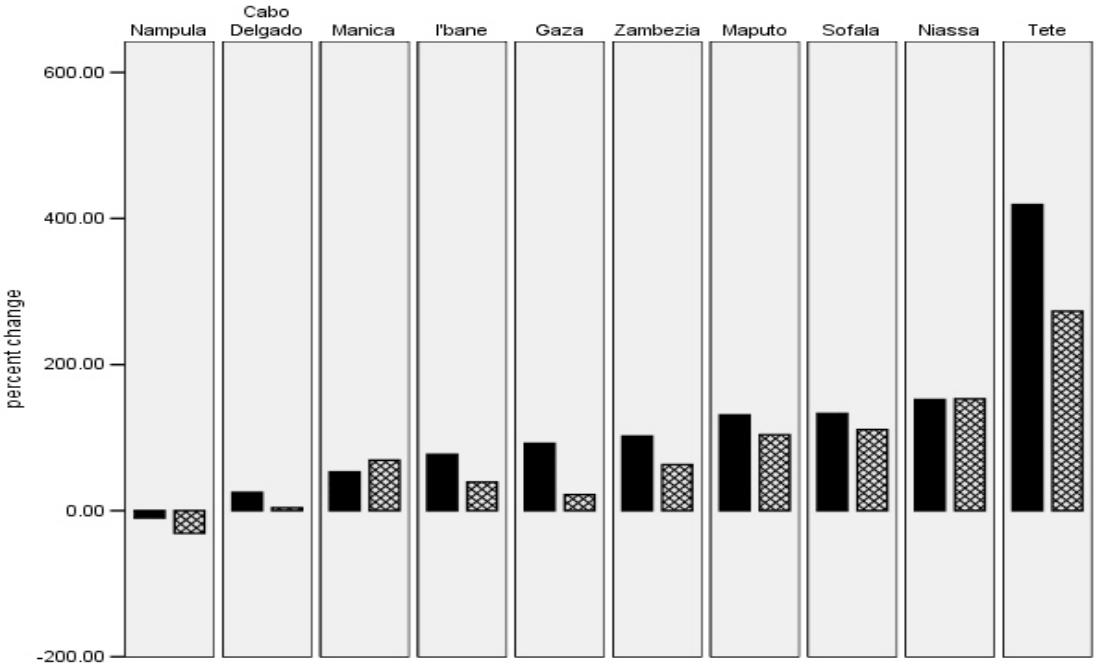


Figure 2. Mean and Median Percent Change, 1996-2002



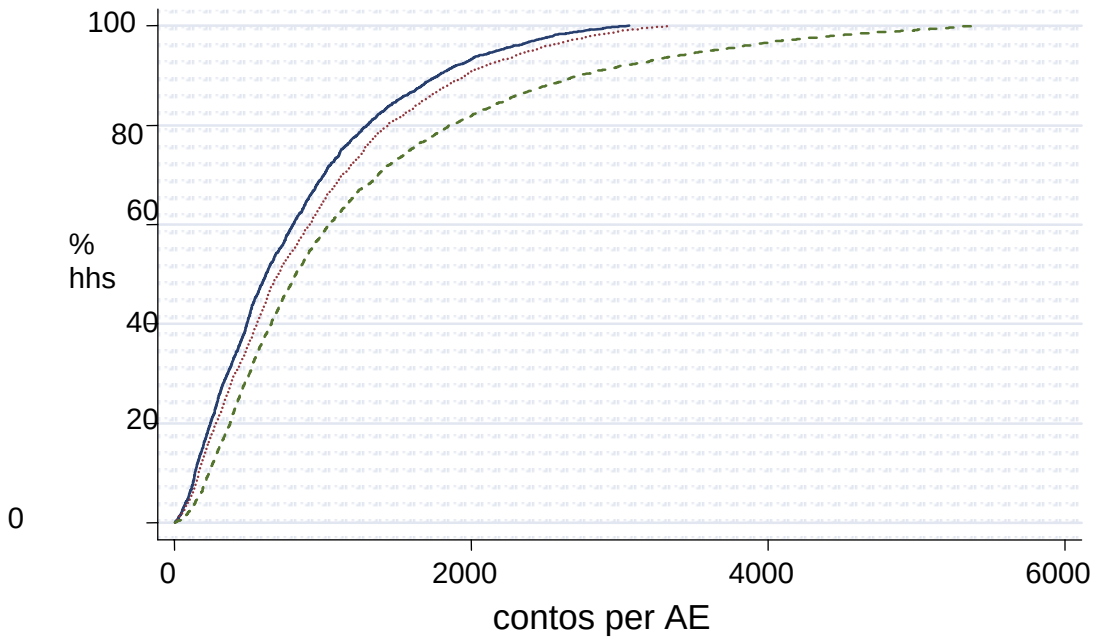
Median household income per AE in 2002 was 867 contos (equivalent to about $37 at the time of the survey), and much lower than the mean of 1,641 contos. The increase in real median income compared to 1995-96 was less than half the increase in the mean. Most provinces have median household income per AE between 800 and 1,200 contos. Exceptions

are Maputo, where median income is the highest at 1,761, and Gaza, with the lowest median income at 654 contos (excluding remittances). Spatial patterns of growth for median household income per AE are similar to the mean except for Gaza, where the increase in median income was very small relative to the mean, Manica, where median income increased by a greater percentage than the mean, and Nampula, where median income fell proportionately faster than the decrease in the mean. As will be seen in the next section, changes in household median income are strongly affected by the contribution to income from crop production.

3.2. Distribution of Household Incomes

A key concern for policymakers is whether the income generated by rural economic growth is broad-based or whether only a small proportion of households benefit. Figure 3 shows the cumulative distributions of household income per AE in 1995-96 (with a solid line indicating the flexible inflator and a dotted line the fixed inflator) and 2002 (represented by the dashed line). The vertical axis indicates the percent of households with incomes at or below the value in contos

Figure 3. Cumulative Distribution Function of TIA 96 Total Household Income per AE (IAF Flexible Inflator), TIA 96 Total Household Income per AE (IAF Fixed Inflator), and TIA 02 Total Household Income per AE



Solid line = 96 flexible Dotted line = 96 fixed Dashed line = 2002

per AE indicated by the horizontal axis directly below a given cumulative distribution. The fact that the dashed line representing the 2002 distribution always lies to the right of the 1996 distribution indicates that all households experienced some increase in income between the two periods. The fact that the lines diverge much more rapidly above the 60th percentile indicates that poorer households in the distribution benefited less in absolute terms than wealthier households. To investigate further the distribution of household income in the two time periods, we first divide each cumulative distribution into five equal segments, or quintiles, with each quintile containing 20% of the sample households in each year.[4]

Table 3 presents mean and median household income per AE for each income quintile (1 is the lowest income quintile and 5 is the highest), and the percent change compared to 1995-96. The table confirms a result depicted in Figure 3, namely that all income quintiles experienced income growth. Indeed the increase in median income for the lowest two quintiles was higher in percentage terms than the median increase for the population as a whole. Nevertheless, rural income inequality remains very high as the median income per AE of the highest income quintile is nearly 18 times larger than the median income per AE of the lowest quintile.

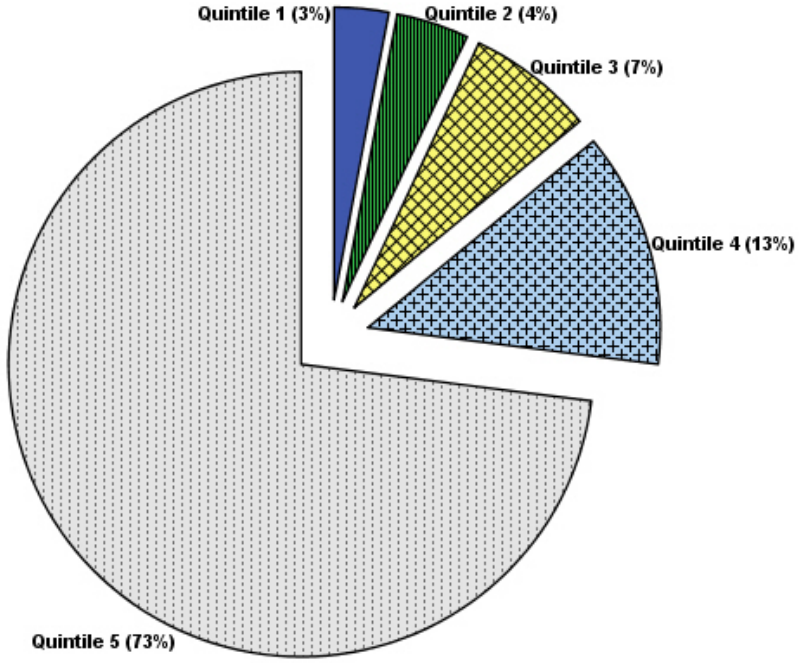
Table 3. Difference in Mean and Median Total Net Household Income per AE by Income Quintile, 1996 and 2002

Quintiles of Net HH Income/AE	Mean Total Net HH Income/AE (2002 contos)	Percent Change 1996-2002	Median Total Net HH Income/AE (2002 contos)	Percent Change 1996-2002
(low) 1	215	63	231	66
2	519	37	524	39
(mid) 3	877	31	867	30
4	1,559	38	1,521	37
(high) 5	5,038	88	3,531	59
Total	1,641	65	867	30

The extent of inequality in the distribution of income gain across households is visualized in Figure 3. Of the total increase in income generated by the rural economy, over 70% went to the top income quintile, while less than 3% went to the poorest income quintile. Income gain accruing to the top quintile of households may well be exaggerated due to underestimation of wage earnings by salaried family members in TIA 96, a problem discussed further in section 4. Regardless of the possible overestimation of income gain to the top quintile, the extremely low level of earned income for the poorest quintiles justifies a continued policy emphasis on the reduction of absolute poverty. This conclusion is consistent with the findings of the IAF study (MPF 2004).

[4] Quintiles are calculated by first ranking households from lowest income per AE to highest, then dividing them into five groups of equal size. So each quintile contains 20% of the households, and the highest income in one quintile is always lower than the lowest income in the next quintile.

Figure 4. Share of Total Increase in Rural Incomes 1996-2002 Accruing to Each Quintile of Rural Households (1 = lowest; 5 = highest)



Policymakers are also concerned that economic growth be regionally balanced. Table 4 shows the distribution of households in each income quintile in the north, center, and south of the country. If the spatial distribution of income quintiles was even across the whole country, then every cell in the table would have a value of 20%. Table 4 indicates that in 1995-96 the south had a high share of the top income quintile (25%), while the center had an even higher share of the lower two income quintiles (33% and 27%) and a very low share of the top quintile (8%). The north had relatively high shares of the top two income quintiles. The key pattern here is that in 1996, the center was clearly worse off than the other two regions.

By 2002, the center had dramatically changed its situation, and in fact registered the highest share in the top quintile (28%). The north's share of top quintile households fell from 22% to 15% over the period. Overall, however, observed regional disparities were lower in 2002 than in 1996. When income transfers (remittances) are included, the south looks slightly better than the center, but the basic pattern does not change.

Table 4. Distribution of Household Earned Income by Quintiles Within Regions of Mozambique in 1996 and 2002

	Quintiles of Total Net HH Income/AE (row percent of HHs in given quintile by region)					
Region	1-low	2	3-mid	4	5-high	Total
1996						
North	17	19	20	23	22	100
Center	33	27	19	12	8	100
South	18	18	21	18	25	100
National	20	20	20	20	20	100
2002						
North	19	21	22	22	15	100
Center	20	18	17	17	28	100
South	22	18	16	18	26	100
National	20	20	20	20	20	100
2002 Including Remittances						
North	21	22	22	21	15	100
Center	19	18	18	18	27	100
South	18	17	17	20	28	100
National	20	20	20	20	20	100

Note: Zambezia province is included in the "north" region

3.3. Changes in Household Size and Composition between 1996 and 2002

Investigating household demographics is important because labor is a key resource for rural households in both farm and non-farm activities. Also, Walker et al. (2004) found that as household size increases, with all other factors held constant, total income increases by a smaller proportion. Consequently, income per person can be expected to decrease if average household size increases or increase if average household size decreases.

Household size decreased in terms of number of household members and AEs between 1995-96 and 2001-02.[5] Table 5 shows the number of household members, household AEs, and age of household head by income quintile. For the country as a whole, the number of members decreased 7% while the number of AEs fell 8%, with the smallest decrease occurring in the highest income quintile. The average age of household heads has also decreased by 2.6 years.

[5] It is important to note that the definition of household membership used in TIA 96 and TIA 02 were very similar.

