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HOUSEHOLD INCOME AND ASSETS IN RURAL MOZAMBIQUE, 2002-2005: CAN PRO-POOR GROWTH BE SUSTAINED?

By

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Household Income and Assets in Rural Mozambique, 2002-2005: Can Pro-Poor Growth Be Sustained?

by

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EXECUTIVE SUMMARY

Mozambique made impressive reductions in poverty from 1996 to 2002. The national poverty rate, as documented