Table 5. Household Size and Age of Household Head by Quintile of Household Net Income in 1995-96 and 2001-02

Quintiles of Net HH Income/AE	HH Size (no.) 1996	HH Size (no.) 2002	Percent Change 1996-02	HH Size (AE) 1996	HH Size (AE) 2002	Percent Change 1996-02	Age of HH Head (yrs) 1996	Age of HH Head (yrs) 2002
(low) 1	5.8	5.4	-8	4.4	4.0	-3	44.2	43.0
2	5.8	5.2	-12	4.3	3.8	-7	45.5	42.3
(mid) 3	5.4	5.0	-11	4.1	3.7	-7	44.7	41.7
4	5.1	4.6	-8	3.9	3.5	-5	45.3	42.8
(high) 5	4.7	4.7	-1	3.6	3.6	-6	43.1	40.3
Total	5.4	5.0	-8	4.1	3.7	-6	44.6	42.0

The change in household size has not been even geographically. Table 6 shows household size and prime age adult male and female composition by province. Average household size has decreased most in the southern provinces, and in the central provinces of Manica and Tete, and decreased least in the northern provinces. In the southern provinces, the decrease in household size appears to have been driven by a very large decrease in the number of males age 15-59. There are many possible factors underlying the observed change in household size and number of adults over time, such as a faster rate of new household formation, increased out-migration of young adults for wage employment, and the effects of HIV/AIDS on mortality.

Table 6. Household Size and Prime Age Male and Female Composition by Province in 1995-96 and 2001-02

	Household Size (no.)			Males Age 15-59			Females Age 15-59		
	1996	2002	Percent	1996	2002	Percent	1996	2002	Percent
Province	---- Mean ----		Change	---- Mean ----		Change	---- Mean ----		Change
Niassa	5.15	5.29	3	1.13	1.14	1	1.22	1.31	7
C. Delgado	4.47	4.34	-3	1.07	1.03	-4	1.22	1.17	-5
Nampula	4.74	4.44	-7	1.10	1.05	-4	1.12	1.08	-4
Zambezia	5.27	4.81	-9	1.24	1.12	-10	1.34	1.23	-8
Tete	5.77	5.08	-12	1.15	1.02	-11	1.37	1.23	-10
Manica	6.42	5.73	-11	1.36	1.27	-7	1.58	1.41	-11
Sofala	5.85	5.90	1	1.27	1.38	8	1.66	1.58	-5
Inhambane	5.77	5.25	-9	1.33	1.05	-21	1.76	1.56	-11
Gaza	6.96	5.73	-18	1.68	1.34	-20	2.21	1.61	-27
Maputo	6.15	5.46	-11	1.47	1.26	-15	1.80	1.63	-9
National	5.36	4.97	-7	1.23	1.13	-8	1.42	1.29	-9

Labor availability for agriculture is affected not only by changes in demographics, but also the proportion of prime-age adults who consider agriculture to be their primary occupation. Nationwide this proportion declined from 83% in 1996 to 75% in 2002. The decline was greatest in the southern provinces and least in the northern provinces.

Table 7. Percent of Prime Age Adults Reporting Agriculture as Primary Activity by Province in 1996 and 2002

	Percent Adults Age 15-59 with Principal Activity in Agriculture		
Province	1996	2002	Percent Change
Niassa	93	89	-4.9
Cabo Delgado	88	81	-8.4
Nampula	82	82	0.2
Zambezia	87	76	-12.8
Tete	89	85	-5.2
Manica	84	73	-12.2
Sofala	84	71	-15.6
Inhambane	79	66	-16.6
Gaza	73	59	-19.6
Maputo	67	49	-26.4
Total	83	75	-9.4

Another potentially important demographic change for agriculture is the share of households headed by females. Walker et al. (2004) found that while female headed households in general had lower income per person, the effect was much more pronounced if the woman was a widow. Table 8 presents the proportion of households in each income quintile headed by women and headed by widows. There has been a large increase in the proportion of households reporting a woman as the head, from 14% in 1995-96 to 24% in 2001-02. Since the increase in widow heads is much smaller than the increase in female heads, the latter can only partly be explained by increased prime-age adult mortality in Mozambique due to HIV-AIDS.

Table 8. Percent of Female-headed and Widow-headed Households by Income Quintile in 1995-96 and 2001-02

Quintiles of Total Net	Female Head of HH (%)		Widow Head of HH (%)	
HH Income/AE	1996	2002	1996	2002
(low) 1	20.4	34.3	8.9	13.4
2	16.4	27.1	8.3	11.1
(mid) 3	12.2	22.1	5.1	8.2
4	12.2	22.2	6.1	8.6
(high) 5	10.8	15.7	5.4	4.0
Total	14.4	24.3	6.8	9.0

Table 8 also shows that households in the lowest income quintiles had the highest share of female headed households in both years, and the largest increase over time. The share of households headed by widows shows a smaller increase overall, and actually fell among households in the highest quintile of income per AE.

A provincial look at these changes in female headship (Table 9) suggests that both southern and northern provinces are contributing to large changes in the national numbers. Unfortunately, TIA 96 and TIA 02 do not provide sufficient demographic information to confirm whether or not outmigration has increased. In the southern provinces of Inhambane and Gaza, poor agricultural returns in 2000-2002 due to drought conditions could have

provided an incentive for increased male outmigration. But this does not help explain the large increases in female household heads in the northern provinces of Nampula, Cabo Delgado, and Niassa.

Table 9. Percent of Female-headed and Widow-headed Households by Province in 1995-96 and 2001-02

	Female Head of HH (%)		Widow Head of HH (%)	
Province	1996	2002	1996	2002
Niassa	10	33	1	5
C. Delgado	10	23	4	7
Nampula	10	22	2	5
Zambezia	13	20	6	8
Tete	17	27	8	11
Manica	28	21	16	9
Sofala	16	23	12	12
Inhambane	18	29	9	13
Gaza	21	33	12	21
Maputo	30	33	15	16
National	14	24	7	9

Taken together, the results in Tables 8 and 9 indicate that the disadvantaged group of female-headed and widow-headed households is increasing over time. Given the numerical importance of these groups in the population, any broad-based poverty reduction strategy will need to consider specific interventions to help them overcome constraints. Further research is needed to identify the most appropriate interventions, taking into account whether households have reliable access to remittances.

3.4. Changes in Rural Household Assets

Sections 3.1 and 3.2 discussed differences in mean and median household income between 1995-96 and 2001-02, and examined the extent to which different provinces and income strata have seen increases between the two periods. In broad terms, all regions of the country (with the exception of Nampula province) and all income quintiles show some increase in income between the two periods, although income levels remain very low, and extremely low for the poorest quintiles. Since growth in household income enables households to accumulate assets, we would expect to find increases in household asset levels between 1996 and 2002. Both TIA surveys included measures of three types of asset: human capital, which is generally found to be positively associated with productivity and income; ownership of small ruminants, which represent a store of wealth that can be drawn on in time of adversity; and bicycle ownership, which is both a productive asset for trade as well as a consumer capital good (improving access to public and social services).

Human capital and ownership of assets have increased between the two survey periods. Table 10 shows the average number of years of education of household heads, and ownership of goats and bicycles, by income quintile. Average education of household heads increased by 0.3 years overall to 2.2 years, with the biggest increase in the top income quintile. Ownership of goats increased from 20% to 27% of households, with all income quintiles

showing an increase in ownership. The increase in the proportion of the poorest households owning small ruminants was second only to the top income quintile. Bicycle ownership trebled overall, with all income quintiles showing an increase.

Table 10. Household Head Education, and Ownership of Small Ruminants and Bicycles by Income Quintile in 1995-96 and 2001-02

Quintiles of Net HH Income/AE	Education of HH Head (years)		HH Maximum Education (years)		Percent Owning Goat/Sheep		Percent Owning Bicycle	
	1996	2002	1996	2002	1996	2002	1996	2002
(low) 1	1.6	1.8	2.8	3.0	15	23	4	11
2	1.7	1.9	2.9	2.9	19	26	4	18
(mid) 3	1.7	1.9	2.7	2.8	22	26	7	23
4	1.9	2.2	2.8	3.1	20	27	7	30
(high) 5	2.3	3.4	3.1	4.2	22	33	12	33
Total	1.9	2.2	2.9	3.2	20	27	7	23

While the overall level of education is still very low, and the majority of households do not yet have small ruminants or bicycles, there has been measurable improvement across all income strata since 1995-96. The accumulation of assets indicates that the welfare improvement implied by our 1996 and 2002 income estimates reflect more than year-to-year income volatility. We now turn to an in-depth analysis of the sources of changes in household income between the two survey periods.

4. CHANGES IN COMPOSITION OF HOUSEHOLD INCOME BETWEEN 1996 AND 2002

The previous section reviewed changes in the amount of household income geographically and by income strata as measured by the TIA surveys of 1995-96 and 2001-02. Changes in household demographic composition and asset ownership were also reviewed. Growth in household income was positive and regionally balanced, although the majority of rural households remain very poor, and the lowest income strata are extremely poor. In this section we look at what types of economic activity contributed to changes in rural household income between the two surveys. Specifically, we consider the contribution of on-farm (crop and livestock) and off-farm (wage employment and self-employment or micro-small-scale enterprises) activities.

4.1. Changes in Sources of Income for Rural Households 1995-96 and 2001-02

We first look at the proportion of households receiving income from each of the four types of income source and then the share of income contributed by each. Table 11 shows the percentage of households in each income quintile receiving income from crop, livestock, self-employment activities, and wage labor. Among the on-farm activities, almost all households generated income from crop production in both time periods, regardless of income level. The share of households with livestock sales is twice as high overall in 2001-02 compared to 1995-96, with larger increases among the higher income quintiles.

The probability of a household having off-farm income sources increases the higher the income quintile. For wage income, there is a small overall decline between the two TIA survey periods, but with marked differences among income quintiles. The bottom three income quintiles show a sharp drop in the proportion of households with a wage income source, while the top income quintile has a large increase. The share of households with income generated from self-employment or micro-small enterprise (MSE) income shows a modest increase overall between 1995-96 and 2001-02, but the pattern of change among income quintiles is very different from that of wage income. The proportion of households with MSE income in the lowest income quintiles increased while that for the top three income quintiles remained constant; higher income households, however, remained much more likely to be earning MSE income than lower income households.

Table 11. Percent of Households with Given Income Source by Income Quintile in 1995-96 and 2001-02

Quintiles of Net HH	Crop Income		Livestock Sales		Wage Income		MSE Income	
Income/AE	1996	2002	1996	2002	1996	2002	1996	2002
(low) 1	99%	98%	10%	17%	16%	5%	9%	27%
2	100%	100%	14%	26%	17%	8%	22%	36%
(mid) 3	100%	100%	16%	31%	20%	11%	36%	38%
4	100%	99%	15%	34%	26%	21%	49%	48%
(high) 5	100%	98%	15%	34%	25%	37%	61%	61%
Total	100%	99%	14%	28%	21%	17%	35%	42%

Table 12 shows the mean share of total household income (excluding remittances) contributed by crops, livestock, wages, and self-employment in 1995-96 and 2001-02.

Overall, the income share from crop production dropped between the two periods, but remains by far the most important share, contributing more than 80% of income for the poorest 60% of households (the bottom three quintiles). The share of income from livestock sales remains very small (3%) with little variation among income quintiles.[6] The wage income share increased to 9% overall, but almost all of the increase was in the top two income quintiles. Income from self-employment increased its overall share slightly to 15%, with all the increase in the top and bottom quintiles. In section 4.2 we will examine how the types of self-employment income that a household participates in vary over the income quintiles.

Table 12. Mean Household Shares of Total Gross Household Income by Income Source by Income Quintile in 1995-96 and 2001-02

Quintiles of Net HH Income/AE	Gross Crop Income (%)		Livestock Sales Value (%)		Wage Income (%)		Net MSE Income (%)	
	1996	2002	1996	2002	1996	2002	1996	2002
(low) 1	93	86	2	3	3	2	3	8
2	88	85	2	3	1	2	9	10
(mid) 3	81	81	1	3	2	5	16	12
4	79	70	1	3	2	11	17	16
(high) 5	76	45	1	2	2	25	21	27
Total	83	73	1	3	2	9	13	15

Table 13 shows the change in net household income per AE between 1996 and 2002, and the percent contribution of each activity to this total change. For the poorest 60% of households (quintiles 1-3), crop income contributed between 77% and 80% of the total increase in mean income. For the top income quintile, by contrast, crop income fell while income from wage employment and MSE activities increased dramatically.[7]

Table 13. Percent Change in Household Income by Income Source by Income Quintile in 1995-96 and 2001-02

Quintiles of Net HH Income/AE	Change in Mean Total Net HH Income/AE (2002 contos)	Percent of Change in Mean Total Income Coming from Each Source			
		Net Crop Income	Livestock Sales	Wage Income	Net MSE Income
(low) 1	83	78	5	-3	21
2	141	77	6	5	12
(mid) 3	205	80	8	14	-1
4	431	39	9	38	13
(high) 5	2,362	-8	4	55	49
Total	644	10	5	47	39

[6] Additional analysis of TIA data indicate that one reason for the small share of household income from livestock sales is the high level of losses due to theft and disease (T. Walker, personal communication, March 2006).

[7] Part of the reason for the large apparent increase in wage and MSE income in the top income quintiles is very likely due to better recording of these income sources in TIA 02 compared to TIA 96.

A key conclusion from the analysis presented in this section is that, in the near term at least, increases in crop income are essential for pro-poor growth. Since the majority of households are net food buyers (Tschirley, Abdula, and Weber 2006), it is very important that increases in crop income are driven by increases in crop productivity (yield per unit of area) rather than by increases in price due to local or regional scarcity. Indeed, reducing the proportion of households who are net food buyers may be a pre-condition for poor rural households to be able to invest labor and capital in off-farm activities.

4.2. Changes in Income from Off-farm Enterprises 1995-96 and 2001-02

As shown in Table 11, participation in MSE activities increased at the national level for the lowest two income quintiles from 1996 to 2002 (from 9% to 27% for the lowest income quintile and 22% to 36% for the second-lowest income quintile), while participation for other quintiles remained about the same. While rural household income diversification into non-farm activities is generally considered positive for households, it is important to keep in mind that MSE encompasses a wide range of activities which vary greatly in barriers to entry, returns, sustainability, and linkage to the local economy (Barrett et al. 2005). For example, Natural Resource Extraction (NRE)-based MSE activities, such as cutting firewood and producing charcoal, typically have low capital entry barriers–good for the poor–yet are unsustainable in the longer-term without much more careful management, and typically deliver low returns. In this section, we focus on the provinces where a detailed MSE module was implemented in 1996 (Nampula, Zambêzia, Sofala, and Manica), with the objective of examining more carefully the types of MSE activities that households are engaged.[8]

The national pattern of increased MSE participation in the bottom two income quintiles and little change in participation in the top three quintiles is repeated in our four province sub-sample. Disaggregating MSE activities into NRE-based activities and other activities provide additional insights (Table 14). All income quintiles reported an increase in participation in NRE-based activities. For non-NRE-based activities, only the bottom two income quintiles increased participation whereas the top three income quintiles held constant or slightly reduced participation.

Table 14. Frequency of Household Participation in NRE and Non-NRE Enterprises by Income Quintile in 1995-96 and 2001-02

Quintiles of Total Net HH Income/AE	Any MSE Activity (%) 1996	(%) 2002	NRE-based MSE (%) 1996	(%) 2002	Other MSE (%) 1996	(%) 2002
(low) 1	16	30	2	11	14	23
2	24	36	4	11	21	29
(mid) 3	36	31	6	9	32	27
4	44	45	8	14	38	38
(high) 5	60	58	10	18	52	51
Total	36	40	6	13	31	33

Note: Nampula, Zambezia, Sofala, and Manica provinces only

[8] Except for the four provinces indicated, TIA 96 does not provide enough information to disaggregate MSE participation and returns by activity types such as those involving NRE.

Information on mean and median earnings from NRE and non-NRE activities by income quintile is presented in Table 15. The top three income quintiles report healthy increases in mean and median incomes from both NRE and non-NRE activities. For non-NRE activities, mean income growth was especially high for the top income quintile, while for NRE-based activities, median earnings show large increases for the top three income quintiles. The fact that the top three income quintiles increased their participation in NRE-based MSEs, but not other types of MSE, suggests that there may be greater barriers to entry to non-NRE activities. While further disaggregation of MSE activities is warranted to understand better the trends in participation and returns by activity type, it is apparent that returns to MSE activities have increased since 1996 for most quintiles, though the increases tend to be much smaller for the lower income quintile households.

Table 15. Mean and Median Household Earnings from NRE and Non-NRE Enterprises by Income Quintile in 1995-96 and 2001-02

Quintiles of Total Net HH Income/AE	NRE MSE Earnings/AE (contos)						Other MSE Earnings/AE (contos)						Percent Change 1996-2002			
	1996			2002			1996			2002			NRE		Other	
	% HHs	Mean	Median	% HHs	Mean	Median	% HHs	Mean	Median	% HHs	Mean	Median	Mean Earning/ AE	Median Earning/ AE	Mean Earning/ AE	Median Earning/ AE
(low) 1	2	67	43	11	64	45	14	48	28	23	64	42	-5	5	33	52
2	4	108	101	11	130	85	21	92	68	29	70	83	21	-16	-24	22
(mid) 3	6	142	70	9	263	260	32	184	105	27	222	167	86	270	21	59
4	8	179	58	14	342	197	38	270	134	38	395	225	91	238	46	68
(high) 5	10	1,175	178	18	1,332	722	52	1,002	490	51	1,884	945	13	306	88	93
Total	6	489	89	13	538	152	31	452	124	33	719	167	10	70	59	34

4.3. Changes in Crop Income 1995-96 and 2001-02

Crop income, including production retained for household consumption or seed, is the single most important income source for all income quintiles among rural households. It provides more than 80% of total household income for the poorest 60% of households. Increases in crop income clearly meet at least one dimension of pro-poor growth, namely to be broad-based. In this section we look more closely at the composition of crop income growth. We first examine changes in crop mix and the contribution of different crop groups to changes in crop income between 1995-96 and 2001-02, and then look more closely at crop production in the two survey periods.

4.3.1. Diversification of Crop Production

Crop production appears considerably more diversified in 2001-02 compared to 1995-96. Table 16 shows that the mean number of crops grown per household increased from less than five crops in 1995-96 to almost eight crops in 2001-02, and the number of crops grown by households in the poorest income quintile doubled. Higher income households typically grow more crops of all types than lower income households. Among the different types of crops shown in Table 16, food crops are the most numerous, followed by tree crops and horticultural crops (sugar cane is grouped with tree crops because it is a perennial). Cash crops remain the least frequently grown, with only one household in five growing at least one cash crop. Households in the top two income quintiles are three times more likely to have a cash crop than households with the lowest incomes.

Table 16. Number of Crops Grown by Type of Crop and Income Quintile in 1995-96 and 2001-02

Quintiles of Total Net HH Income/AE	All Crops		Food Crops		Field Cash Crops		Perennial Crops		Horticulture	
	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002
(low) 1	3.0	6.1	2.2	2.9	0.0	0.1	0.6	1.9	0.1	1.3
2	4.2	7.4	3.0	3.8	0.0	0.2	0.9	2.1	0.2	1.4
(mid) 3	4.7	7.9	3.3	4.2	0.1	0.2	1.1	2.1	0.3	1.4
4	5.2	8.8	3.6	4.4	0.1	0.3	1.3	2.3	0.3	1.8
(high) 5	5.7	9.2	3.9	4.2	0.2	0.3	1.4	2.5	0.3	2.2
Total	4.6	7.9	3.2	3.9	0.1	0.2	1.1	2.1	0.2	1.6

Notes: Food Crops: cereals, pulses, roots and tubers
Field Cash Crops: cotton, tobacco, sisal, tea, soybeans, paprika, sunflower, sesame
Perennial Crops: fruit trees, cashew, cocoa, sugar cane

Part of the apparent increase in crop diversification may be the result of improvements in the TIA questionnaire and training. The horticulture and perennial crop categories, with the largest increases in the number of crops cultivated between the two survey periods, are an example. The TIA 02 questionnaire included greater specificity for these crop categories and hence at least part of the observed increase may have been due to under-counting of these crop types in TIA 96. The increase in the number of food crops grown is much less likely to have been affected by under-counting.

Looking within the food crop group, Table 17 shows that the largest increase in number of crops grown is observed within the pulses group (beans and groundnuts), followed by roots and tubers (cassava, sweet potato, and Irish potato). Overall, the mean number of crop groups grown by a given household increased from three to four between the two time periods. The observed diversification in cropping patterns provides a foundation for potential improvements in dietary quality.

Table 17. Total Number of Food Crops Grown by Income Quintile in 1995-96 and 2001-02

Quintiles of Total Net HH Income/AE	Cereals		Pulses		Roots and Tubers		Crop Categories	
	1996	2002	1996	2002	1996	2002	1996	2002
(low) 1	1.3	1.2	0.5	1.0	0.4	0.8	2.1	3.2
2	1.5	1.4	0.9	1.4	0.6	1.0	2.7	3.8
(mid) 3	1.4	1.6	1.1	1.6	0.7	1.1	3.0	4.0
4	1.5	1.7	1.2	1.6	0.9	1.1	3.3	4.1
(high) 5	1.4	1.5	1.4	1.6	1.0	1.1	3.5	4.1
Total	1.4	1.5	1.0	1.4	0.7	1.0	2.9	3.8

4.3.2. Increases in Crop Income Are Pro-Poor

Table 18 shows the mean value of net crop income per AE in 1995-96 and 2001-02 by household income quintile. The left column in the table reports the sum of net crop income for all crops in each survey period, while the other columns show the contribution and change for specific crops groups. Across all households, net crop income per AE from all crops was only 8% higher in 2001-02 compared to the earlier period. But this change in average net crop income for the whole population hides important differences among income quintiles. Households in the three lower income quintiles had increases in total net crop income ranging from 31% to 55%, whereas households in the highest income quintile reported a 10% lower net crop income in 2001-02 compared to 1995-96. The poorest households also show increases in crop income from all crop groups, especially cereals, roots and tubers, and pulses. The highest income households saw increases in crop income from cash crops, horticultural crops, and cereals, but decreases in the value of tree crops, fruit sales, pulses, and roots and tubers.

Table 18. Net Crop Income and Income from Different Crop Groups per AE, in 1995-96 and 2001-02, by Household Income Quintile

Quintiles of Total Net HH Income/AE	Total Net Crop Income/AE			Cereal Income/AE			Pulse Income/AE			Root/Tuber Income/AE		
	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change
(low) 1	118	182	55	79	82	4	15	26	73	42	80	91
2	328	437	33	136	161	19	39	60	56	137	170	24
(mid) 3	538	702	31	182	246	35	69	99	45	243	274	13
4	886	1,055	19	230	371	61	117	132	13	444	424	-4
(high) 5	1,998	1,806	-10	465	671	44	314	201	-36	811	654	-19
Total	773	836	8	218	306	40	111	104	-6	335	320	-4

Quintiles of Total Net HH Income/AE	Coconut/Cashew Income/AE			Cash Crop Income/AE			Horticulture Sales Value/AE			Fruit Sales Value/AE		
	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change
(low) 1	6	14	118	1	3	477	0	4	1271	1	3	93
2	17	26	57	3	17	456	2	5	212	4	7	86
(mid) 3	33	35	7	11	46	317	4	10	185	10	9	-18
4	72	59	-18	18	60	243	8	17	120	18	21	21
(high) 5	183	79	-57	164	210	28	15	102	572	77	41	-46
Total	62	43	-31	39	67	72	6	28	384	22	16	-27

Note: Crop income for a given crop group is the average across all households in the sample, including those households that may not have grown a particular crop group.

4.4. What Caused Changes in Crop Income?

Previous sections have shown that income growth from 1996 to 2002 for the majority of rural Mozambican households has been driven largely by increasing food crop income, while growth for the wealthiest 20% of rural households was led by rapid increases in income from wages and MSE activities. Because of the dominant role of food crop income in pro-poor growth, we need to understand the underlying factors. Changes in crop income can come from changes in crop production, changes in crop prices, or some combination of both changes in production and prices. In this section we investigate trends in crop production and prices to better understand the contribution of each to observed changes in crop income.

4.4.1. What Happened to Crop Production?

Changes in crop production can be caused by a change in the resources or level of effort devoted by rural households to crop production, or by changes in the productivity of those resources (generally associated with improved or more effective use of crop production technology), or by stochastic factors such as weather and pest incidence. Although two years of data are never enough to draw conclusions about production trends, and the TIA data in any case provide a partial indication of productivity (because labor allocation to crop production is not measured directly), it is possible to make an informed judgment about whether the trends are likely to be positive, negative, or constant.

Discerning the underlying trends in crop production and productivity is complicated by poor rainfall in 2001-02 as compared to 1995-96. To sort out the underlying trends, we do three things. First, we include data from TIA 03 (the 2002-03 growing season) to provide an additional annual data point in the analysis. Second, we quantify the quality of the rainfall season in all three years using a simple water balance model. Third, we examine crop production per hectare and per household AE. On the basis of this detailed analysis, we are able to advance tentative conclusions regarding trends in agricultural production in Mozambique.

Changes in Aggregate Crop Production: In 2001-02, aggregate production of many food crops declined or was either lower or similar in magnitude to that achieved in 1995-96. Table 19 provides aggregate crop production estimates from TIA in each of the two periods, as well as 2002-03. As compared with 1995-96, aggregate maize production rose slightly, by 3% in 2001-02 and 9% in 2002-03. Aggregate sorghum and millet production was much lower in 2001-02 and 2002-03. Rice production was 8% lower in 2001-02, but rebounded to levels 15% higher in 2002-03 compared with 1995-96. Total cereal production as measured by TIA was 7% lower in 2001-02 compared to 1995-96, and only 3% higher in 2002-03.

Table 19. Household Participation and Estimated National Production of Principal Crops Based on TIA (1995-96, 2001-02, and 2002-03)

	1995-96		2001-02		2002-03		% Change in Production		
Crop	% HHs Growing	Production ('000 tons)	% HHs Growing	Production ('000 tons)	% HHs Growing	Production ('000 tons)	1996-02	1996-03	2002-03
Maize	78	1,080	77	1,111	76	1,178	3	9	6
Rice	24	101	30	93	24	117	-8	15	25
Sorghum	34	243	33	138	33	191	-43	-21	38
Millet	6	35	7	12	5	22	-65	-37	78
All grains	89	1,458	88	1,354	86	1,507	-7	3	11
Groundnuts	41	132	47	102	42	87	-23	-34	-14
Cowpea	30	81	44	54	46	64	-34	-22	18
Sweet beans	4	19	9	35	10	41	91	120	15
Other beans	20	55	35	54	22	61	-1	12	12
All pulses	64	286	73	245	71	253	-14	-12	3
All beans	47	154	62	143	58	165	-7	7	15
Cotton	5	30	7	103	5	75	242	149	-27
Tobacco	2	11	3	43	3	51	290	368	20
Cashew	29	109	29	61	27	44	-44	-60	-28

As compared to 1995-96, production levels of the most widely cultivated legumes–groundnuts and cowpeas–were markedly lower in 2001-02 and 2002-03. Only sweet beans (*feijão manteiga*) showed a big increase. This is likely a response to strong market demand, given that production of this bean has for many years been more commercially oriented than that of other beans, and its production is concentrated in mid-altitude areas of Tete and Niassa, with market opportunities in Malawi as well as Mozambique. The general decline in aggregate legume production is more troubling considering that a higher proportion of households participated in pulse production in 2001-02 and 2002-03 as compared with 1995-96.

Tobacco and cotton showed large aggregate production increases compared to 1995-96. Cashew production was lower in both 2001-02 and 2002-03 compared to 1995-96. Changes in cassava and sweet potato production are not considered here because the TIA 96 instrument likely undercounted production of these crops in 1995-96, making comparison across years misleading.

Mozambique's Early Warning Unit (*Aviso Prévio)* also publishes production forecasts, based on a different method.[9] In contrast with TIA, *Aviso Prévio* (AP) estimates for 1995-96, 2001-02, and 2002-03 show a strong positive trend in cereal and pulse production (Table 20). These large differences between the Ministry of Agriculture's two sources of agricultural production estimates are a point of concern. To help resolve these differences, we now turn to an analysis of rainfall in the relevant crop years.

[9] One key difference is that *Avisio Prévio* uses "crop cuts" in a sample of farmers' fields to forecast crop production whereas TIA uses farmers' own estimates of crop production. Both methods have advantages and disadvantages that need to be evaluated in the context of the survey objectives and overall methodology (including sampling).

Table 20. Household Participation and Estimated National Production of Principal Crops Based on TIA and *Avisio Prévio* (1995-96, 2001-02, and 2002-03)

	1995-96			2001-02			2002-03						
	% TIA HHs	Production ('000 tons)		% TIA HHs	Production ('000 tons)		% TIA HHs	Production ('000 tons)		% Change Production 96-02		% Change Production 96-03	
Crop	Growing	TIA	*AP*	Growing	TIA	*AP*	Growing	TIA	*AP*	TIA	*AP*	TIA	*AP*
Maize	78	1,080	917	77	1,111	1,194	76	1,178	1,198	3	30	9	31
Rice	24	101	132	30	93	161	24	117	194	-8	22	15	47
Sorghum	34	243	249	33	138	314	33	191	314	-43	26	-21	26
Millet	6	35	42	7	12	50	5	22	48	-65	19	-37	15
All grains	89	1,458	1,339	88	1,354	1,718	86	1,507	1,753	-7	28	3	31
All pulses	47	154	139	62	143	174	58	165	176	-7	25	7	27

Table 21. Changes in Recorded Rainfall by Station and by Calendar Quarter

		Changes in Rainfall 1996-02					**Changes in Rainfall 1996-03**				
Station	Province	pQ4* (%)	Q1 (%)	Q2 (%)	pQ4+Q1+Q2 (%)	Q1+Q2 (%)	pQ4* (%)	Q1 (%)	(%) Q2	pQ4+Q1+Q2 (%)	Q1+Q2 (%)
Changalane		46	-61	-9	3	-45	-62	-45	-40	-53	-44
Pemba	C.Delgado	35	-35	16	-23	-29	81	18	35	26	20
Lichinga	Niassa		54	-49		35		46	-80	54	23
Nampula	Nampula	-7	37	36	31	37	126	83	-63	63	52
Quelimane	Zambezia	-47	-35	-40	-38	-36	-58	-3	6	-12	-1
Beira	Sofala	12	-57	32	-30	-41	33	2	-4	7	0
Tete	Tete		-44	-69		-46	-26	38	-83	-1	25
Chimoio	Manica	29	-59	-37	-32	-55	-31	-45	-46	-41	-45
Inhambane	Inhambane	177	-70	-73	-20	-71	13	-28	138	15	16
Xai Xai	Inhambane	45	-69	-29	-29	-50	-33	-37	5	-20	-17
Maputo	Maputo	89	-57	-91	-20	-64	-58	-73	-24	-61	-63

Rainfall Quality for Crop Production Over Time: Rainfall in 2001-02 during the crucial first quarter was more than a third lower than 1995-96 in eight out of ten provincial reporting stations; in 2002-03, rainfall was lower in three out of eight provinces compared to 1995-96 (Table 21). Using the same monthly data and a simple water balance model (see Appendix D for more detail on the model and data), we compute runoff, days of drought, and overall rainfall quality indices by region for the January-April period for each year from 1995 to 2003. These results are presented in Table 22, with the Runoff Index in the top left, Days of Drought in the bottom left, overall Rainfall Quality Index (RQI) in the top right, and the ranking of the years on the basis of the RQI in the bottom right. Results show that first quarter rainfall was considerably better in 1995-96 as compared to 2001-02 and 2002-03 in the north and south, while the center had slightly better conditions in 2001-02. The main problem the north in 2001-02 and 2002-03 was excessive runoff, while drought was the main problem for the south; the region had 46 days of drought in 2001-02, compared to 4 days in 1995-96. When drought and runoff are combined into a simple index measuring, the overall quality of the rainfall regime, and when each year from 1995 to 2003 is ranked on the basis of this index, we find that 2001-02 in the south was 32nd out of 45 years (1 is best, 45 worst), while the north was 42nd out of 45. Rainfall in the center in 2001-02 was relatively good, ranking 11th out of 45.

Table 22. Runoff, Drought, and Rainfall Quality Indices by Region, 1996, 2002, 2003

Runoff Index (January-April), 1995-2003				**Rainfall Quality Index (January-April), 1995-2003**			
Year	North	Center	South	Year	North	Center	South
1995	0.0	0.0	0.0	1995	56.7	56.7	10.7
1996	0.0	13.9	0.0	**1996**	57.4	53.2	54.9
2001	0.0	28.4	0.0	2001	56.2	48.9	43.9
2002	30.7	0.0	0.0	**2002**	44.2	57.4	26.0
2003	42.5	22.2	0.0	**2003**	44.8	43.3	30.1
mean	4.4	8.4	1.9	mean	53.9	52.3	37.1
min	0.0	0.0	0.0	min	40.7	34.6	0.0
max	50.1	41.1	31.0	max	57.4	57.4	57.4

Days of Drought (January-April), 1995-2003				**Quality Index Rank Out of 45 years (1995-2003)**			
Year	North	Center	South	Year	North	Center	South
1995	0.0	0.7	55.1	1995	19	14	41
1996	0.0	0.0	3.7	**1996**	**12**	**26**	**10**
2001	0.0	0.0	18.9	2001	23	32	22
2002	5.5	0.0	46.3	**2002**	**42**	**11**	**32**
2003	0.0	7.1	38.8	**2003**	**43**	**42**	**28**
mean	3.1	2.4	23.1	Index = drought days*7 + runoff index*3			
min	0.0	0.0	0.0	Quality Index = 57.41 – index			
max	23.3	21.9	82.7				

Overall, the pattern of crop production over time estimated by TIA appears more consistent with the rainfall quality data than that estimated by AP.

Household Crop Production per Hectare: Crop productivity is typically measured by output produced (kg) per area cultivated to the crop (hectare) or output produced per labor unit applied. The former is more commonly reported, perhaps because measuring area cultivated

is much less time-intensive than recording labor applied. Because there are important differences in the methods used in the TIA 96 and TIA 02/TIA 03 instruments to measure crop-specific area of intercrops within a given farmer's field, our analysis is restricted to monocropped fields of maize and rice (the only cereal crops with a large proportion of monocropped fields). We find that median household monocrop maize yields were 16% lower in 2001-02 compared to 1995-96, while median yields of monocrop rice were 19% lower. Again, this is consistent with the rainfall quality analysis presented in the preceding section.

Household Crop Production Per Adult Equivalent: Without accurate information on the level of effort devoted to agriculture, a household's labor force as measured by AE is too crude a proxy for deriving an accurate measure of labor productivity in agriculture. Nevertheless, from a poverty perspective, increases in crop production per AE (other things being equal) translate into more produce available for sale or less needing to be purchased in the market. The opposite is true for declines in crop production per AE–less is available for sale or more needs to be purchased from the market. Table 23 presents results on median household crop production per AE based on TIA data in 1995-96, 2001-02 and 2002-03.

With the exception of sweet beans (*feijão manteiga*), median production per AE for all major food crops declined from 1995-96 to 2001-02 and 2002-03 (although 2002-03 appears to have been a slightly better year than 2001-02). Tobacco and cotton production per AE show strong increases, with Tete and Sofala being the main geographical locus of production increases.

As compared with 1995-96, median household maize production per AE was 15% lower in 2001-02 (consistent with the 16% fall in median household monocrop maize yields reported in the previous section). Median household rice production per AE was 38% lower between the two survey periods, a considerably larger decline than the observed decline in monocrop rice yields (19% decline). This inconsistency is most likely explained by increased household participation in rice production–new rice producing households have less experience with the crop than longer-term producers, and newcomers may well have poorer soil and production conditions.

Except for sweet beans (*feijão manteiga*), median household production of pulses per AE was significantly lower in 2001-02 compared to 1995-96. Recall that earlier we showed declines in aggregate production for most pulses, even in the face of increased household participation. The exception is sweet beans, for which increases in median production per AE were driven by positive results in Niassa, where better rainfall in 2002 compared to 1996 helped to double production, while Tete showed a 50% increase.

Table 23. Median Household Crop Production per AE for Producing Households (1995-96, 2001-02, and 2002-03)

	TIA 1996		TIA 2002		TIA 2003		% Change Median Production/AE	
Crop	% HH Growing	Median Production (kg/AE)	% HH Growing	Median Production (kg/AE)	% HH Growing	Median Production (kg/AE)	1996-02	1996-03
Maize	78	79.3	77	67.8	80	68.5	-15	-14
Rice	24	23.8	30	14.7	26	22.1	-38	-7
Sorghum	35	42.8	33	20.5		25.4	-52	-41
All cereals	90	112.8	92	88.5	90	96.2	-22	-15
Groundnuts	41	18.7	47	8.6	46	9.4	-54	-50
Cowpeas	33	11.0	44	5.6	53	6.0	-49	-45
Sweet beans	5	14.6	9	15.8		17.8	8	22
Other beans	23	16.0	35	7.7		10.5	-52	-34
All pulses	65	29.5	82	19.1	77	18.9	-35	-36
Cotton	5	37.5	7	95.9	5	83.7	156	123
Tobacco	2	14.5	3	31.3	3	61.7	116	327
Cashew	29	18.0	29	8.3	27	7.5	-54	-58

Geographically, declines for food crops other than sweet beans (*feijão manteiga*) were widespread. In the case of maize, for example, only Niassa showed substantial increases in median maize production per AE; Zambêzia showed a small increase, while all other provinces showed declines. Production per AE of rice, sorghum, groundnuts, cowpeas, and pigeonpeas declined in every province.

Changes in Input Use: The main constraint to increased crop productivity is limited access to and use of improved crop production technology (Walker et al. 2004). Table 24 presents information on the use of agricultural inputs in the two survey periods. Use of inorganic fertilizer, manure, and irrigation increased between 1995-96 and 2001-02 but, at just 4%, 6%, and 11%, respectively, use remains at very low levels relative to other countries. Even in the top income quintile, less than 10% of households used fertilizer in 2001-02. Much of the fertilizer use is associated with tobacco: only 2.6% of non-tobacco growers used fertilizer compared to 32% of tobacco growers. Outside the main tobacco growing areas of Tete and Niassa, only 2.3% of households used inorganic fertilizer compared to 12% within these two provinces.

Access to improved seed is also very limited. For 2001-02, Massingue et al. (2004) estimate that production of improved seed by commercial companies was sufficient to plant only 6% of the total cultivated area, and that 80% of this seed was distributed through relief channels. With minimal levels of use of improved seed and related agricultural inputs, there is no reason to expect increases in crop production per AE.

Table 24. Households Using Agricultural Inputs in 1995-96 and 2001-02 by Household Income Quintile

Quintiles of Net HH Income/AE	Animal Traction (%)		Inorganic Fertilizer (%)		Organic Fertilizer (%)		Irrigation (%)		Hires Labor (%)	
	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002
(low) 1	4	11	0	2	2	5	3	8	12	8
2	5	8	1	2	3	5	3	8	12	9
(mid) 3	8	8	1	3	5	5	4	9	18	14
4	7	10	1	4	3	6	4	11	24	16
(high) 5	9	18	3	9	3	10	5	18	28	36
Total	7	11	1	4	3	6	4	11	19	16

The proportion of households hiring wage labor decreased in all but the top income quintile. This change is consistent with a poor agricultural year in which many households knew they would not have sufficient income or production with which to remunerate their workers. Seasonal agricultural labor typically earns very low wages, and is often part of a survival strategy for poor households rather than a profitable destination for their labor resources. For those households who needed such labor opportunities as part of their coping strategies, the decline in hiring was certainly a negative factor in 2001-02.

Looking at services that complement agricultural input use, only 3% of households indicated that they had access to credit in 2001-02, while 13% had received advice from a government or NGO extension agent. On a more positive note, 47% of households interviewed for the 2001-02 TIA had received some form of information regarding crop prices; two-thirds of the households received this information via radio. Access to market information was highest (67%) in Nampula province, where a provincial agricultural market information system (*Esisapo*) has received technical support from SIMA and broadcasts price and market information on the local *Radio Moçambique* channel.

Why Has Median Food Production Per Adult Equivalent Decreased?: Adverse rainfall conditions in 2001-02 (in the north and south) clearly had a negative effect on production, especially when compared to 1995-96, which was a good rainfall year. Beyond this, we examine several additional factors that might help explain lower observed production per AE relative to TIA 96. First, increased crop diversification could contribute to lower production per AE of specific cereals and pulses if more crops were produced on the same or similar cultivated area. For example, if a household grows more types of pulses than before, then production of one particular pulse might fall while total household pulse production might increase (or remain constant). To test whether this effect may have been important, we grouped all cereals together into one group, and all pulses into another group, and analyzed median household production. We find that relative to TIA 96, household cereal production per AE was 22% lower in 2001-02 and 15% lower in 2002-03, and pulse production per AE was 35% and 36% lower for the same years. Diversification within these crop groups clearly does not explain falling production per AE for all cereals and pulses combined.

Second, household diversification into non-farm activities could imply less effort per household member in crop production, or reflect a lack of success in crop production. To test this hypothesis, we grouped households in 1996 and 2002 into quartiles of the share of non-farm income in total income, and compared mean production per AE of individual food crops and crop groups for each quartile across the time period. No evidence was found to support

the hypothesis that household groups with higher shares of non-farm income experience larger production decreases over time.[10]

Third, the growth from 1996 to 2002 in the number of households and the decline in household size and in the age of the household head both imply that household formation is occurring more rapidly in the period between 1995-96 and 2001-02 than previously (perhaps due to general improvements in economic conditions, as implied by TIA and IAF results on asset holdings). These new households may be led by less experienced farmers who are cultivating potentially marginal areas which have recently opened up. We do not have the data to test this possibility in a rigorous fashion.

Fourth, because TIA 96 and TIA 02 did not sample the same districts, the populations being compared in the two samples may not be the same.[11] To control for this potential effect, we redid the crop production per AE analysis using only districts which were sampled in both TIA 96 and TIA 02. This approach generated a very similar pattern of results to the full TIA 02 sample.[12]

Finally, one must ask whether there was any *a priori* reason to expect land or labor productivity in Mozambique to show strong positive trends over the 1996-2002 period? Such trends could be driven by a combination of higher and better quality labor input into agriculture, and higher and better quality use of external inputs, including improved seed. The quantity and quality of labor input in agriculture during the civil war was clearly compromised by insecurity in many areas of the country. This insecurity lasted until the very end of the war in October 1992, but then diminished quite rapidly. By the beginning of the 1995-96 growing season–three years after the end of the war–it is likely that continuing fears of insecurity would have largely ended. We thus find little reason to believe that households during that growing season would have been restricted in the quantity and quality of labor they applied to their fields, and thus little reason to expect labor input to have improved substantially from 1996 to 2002.

We have already shown in the previous section that external input use remains exceptionally low in Mozambique. Although fertilizer has increased since 1996, the increase has been confined primarily to one crop (tobacco) and two provinces (Tete and Niassza), and even in those provinces it is used by too few farmers to make a substantial difference in overall productivity levels. One well-documented consequence of continuous land cultivation by established households, combined with limited or no fertilizer and manure application, is declining soil fertility and increasing weed pressure. On balance, then, we suggest that there is little reason to have expected broad-based and substantial improvements in the productivity of land or labor in rural Mozambique during the period of our discussion, and some reason to expect stagnant or even declining productivity in some areas.

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[10] This comparison is approximate considering that we cannot track the same households over time. A household might have fallen in one non-farm income share quartile in 1996 but a different one in 2002.

[11] Each sample was designed to be representative of the entire population of the country, but each has its own sampling error which could affect results. Also, the TIA 96 sample was based on population projections from the population census undertaken in the mid-1980s. Such projections may not have been reliable in all areas of the country given the amount of population movement that had occurred in the interim.

[12] Of 60 districts covered by TIA 96, 45 match with TIA 02 districts (TIA 02 covered 80 districts in its sample). Thus, this approach excludes about 25% to 30% of households in 1996, and about 45% in 2002. The TIA 96 districts which did not match with TIA 02 districts (and which were excluded) were fairly evenly distributed across the provinces.

4.4.2. What Happened to Crop Prices?

How can declines in median household production of major food crops from 1995-96 to 2001-02 be consistent with findings of improved household expenditures (IAF), improved incomes (TIA) and assets (IAF and TIA) during the same time period? The answer is that declines in median crop production per AE and per hectare need not result in lower crop incomes if crop prices increase enough to offset declines in production.

In fact, real producer (farmgate) prices of some food crops, as reported in the TIA surveys, increased enough from 1995-96-2001-02 to more than compensate for production decreases resulting in an increase in the median *value* of production per AE. Table 25 presents information on changes in crop prices, median household crop production, and median value of household crop production between 1995-96 and each of the two TIA surveys. In the case of maize, rice, and sweet beans, large increases in real crops prices were more than enough to offset lower median production and generate increases in value of production per AE. TIA 02 and TIA 03 data generate similar patterns in price, production, and value changes for different crops.

Table 25. Changes in Median Real Crop Price, and Median Household Quantity and Value of Production of Principal Crops, 1995-96 to 2001-02 and 1995-96 to 2002-03

	% Change in National HH Median Values from 1996-2002			% Change in National HH Median Values from 1996-2003		
Crop	Price/kg	Production/AE	Value of Production/AE	Price/kg	Production/AE	Value of Production/AE
Maize	81	-15	40	68	-14	45
Rice	320	-38	116	205	-7	181
Sorghum	59	-52	-18	64	-41	-1
Groundnuts	58	-54	-22	79	-50	-22
Common beans	43	8	42	71	22	102
Cowpeas	12	-49	-32	51	-45	-10
Other pulses	53	-52	-43	85	-34	-4
Cotton	-56	156	19	-51	123	24
Tobacco	-48	116	19	-62	327	115
Cashew	-10	-54	-55	5	-58	-53

However, it must be noted that higher crop income due to price increases does not necessarily mean improved welfare. Because the majority of rural Mozambican households are either net buyers of cereals, beans, and oilseeds or neither buy or sell (Tschirley, Abdula, and Weber 2006), higher market prices do not necessarily compensate these households for production declines; actual welfare may be lower than implied by their crop income, as defined here.[13]

Because we used IAF inflators to convert 1996 TIA nominal prices to real (2002) values, the result that real TIA farmgate prices increase from 1996 to 2002 (Table 25) implies that these

[13] In fact, net buyers of a commodity will tend to be worse off than implied by our method of valuing crop production using farmgate sale prices. This is because in the event of production decline accompanied by higher farmgate (and retail) prices, net buyers will face an even higher margin between producer and retail prices in the lean season, when they will likely be forced to purchase the commodity after consuming all of their home production.

prices rise faster than the IAF food prices used to construct their inflators. To check this unexpected result, we compare IAF and SIMA (retail) commodity prices with those from TIA, applying the IAF inflators to nominal third quarter 1996 IAF and SIMA prices (the third quarter of the year is when most sales would take place). Results in Table 26 show that, overall, both IAF and SIMA data broadly support the finding in TIA that real commodity prices increased substantially from 1996 to 2002.

Table 26. Percent Change in Real Median Prices from 1996-2002 (Third Quarter) in IAF, TIA, and SIMA Data

	% Change Real Median Price 1996-02						
	IAF (Rural Retail)			SIMA (Rural Retail)		SIMA (Urban and Rural Retail)	
Commodity	Quarter 3	Annual	TIA (Farmgate Sale Price)	Quarter 3	Annual	Quarter 3	Annual
Maize flour	59	72		39	37	38	49
Maize grain	20	36	74	96	101	90	91
Rice	10	7	320	-6	-11	-14	-19
Groundnut	104	178	59	-10	-29	-4	-10
Cowpea	66	61	12	20	37	13	29
Cassava flour	-17	-5				-4	28
Cassava			-38				

Specific results emerging from the comparison presented in Table 26 include:

- Real maize prices increased significantly in all three price series, especially for maize meal.
- National median rice prices increased slightly in IAF, fell moderately in SIMA, and rose dramatically in TIA. This latter result is explained by several factors. First, the provinces with the most TIA rice producers (Cabo Delgado, Zambezia, Sofala, Nampula) also showed considerable retail price increases in IAF and SIMA, with the exception of IAF prices in Nampula. Second, only 3.4% of TIA households sold rice, nearly 40% of sales transactions were in Zambezia, and this province had the highest prices in TIA. Finally, TIA sales prices of domestic rough rice and IAF and SIMA retail purchase prices of milled rice may be tracking different markets: the vast majority of rice purchases in the country are of imported, broken rice which comes into the country at very low prices.
- Real groundnut prices increased in both IAF and TIA (more so in the former), and fell in SIMA. A large price increase would be expected given that TIA 96 and TIA 02 aggregate production figures show a -20% decline in production.
- Real cowpea prices increased in all three price series, though the increase is much larger in IAF than in TIA.
- Real cassava and cassava meal prices declined in all three price series. Since cassava and cassava flour are potential substitutes for maize in the calculation of flexible IAF deflators, the decline in cassava prices offsets higher prices for other commodities in the food component of the expenditure basket.

5. CONCLUSIONS

The main purpose of the analysis presented in this paper is to provide a quantitative understanding of the level and composition of rural household incomes in 2001-02, and changes observed since 1995-96, to inform the design of national rural development and poverty reduction strategies in Mozambique. A related purpose has been to assess the extent to which the results of this comparative analysis are consistent with results from IAF surveys conducted during the same years, and to generate insights that may not be available from the IAF data. IAF and TIA are complementary data sets. IAF is based on household expenditure data, which are generally considered the best and most accurate measure of household welfare, and for that reason are preferred in poverty assessments. TIA is based on household income data, which in an agricultural economy can fluctuate substantially from year-to-year around a trend. Income data are therefore not generally preferred in poverty assessments, but they provide a much more detailed picture of households' economic activities and of the contribution of each to their well-being; they allow us to look behind the poverty trends and to assess the underlying factors that help explain those trends.

We have thus wished to evaluate rural economic growth from a three-dimensional perspective: has this growth been rapid, has it been broad-based, and if so, is it sustainable? We first summarize our findings in regard to rural household income growth, and then identify concrete steps that can be taken to improve sustainable growth in the future.

5.1. Patterns of Change in Rural Household Incomes 1995-96 to 2001-02

We went to some length in this paper to disaggregate the observed growth in incomes, first into several agricultural and non-agricultural sources, and then in the cropping income to determine the relative contributions of increased productivity compared to prices. Several key patterns were identified. First, mean rural household income per AE was 65% higher, and median income 30% higher, in 2001-02 compared to 1995-96.[14] While households at all income levels saw their incomes rise, median incomes for the top 20% of households were more than double those of the next highest income quintile, and more than 15 times the income of the poorest 20%. With the exception of the top 20% of the population, rural household incomes remain very low, and remain critically low for the poorest 60% of the population. Encouragingly, regional disparities in rural household incomes have diminished since 1995-96, and ownership of goats and bicycles has increased among households at all income levels.

Second, increases in income for the highest income households have come primarily from off-farm skilled wage and self-employment opportunities. This route out of poverty will not be available to the majority of rural households in the near term because of limited projected employment growth in the public and NGO sectors, the high educational requirements for formal sector employment relative to current educational attainment of the rural population, and the concentration of high wage employment opportunities in the south of the country.

Third, participation in self-employment activities has increased across all income groups, but most of this increase has been in NRE activities such as firewood collection and charcoal production. These activities are problematical from the standpoint of environmental

[14] This using the IAF Flexible Adjusted Deflator.

sustainability, and also in terms of the long-term returns they are likely to generate for participating households.

Fourth, increases in crop income have played a dominant role for the bottom 60% of earners, and have been of equal importance to off-farm income growth for the next 20% (the fourth quintile). This increase in cropping income has been associated with substantial diversification of cropping patterns across all income groups, with the average number of crops grown increasing by about 75%.

5.2. Concerns Related to the Sustainability of the Crop Income Component of Rural Household Income Growth

Our fifth and final major finding is that this increased cropping income has been driven almost entirely by increased prices: production of most crops fell per hectare and per AE in the households, but prices increased more than enough to compensate. We checked IAF and SIMA data for the two periods and found that they largely confirm the large increases in real prices found in TIA. Thus, the evidence is strong that physical crop productivity was lower in 2001-02 than it was in 1995-96.

This finding raises at least two troubling issues. First, the welfare improvement for households with increased crop income may be overstated, because much of this "income" is in the form of crop production retained on the farm for consumption; higher market prices for these foods do not make them more valuable in consumption to these households. Additionally, recent research shows that at least 61% of rural households in Mozambique are net buyers of maize, meaning that they purchase more maize (in the form of grain or meal) than they sell (Tschirley, Abdula, and Weber 2006). Higher food crop prices actually reduce the welfare of these households. Second, growth in agricultural productivity is a fundamental building block for sustained increases in rural incomes. Because most rural non-farm activities are depend on agriculture to generate effective demand for their goods and services, stagnant agricultural productivity will undermine the prospects for growth in the rural non-farm sector.

Because rainfall during the 2001-02 growing season was substantially worse than in 1995-96 across most areas of the country, and because of the limitations in using household AEs as a proxy for labor allocation to agricultural activities, we cannot conclude from these two surveys that productivity is showing a medium-term downward *trend*. However, we have argued on the basis of complementary information, some in TIA and some from other sources, that agricultural productivity in Mozambique may well be stagnant.

5.3. Steps to Ensure Strong Agricultural Productivity Growth

For the majority of the rural poor the fastest way to reduce poverty and improve food insecurity is by increasing the quantity and value of agricultural production, particularly crop production, combined with a gradual shift from unskilled low wage and self-employment in the NRE sector to skilled wage and value-added self-employment opportunities. As shown by the rapid growth of household incomes in Tete province, a high value cash crop like tobacco can be a powerful engine for rural economic growth, both through increased crop income and the resulting increased demand for additional locally produced goods and services.

In line with the findings of the earlier study of the determinants of rural household income in Mozambique (Walker et al. 2004), agricultural growth should be pursued through a twofold strategy of encouraging the emergence of a commercial smallholder group while strengthening the food security and cash earning opportunities for the majority of semi-subsistence smallholders. Semi-subsistence smallholders will benefit indirectly from the success of commercial smallholders through increased wage earning opportunities.

Commercial smallholders need assistance to expand cultivated areas through the use of animal traction, to increase high value horticultural crop production with small-scale irrigation, and improve post-harvest storage and marketing. Studies on the costs and benefits of specific investment packages for different types of commercial smallholder are urgently needed.

The majority of semi-subsistence smallholders can expand their incomes rapidly through the introduction of higher yielding and drought tolerant and disease resistant food crop varieties, by adoption of conservation farming methods (especially in drought prone areas), and expanded access to cash crop opportunities. Again, studies of the cost and benefits of specific technologies and diffusion strategies are urgently needed, and the recruitment and training of a cadre of social scientists for IIAM is underway.

While difficulties in the estimation of cassava yields make it difficult to quantify the incidence and depth of food insecurity in 2001-02 compared to 1995-96 through the TIA surveys, additional research and extension appears necessary to strengthen food security for semi-subsistence farmers. In particular, households with limited land and/or labor need assistance to develop strategies for year-round balanced nutrition. Changing household demographics, such as decreasing household size and the increasing proportion of female-headed and widow-headed households, need to be taken into account in developing improved food security strategies. Work on long-term solutions to food insecurity has been neglected in recent years due to a focus on emergency food aid. Reduced incidence of malaria in the growing season through community-wide adoption of impregnated mosquito nets during the growing season could also help boost labor productivity for vulnerable families.

APPENDICES

Appendix A. Cassava Production Imputations for 1996

Cassava production was under-reported in TIA 96 due to weaknesses in questionnaire design. TIA 02 captured this production much better. We therefore utilized mean production from 2002, calculated separately for each income quintile in each province (quintiles calculated separately for each province), and applied these figures to the appropriate quintiles in 1996. Both years show strong correlation within a province between income quintile and cassava production.

Table A1. Original Reported 1996 Cassava Production, and 2002 Data Applied to 1996 in Imputations (kg/AE)

Province	Income/AE Quintiles	Original 1996	2002 Means Imputed to 1996
Niassa	1	79	120
	2	82	218
	3	119	191
	4	154	388
	5	213	387
Cabo Delgado	1	78	206
	2	99	298
	3	129	338
	4	166	494
	5	310	462
Nampula	1	72	415
	2	119	656
	3	140	761
	4	186	965
	5	282	1,422
Zambezia	1	52	212
	2	67	420
	3	84	703
	4	98	969
	5	139	1,069
Tete	2	1	82
	3	0	132
	4	1	236
	5	31	277
Manica	1	5	119
	2	18	120
	3	7	150
	4	12	269
	5	39	405
Sofala	1	10	130
	2	10	190
	3	21	234
	4	22	313
	5	36	402
Inhambane	1	51	167
	2	68	291
	3	82	396
	4	128	866
	5	146	1,655
Gaza	1	13	73
	2	25	113
	3	35	159
	4	52	216
	5	71	307
Maputo	1	12	79
	2	21	177
	3	15	201
	4	26	328
	5	45	616

Appendix B. Regression Results for 2002 Cassava Imputation for Those Reporting the Crop But Not Reporting Production

```
      Source |       SS       df       MS              Number of obs =    1998
-------------+------------------------------           F( 81,  1917) =   21.14
       Model |  5.0599e+09    81  62468329.2           Prob > F      =  0.0000
    Residual |  5.6639e+09  1917  2954552.15           R-squared     =  0.4718
-------------+------------------------------           Adj R-squared =  0.4495
       Total |  1.0724e+10  1998  5367272.84           Root MSE      =  1718.9

------------------------------------------------------------------------------
       qntkg |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    areamand |   1470.263   196.1354     7.50   0.000     1085.602    1854.925
      areasq |  -279.8907    68.3953    -4.09   0.000    -414.0277   -145.7537
_Iprovdi~105 |   282.5164   649.9749     0.43   0.664    -992.2158    1557.249
_Iprovdi~108 |   465.4011   477.3599     0.97   0.330    -470.7982      1401.6
_Iprovdi~114 |   680.7226   703.9618     0.97   0.334    -699.8889    2061.334
_Iprovdi~116 |   408.8845   649.8402     0.63   0.529    -865.5836    1683.353
_Iprovdi~203 |   759.7503   574.0799     1.32   0.186    -366.1364    1885.637
_Iprovdi~204 |   505.2695    274.378     1.84   0.066     -32.8413     1043.38
_Iprovdi~206 |   497.2346   328.2681     1.51   0.130    -146.5656    1141.035
_Iprovdi~209 |   805.8122   353.4654     2.28   0.023     112.5951    1499.029
_Iprovdi~210 |   303.3254   431.7135     0.70   0.482    -543.3521    1150.003
_Iprovdi~211 |   744.5727   317.0988     2.35   0.019     122.6778    1366.468
_Iprovdi~212 |   950.5194   328.4901     2.89   0.004      306.284    1594.755
_Iprovdi~213 |   614.6264   338.8723     1.81   0.070    -49.97059    1279.223
_Iprovdi~215 |   23.87233   337.7799     0.07   0.944    -638.5824    686.3271
_Iprovdi~302 |   2583.315   500.7221     5.16   0.000     1601.298    3565.332
_Iprovdi~307 |   968.0501   393.7386     2.46   0.014     195.8491    1740.251
_Iprovdi~308 |   2791.497    412.622     6.77   0.000     1982.262    3600.732
_Iprovdi~309 |    849.693   445.3319     1.91   0.057     -23.6929    1723.079
_Iprovdi~311 |    1164.18   406.6318     2.86   0.004      366.693    1961.667
_Iprovdi~312 |   1535.036   703.6335     2.18   0.029     155.0683    2915.004
_Iprovdi~313 |   1590.022   316.6971     5.02   0.000     968.9153    2211.129
_Iprovdi~316 |   2574.257   431.3321     5.97   0.000     1728.328    3420.187
_Iprovdi~317 |   201.7392   608.1053     0.33   0.740    -990.8782    1394.357
_Iprovdi~319 |   1145.347   448.3519     2.55   0.011     266.0383    2024.656
_Iprovdi~321 |   2582.153   403.1614     6.40   0.000     1791.472    3372.834
_Iprovdi~402 |   3415.502   769.5595     4.44   0.000     1906.241    4924.764
_Iprovdi~404 |   2635.475   389.3418     6.77   0.000     1871.897    3399.053
_Iprovdi~405 |   1533.431   360.9114     4.25   0.000     825.6107    2241.251
_Iprovdi~406 |   1311.911   307.5937     4.27   0.000     708.6574    1915.164
_Iprovdi~408 |   2025.155   297.3662     6.81   0.000     1441.959     2608.35
_Iprovdi~409 |   1062.327   282.9964     3.75   0.000     507.3133     1617.34
_Iprovdi~410 |    1011.82   478.5364     2.11   0.035      73.3136    1950.327
_Iprovdi~411 |   2738.991   276.6229     9.90   0.000     2196.477    3281.505
_Iprovdi~412 |   1716.462   312.3798     5.49   0.000     1103.822    2329.102
_Iprovdi~413 |   1547.807   341.7587     4.53   0.000     877.5495    2218.065
_Iprovdi~414 |   -171.232   295.7694    -0.58   0.563    -751.2957    408.8317
_Iprovdi~415 |   862.5746    611.105     1.41   0.158    -335.9258    2061.075
_Iprovdi~416 |  -269.6797    377.752    -0.71   0.475    -1010.528    471.1683
_Iprovdi~502 |   605.7502   358.8236     1.69   0.092     -97.9754    1309.476
_Iprovdi~504 |  -254.7547   1719.222    -0.15   0.882    -3626.496    3116.987
_Iprovdi~507 |   293.5764   520.8526     0.56   0.573     -727.921    1315.074
_Iprovdi~508 |   228.4289   651.8384     0.35   0.726    -1049.958    1506.816
_Iprovdi~509 |   31.97681   417.8178     0.08   0.939    -787.4484     851.402
_Iprovdi~511 |   320.1892   459.8719     0.70   0.486    -581.7125    1222.091
_Iprovdi~512 |   299.3159   518.9639     0.58   0.564    -718.4773    1317.109
_Iprovdi~513 |   46.42253   546.3534     0.08   0.932    -1025.087    1117.932
_Iprovdi~602 |   444.1966    314.348     1.41   0.158    -172.3033    1060.696
_Iprovdi~603 |   350.4383   300.3251     1.17   0.243      -238.56    939.4365
_Iprovdi~604 |   275.5548   460.8756     0.60   0.550    -628.3153    1179.425
_Iprovdi~605 |   750.7171   249.9378     3.00   0.003     260.5385    1240.896
_Iprovdi~606 |   97.26358    992.722     0.10   0.922    -1849.665    2044.192
_Iprovdi~608 |    196.324   272.7927     0.72   0.472    -338.6777    731.3257
_Iprovdi~609 |   1176.449   287.4224     4.09   0.000     612.7554    1740.142
_Iprovdi~610 |    330.974   702.0491     0.47   0.637    -1045.886    1707.834
_Iprovdi~702 |   556.4835   395.3454     1.41   0.159    -218.8687    1331.836
_Iprovdi~704 |   279.6541   519.3183     0.54   0.590    -738.8341    1298.142
_Iprovdi~706 |   342.3569   574.3272     0.60   0.551     -784.015    1468.729
_Iprovdi~707 |   191.0718   477.2418     0.40   0.689     -744.896     1127.04
_Iprovdi~710 |   339.5328   573.8379     0.59   0.554    -785.8792    1464.945
_Iprovdi~711 |   1712.289   459.6434     3.73   0.000     810.8353    2613.742
_Iprovdi~713 |   377.2422    543.992     0.69   0.488     -689.636     1444.12
_Iprovdi~802 |   1429.609   287.8294     4.97   0.000     865.1178    1994.101
_Iprovdi~807 |   3830.173   263.0257    14.56   0.000     3314.326    4346.019
_Iprovdi~809 |   1047.083   272.0625     3.85   0.000     513.5132    1580.652
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_Iprovdi~810 |   843.2557   294.3478     2.86   0.004     265.9803    1420.531
_Iprovdi~811 |   1160.939   232.9034     4.98   0.000     704.1684     1617.71
_Iprovdi~812 |   631.3415   264.2655     2.39   0.017     113.0635     1149.62
_Iprovdi~813 |   1069.885   240.4564     4.45   0.000     598.3011    1541.469
_Iprovdi~903 |    243.161   236.7519     1.03   0.305    -221.1573    707.4794
_Iprovdi~906 |  -63.34172   461.2867    -0.14   0.891    -968.0182    841.3347
_Iprovdi~907 |  -66.52163   651.0868    -0.10   0.919    -1343.434    1210.391
_Iprovdi~908 |   121.7751   264.9787     0.46   0.646    -397.9017    641.4518
_Iprovdi~909 |   363.8269   242.3613     1.50   0.133    -111.4926    839.1464
_Iprovdi~910 |  -28.44565   294.3429    -0.10   0.923    -605.7115    548.8203
_Iprovdi~912 |   288.2757   218.4474     1.32   0.187    -140.1438    716.6951
_Iprovd~1002 |   1006.228   255.9062     3.93   0.000     504.3445    1508.112
_Iprovd~1004 |   485.8322   223.9234     2.17   0.030      46.6731    924.9913
_Iprovd~1006 |    428.773   296.9008     1.44   0.149    -153.5096    1011.056
_Iprovd~1007 |   422.1517   265.3286     1.59   0.112    -98.21126    942.5147
_Iprovd~1008 |    315.343   296.0912     1.07   0.287    -265.3518    896.0378
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Appendix C. Regression Results for Imputation of MSE Income in Six Provinces That Did Not Directly Collect This Information

Dependent Variable:	Total value of MSE earnings for household
NMSE	Number of MSEs reported by household
NMSESQ	NMSE squared
EDHHH	Years of education of household head
NMEM	Number of members in household
NMEMSQ	NMEM squared

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.226[a]	.051	.044	3279423.312

[a] Predictors: (Constant), NMEMSQ, EDHHH, NMSE, NMEM, NMSESQ
[b] Dependent Variable: VCP net MSE Income

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Significance
1	(Constant)	-2308307.229	798199.189		-2.892	.004
	NMSE	2231229.205	626436.348	.501	3.562	.000
	NMSESQ	-320096.362	127966.198	-.352	-2.501	.013
	EDHHH	122223.527	56061.866	.080	2.180	.030
	NMEM	384418.248	171551.939	.288	2.241	.025
	NMEMSQ	-23974.024	12170.484	-.255	-1.970	.049

Appendix D. Documentation of Water Balance Model for Calculating Days of Drought, Days Waterlogging Index, and Overall Rainfall Quality Index, 1995-2004

DAYS OF DROUGHT

Potential Evapotranspiration (PET)

$$PET = 5 * d \quad (1)$$

where d is the number of days in the month (30)

Months with missing observations were dropped except for the 1995/96, 2001/02, and 2002/03 agricultural seasons, where the missing values were substituted by the median of that particular year drawn from a sample of 52 years.

It is assumed that the agricultural season starts in early October and lasts until late April and that the available amount of water to the plant in a given month is not only a function of the rainfall in that specific month. It is also assumed that the monthly soil water retention capacity is 200ml. Therefore, during the periods where the rainfall was less than 350ml but greater than the PET, the amount being transferred from one month to the other was given by the following relationship:

$$qwater_i = qwater_i + qwater_{i-1} - PET \quad (2)$$

where $qwater$= amount of water

i = January, February, …, December

In months with rainfall exceeding 350ml (200ml of soil retention capacity + PET), equation 2 changes to:

$$qwater_i = qwater_i + 200 \quad (3)$$

After adjusting for the available amount of water in each month, the next task was to compute the days of drought, using the following relationship:

$$drought_{month_i} = 30 - \frac{30 * qwater_i}{PET} \quad (4)$$

where $drought >= 0$

The available rainfall data from Tete province were collected in the city of Tete. Therefore, the data was not representative of the region where agriculture is practiced in that province, and hence, data from Tete was excluded from the analysis. Data from Maputo city was also excluded for the same

reason and replaced by the Changalane observations, probably more representative of the rainfall situation in Maputo province.

The number of stations where the data was collected was not constant over time. Only years containing observations from 6 or more (out of 9) were selected. Then, days of drought were computed for January to April, using the following relationship:

$$drought_{Jan-April} = weight * \sum_{Jan}^{April} drought_{month_i} \quad (5)$$

where *weight* is a weighing factor for each province, varying with the number of stations in each year.

Finally, data was aggregated by year, obtaining the total number of days of drought from January to April for each particular year included.

RUNOFF

The initial procedure was similar to the computation of days of drought:

1. Drop years with missing observation for some months
2. Replace the remaining missing values with median values
3. Drop observation from Tete and Maputo city

The amount of water that is lost due to runoff is expressed as follows:

$$runoff_{month_i} = qwater_i - 350 \quad (6)$$

where *runoff >=0*

In order to get the same scale of measurement between days of drought and runoff, some adjustments were needed for the runoff results:

5 groups were computed based on runoff values:

1. *Group =1: 100 > runoff > 50*
2. *Group =2: 150 > runoff >= 100*
3. *Group =3: 200 > runoff >= 150*
4. *Group =4: 300 > runoff >= 200*
5. *Group =5: runoff >= 300*

$$runoff_{month_i} = weight * 2^k * \frac{mean_{drought} * N}{\sum_{k=1}^{5} n * 2^k} \quad (7)$$

where N: Total number of observations (367)

$mean_{drought}$: days of drought mean from January to April

n: number of observations in each group

k: group

Runoff from January to April was found by summing up monthly runoffs from January to April:

$$runoff_{Jan-April} = \sum_{Jan}^{April} runoff_{month_i} \quad (8)$$

THE AGRICULTURAL SEASON QUALITY

The next step was to aggregate runoff data for each year, with the runoff from January to April providing a yearly basis for analysis. At this point, it was necessary to match the runoff results with those of days of drought, in order to obtain the following index:

$$index = .7 * drought + .3 * runoff \quad (9)$$

The agricultural season index that measures the quality of the season was obtained through the following equation:

$$qseason = \max_{index} - index \quad (10)$$

where max_{index} is the index maximum value

Appendix E. Provincial Tables

Table E1. Mean Household Demographic and Socioeconomic Characteristics by Province, 1996-2002

Province	HH Size (AE)		HH Size (no.)		Dependency Ratio		Age of HH Head (yrs)	
	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	3.8	3.9	5.1	5.3	1.3	1.3	43.2	40.0
C. Delgado	3.4	3.3	4.5	4.3	1.0	1.1	41.5	41.9
Nampula	3.5	3.3	4.7	4.4	1.3	1.1	42.4	38.8
Zambezia	4.0	3.6	5.3	4.8	1.2	1.1	43.1	39.4
Tete	4.2	3.7	5.8	5.1	1.5	1.4	44.2	42.2
Manica	4.7	4.2	6.4	5.7	1.3	1.3	43.1	43.8
Sofala	4.4	4.5	5.8	5.9	1.2	1.1	43.4	42.9
Inhambane	4.6	4.1	5.8	5.3	1.0	1.1	50.9	49.4
Gaza	5.7	4.5	7.0	5.7	1.0	1.0	53.7	49.8
Maputo	4.9	4.3	6.2	5.5	1.0	1.0	49.6	46.7
National	4.1	3.7	5.4	5.0	1.2	1.2	44.6	42.0

Province	Education of HH Head (yrs)		HH Maximum Education (yrs)		Female Head of HH (%)		Widow Head of HH (%)	
	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	1.7	2.0	2.4	3.1	10	33	1	5
C. Delgado	1.7	1.8	2.4	2.5	10	23	4	7
Nampula	1.7	2.3	2.2	3.0	10	22	2	5
Zambezia	1.9	2.2	2.7	3.0	13	20	6	8
Tete	1.6	2.3	2.3	3.3	17	27	8	11
Manica	2.2	2.5	3.4	3.8	28	21	16	9
Sofala	1.8	2.4	3.0	3.6	16	23	12	12
Inhambane	1.8	2.3	3.5	3.7	18	29	9	13
Gaza	2.6	2.2	5.0	3.6	21	33	12	21
Maputo	2.2	2.6	4.5	4.2	30	33	15	16
National	1.9	2.2	2.9	3.2	14	24	7	9

Table E2. Mean Household Land, Input, and Asset Characteristics by Province, 1996-2002

	Total Area (mean ha)		Cultivated Area (mean ha)		Total Area/AE (mean ha)		Cultivated Area /AE (mean ha)		Uses Animal Traction (%)	
Region	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	1.61	1.65	1.28	1.51	0.45	0.47	0.35	0.43	0	0
C. Delgado	1.37	1.37	1.10	1.26	0.45	0.45	0.36	0.41	0	0
Nampula	1.40	1.56	1.22	1.06	0.43	0.54	0.38	0.36	0	0
Zambezia	0.98	1.25	0.88	1.14	0.28	0.40	0.25	0.36	0	0
Tete	1.60	2.35	1.25	2.13	0.41	0.69	0.33	0.62	2	35
Manica	1.83	1.92	1.41	1.50	0.42	0.48	0.32	0.38	9	11
Sofala	1.87	2.06	1.33	1.72	0.45	0.55	0.33	0.42	1	2
Inhambane	2.31	1.86	1.96	1.27	0.63	0.53	0.54	0.36	30	47
Gaza	2.03	2.12	1.75	1.51	0.42	0.60	0.37	0.41	37	44
Maputo	1.60	1.77	1.28	1.16	0.37	0.50	0.29	0.33	19	12
National	1.51	1.66	1.26	1.34	0.42	0.50	0.35	0.40	7	11

	Uses Chemical Fertilizer (%)		Uses Manure Fertilizer (%)		Uses Irrigation (%)		Hires Ag Labor (%)		Owns Bicycle (%)	
Region	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	6	7	1	4	2	8	17	21	17	42
C. Delgado	1	3	0	1	1	3	17	22	7	20
Nampula	3	3	2	1	4	2	25	5	9	14
Zambezia	0	1	8	1	1	1	17	13	7	38
Tete	0	15	1	14	0	28	16	31	8	36
Manica	0	3	4	9	8	22	20	28	3	17
Sofala	0	1	1	2	3	6	17	18	4	20
Inhambane	0	2	6	24	8	29	14	19	3	4
Gaza	2	5	2	12	23	27	26	14	3	10
Maputo	0	3	2	15	4	24	14	21	1	9
National	1	4	3	6	4	11	19	16	7	23

	Owns Any Livestock (%)		Owns Cattle (%)		Owns Sheep/Goats (%)		Owns Pigs (%)		Owns Chickens (%)	
Region	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	67	62	0	0	16	15	4	1	11	10
C. Delgado	49	66	1	0	16	23	6	9	13	11
Nampula	76	72	0	1	11	22	15	10	22	11
Zambezia	73	78	0	0	5	11	11	16	20	10
Tete	80	85	8	14	34	52	19	18	17	10
Manica	79	85	9	8	35	48	12	15	18	16
Sofala	88	79	3	1	35	42	17	12	26	18
Inhambane	89	84	10	8	38	41	47	45	23	23
Gaza	75	76	16	18	41	30	20	18	29	26
Maputo	70	74	5	5	21	27	4	11	30	40
National	74	76	3	4	20	27	16	15	21	14

Table E3. Quintiles of Total Net Household Income per AE by Province, 1996-2002

Quintiles of Total Net Household Income/AE, 1996
(% of HHs in Each Province in the Given Quintile)

Province	1-low	2	3-mid	4	5-high	Total
Niassa	30	23	17	15	14	100
C.Delgado	11	20	26	20	24	100
Nampula	4	10	16	34	36	100
Zambezia	28	25	21	16	10	100
Tete	41	26	20	9	3	100
Manica	23	22	21	16	17	100
Sofala	30	30	17	14	9	100
Inhambane	12	19	22	19	27	100
Gaza	28	19	23	17	13	100
Maputo	22	11	18	14	35	100
National	20	20	20	20	20	100

Quintiles of Total Net Household Income/AE, 2002
(% of HHs in Each Province in the Given Quintile)

Province	1-low	2	3-mid	4	5-high	Total
Niassa	12	17	20	23	28	100
C.Delgado	21	20	23	24	12	100
Nampula	17	24	25	20	14	100
Zambezia	23	21	19	22	15	100
Tete	18	15	16	16	35	100
Manica	18	23	18	18	23	100
Sofala	25	17	17	19	23	100
Inhambane	16	18	16	22	28	100
Gaza	33	20	17	11	19	100
Maputo	13	8	12	23	45	100
National	20	20	20	20	20	100

Table E4. Percentage of Households with the Given Income Source by Province, 1996-2002

	Gross Crop Inc. (%)		Livestock Sales (%)		Wage Income (%)		Net MSE Income (%)	
Province	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	99	100	15	26	15	12	16	32
C.Delgado	100	99	12	31	21	5	21	51
Nampula	100	98	12	26	29	11	38	31
Zambezia	100	100	10	24	13	18	41	47
Tete	100	100	20	42	21	18	38	50
Manica	100	99	26	44	24	24	48	46
Sofala	99	98	26	35	15	31	41	40
Inhambane	100	99	15	27	31	18	30	46
Gaza	100	98	15	21	19	21	28	36
Maputo	100	97	0	15	15	38	56	46
Total	100	99	14	29	21	17	35	42

Table E5. Mean Shares of Total Gross Household Income by Province, 1996-2002

	Gross Crop Inc. (%)		Livestock Sales (%)		Wage Income (%)		Net MSE Income (%)	
Province	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	89	84	2	2	2	8	7	6
C.Delgado	88	75	1	2	2	3	9	19
Nampula	91	81	1	2	2	6	7	11
Zambezia	84	76	1	2	1	7	14	15
Tete	73	66	4	6	1	8	22	19
Manica	75	67	2	6	3	12	19	15
Sofala	75	65	3	4	3	19	19	12
Inhambane	83	67	2	3	5	12	10	18
Gaza	81	68	3	3	3	14	13	15
Maputo	65	52	0	2	2	26	33	21
Total	83	73	1	3	2	9	13	15

Table E6. Mean Income per AE by Income Source by Province, 1996-2002

	Total Net HH Income/AE			Net Crop Income/AE			Livestock Sales Income/AE			Wage Income/AE			Net MSE Income/AE		
Province	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change
Niassa	763	1,921	152	646	1,370	112	9	27	195	3	330	10167	105	194	85
C.Delgado	1,084	1,355	25	907	691	-24	14	28	94	29	150	418	133	485	264
Nampula	1,472	1,330	-10	1,261	827	-34	7	26	301	28	168	508	177	310	75
Zambezia	710	1,432	102	517	756	46	3	18	434	3	250	7798	186	409	120
Tete	462	2,396	419	265	1,264	377	21	129	524	3	273	8349	173	731	322
Manica	1,041	1,597	53	601	786	31	30	73	145	20	461	2245	390	277	-29
Sofala	650	1,511	133	391	575	47	16	52	217	18	543	2884	225	342	52
Inhambane	1,259	2,229	77	1,050	971	-8	17	38	125	53	500	851	139	720	416
Gaza	803	1,542	92	608	498	-18	27	53	99	40	496	1141	128	494	287
Maputo	1,346	3,112	131	736	867	18	0	49	NA	30	1,377	4510	580	819	41
Total	997	1,641	65	773	836	8	11	42	267	21	323	1410	191	441	131

Table E7. Sources of Growth in Total Net Household Income per AE by Province, 1996-2002

	Total Net HH Income/AE			Net Crop Income/AE		Livestock Sales Income/AE		Wage Income/AE		Net MSE Income/AE	
Province	1996	2002	Ch 02-96	Ch 02-96	%*	Ch 02-96	%*	Ch 02-96	%*	Ch 02-96	%*
Niassa	763	1921	1,157	724	63	18	2	327	28	89	8
C.Delgado	1084	1355	271	-216	-80	14	5	121	45	351	130
Nampula	1472	1330	-142	-434	306	20	-	140	-	132	-93
Zambezia	710	1432	722	239	33	15	2	247	34	223	31
Tete	462	2396	1,935	999	52	108	6	270	14	557	29
Manica	1041	1597	556	186	33	43	8	441	79	-114	-20
Sofala	650	1511	861	184	21	35	4	525	61	117	14
Inhambane	1259	2229	970	-79	-8	21	2	447	46	580	60
Gaza	803	1542	739	-110	-15	27	4	456	62	366	50
Maputo	1346	3112	1,765	132	7	49	3	1,347	76	238	14
Total	997	1641	644	63	10	30	5	302	47	250	39

%* = proportion of growth in mean total net HH income/AE due to the growth in this income source

Table E8. Percentage of Households with the Given Crop Group by Province, 1996-2002

Province	Cereals (%)		Pulses (%)		Roots/tubers (%)		Coconut/cashew (%)		Field Cash Crops (%)		Hort Sales (%)		Fruit Sales (%)	
	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	99	99	59	76	34	65	0	0	17	25	6	19	13	27
C. Delgado	93	88	65	67	69	84	5	34	8	25	3	16	9	20
Nampula	80	80	86	87	84	86	53	50	17	25	6	5	16	7
Zambezia	86	93	57	59	78	85	32	41	3	12	7	20	19	25
Tete	99	98	42	77	7	56	0	1	2	24	4	30	5	25
Manica	99	99	38	76	25	80	0	8	9	31	19	30	23	27
Sofala	97	93	40	55	42	65	26	27	11	18	7	14	7	13
Inhambane	92	70	88	79	75	93	66	75	5	1	7	11	23	25
Gaza	97	86	77	79	56	76	56	57	1	0	5	7	22	12
Maputo	82	90	48	75	56	85	14	13	2	2	3	13	8	14
Total	89	88	65	73	64	80	32	37	8	18	6	16	15	19

Table E9. Mean Shares of Gross Crop Income by Crop Group by Province, 1996-2002

Province	Cereals (%)		Pulses (%)		Roots/tubers (%)		Coconut/cashew (%)		Field Cash Crops (%)		Hort Sales (%)		Fruit Sales (%)	
	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	63	65	15	11	13	13	0	0	6	5	1	2	2	2
C. Delgado	44	38	15	14	36	31	0	4	2	5	0	2	1	2
Nampula	16	24	16	22	55	33	7	9	5	8	0	1	1	1
Zambezia	25	34	9	6	58	49	4	4	1	2	1	1	2	2
Tete	87	51	8	11	4	18	0	0	0	7	0	3	1	2
Manica	79	59	4	6	9	19	0	1	1	2	2	3	5	3
Sofala	62	51	8	4	20	27	6	3	2	6	0	2	1	1
Inhambane	27	9	11	11	44	53	14	18	0	0	1	2	2	2
Gaza	41	35	16	14	16	35	23	6	0	0	1	2	3	2
Maputo	43	26	10	8	39	54	3	0	0	0	1	2	3	2
Total	38	36	12	12	39	35	6	5	2	4	1	2	2	1

Table E10. Mean Net Crop Income per AE by Crop Group and by Province, 1996-2002

	Net Crop Income/AE			Cereal Income/AE			Pulse Income/AE			Root/tuber Income/AE		
Province	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change
Niassa	646	1,370	112	323	854	165	125	163	31	94	170	81
C. Delgado	907	691	-24	413	296	-28	168	123	-27	259	194	-25
Nampula	1,261	827	-34	182	223	23	203	187	-8	671	251	-63
Zambezia	517	756	46	93	233	150	59	49	-18	311	418	34
Tete	265	1,264	377	209	560	167	26	139	437	31	353	1033
Manica	601	786	31	446	495	11	27	47	73	72	185	158
Sofala	391	575	47	216	323	50	36	20	-44	83	188	127
Inhambane	1,050	971	-8	203	57	-72	121	78	-35	518	667	29
Gaza	608	498	-18	197	202	3	115	72	-37	87	193	122
Maputo	736	867	18	340	191	-44	67	65	-3	336	711	111
Total	773	836	8	218	306	40	111	104	-6	335	320	-4

	Coconut/cashew Income/AE			Field Cash Crop Income/AE			Hort Sales Income/AE			Fruit Sales Income/AE		
Province	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change	1996	2002	% Change
Niassa	0	0	-95	105	98	-7	5	95	1839	12	21	69
C. Delgado	2	33	1831	54	46	-15	5	22	366	32	15	-54
Nampula	96	83	-14	104	99	-5	6	7	26	16	5	-71
Zambezia	29	21	-28	12	30	146	4	13	207	16	15	-3
Tete	0	0		2	259	14044	2	45	2761	6	19	227
Manica	0	2	3541	13	40	217	18	30	69	49	52	6
Sofala	47	11	-77	14	50	259	2	21	1043	8	4	-47
Inhambane	164	171	4	4	1	-69	11	20	74	52	25	-52
Gaza	242	23	-91	0	0	-86	8	83	945	20	12	-39
Maputo	11	3	-71	1	6	661	7	38	475	30	19	-37
Total	62	43	-31	39	67	72	6	28	384	22	16	-27

Share of Crop Group in Change in Mean Net Crop Income/AE

Mean	Net Crop Income/AE			Cereal Inc/AE		Pulse Inc/AE		Root/tuber Inc/AE		Coco/cash Inc/AE		Cash Crop Inc/AE		Hort Inc/AE		Fruit Inc/AE	
Province	1996	2002	Ch 02-96	Ch 02-96	%*	Ch 02-96	%*	Ch 02-96	%*	Ch 02-96	%*	Ch 02-96	%*	Ch 02-96	%*	Ch 02-96	%*
Niassa	646	1,370	724	531	73	38	5	76	11	0	0	-7	-1%	90	12	9	1
C. Delgado	907	691	-216	-117	54	-46	21	-64	30	31	-14	-8	4%	17	-8	-17	8
Nampula	1,261	827	-434	41	-10	-16	4	-420	97	-14	3	-5	1%	1	0	-12	3
Zambezia	517	756	239	140	58	-10	-4	107	45	-8	-3	18	7%	9	4	0	0
Tete	265	1,264	999	350	35	113	11	322	32	0	0	257	26%	43	4	13	1
Manica	601	786	186	49	26	20	11	113	61	2	1	28	15%	12	6	3	2
Sofala	391	575	184	107	58	-16	-9	105	57	-36	-20	36	20%	19	10	-4	-2
Inhambane	1,050	971	-79	-146	184	-43	54	150	-189	7	-9	-3	4%	8	-11	-27	34
Gaza	608	498	-110	5	-5	-43	39	106	-96	-220	200	0	0%	75	-68	-8	7
Maputo	736	867	132	-150	-114	-2	-1	375	285	-8	-6	5	4%	31	24	-11	-9
Total	773	836	63	88	139	-7	-11	-15	-24	-19	-31	28	45%	22	35	-6	-9

%* = proportion of growth in mean total net HH income/AE due to the growth in this income source

Table E11. Mean Number of Crops by Type and Province, 1996-2002**

Province	No. of Crops		Food Crops		Field Cash Crops		Perennial Crops		Hort		Cereals		Pulses		Roots/Tubers		Crop Categories	
	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002	1996	2002
Niassa	3.5	7.4	2.7	4.1	0.2	0.3	0.5	1.5	0.2	1.5	1.6	1.9	0.8	1.3	0.3	1.0	2.4	4.1
C.Delgado	3.8	7.1	3.2	4.1	0.1	0.3	0.5	1.4	0.1	1.3	1.6	1.8	0.9	1.4	0.7	0.9	2.7	3.8
Nampula	5.2	5.8	3.6	4.2	0.2	0.3	1.2	0.9	0.2	0.4	1.3	1.4	1.5	1.9	0.9	0.9	3.5	3.5
Zambezia	4.8	7.3	3.2	3.8	0.0	0.1	1.4	2.2	0.3	1.2	1.4	1.6	0.9	1.1	0.9	1.1	3.0	3.7
Tete	2.6	9.0	2.2	3.7	0.0	0.2	0.2	1.7	0.2	3.3	1.5	1.3	0.5	1.6	0.1	0.9	1.7	4.1
Manica	4.7	11.6	2.8	4.5	0.1	0.4	1.0	3.0	0.8	3.7	1.9	1.9	0.6	1.5	0.4	1.3	2.6	4.7
Sofala	5.0	8.6	3.4	3.5	0.1	0.2	1.1	2.5	0.4	2.3	2.2	1.8	0.6	1.0	0.6	0.8	2.6	3.8
Inhambane	6.3	10.2	3.8	3.4	0.1	0.0	2.1	4.8	0.4	2.0	1.3	0.8	1.5	1.5	1.0	1.0	3.5	3.9
Gaza	5.3	9.4	3.0	3.7	0.0	0.0	2.0	3.8	0.3	2.0	1.1	1.0	1.3	1.7	0.7	1.1	3.2	4.0
Maputo	3.1	8.4	2.4	3.4	0.0	0.0	0.6	2.6	0.1	2.3	0.8	0.9	0.7	1.3	0.8	1.3	2.2	4.0
Total	4.7	7.9	3.2	3.9	0.1	0.2	1.1	2.1	0.2	1.6	1.4	1.5	1.0	1.4	0.7	1.0	2.9	3.8

Field Cash Crops = Cotton, tobacco, hemp, tea, soybean, paprika, sunflower, sesame; perennial crops = fruits, cashew, coconut, sugarcane
Food Crops = cereals, pulses, roots/tubers
Crop Categories = cereals, pulses, roots/tubers, tree crops, horticulture, cash crops
** For comparative purposes, growing a crop is defined as having production >0.

Annex F. IAF Poverty Lines and Deflators

	1996			2002 Flexible Adjusted					2002 Fixed	
Province (Rural)	Food Poverty Line	Nonfood Poverty Line	Total Poverty Line	Food Poverty Line	Nonfood Poverty Line	Total Poverty Line	Flexible Adjusted Food Deflator	Flexible Adjusted Total Deflator	Food Poverty Line	Fixed Food Deflator
Niassa	3,012	1,011	4,023	5,434	1,665	7,099	1.8044	1.7647	6,246	2.0741
Cabo Delgado	3,012	1,011	4,023	5,434	1,665	7,099	1.8044	1.7647	6,246	2.0741
Nampula	2,742	617	3,359	4,471	1,501	5,972	1.6306	1.7778	5,277	1.9245
Zambezia	3,719	1,135	4,854	4,155	1,318	5,473	1.1173	1.1276	5,175	1.3916
Tete	3,845	868	4,713	5,629	1,304	6,933	1.4639	1.4709	6,838	1.7783
Manica	3,845	868	4,713	5,629	1,304	6,933	1.4639	1.4709	6,838	1.7783
Sofala	3,719	1,135	4,854	4,155	1,318	5,473	1.1173	1.1276	5,175	1.3916
Inhambane	4,971	1,462	6,433	6,614	2,394	9,008	1.3305	1.4003	6,858	1.3795
Gaza	4,971	1,462	6,433	6,614	2,394	9,008	1.3305	1.4003	6,858	1.3795
Maputo provincial	5,418	1,898	7,316	11,801	4,963	16,764	2.1781	2.2914	11,801	2.1780

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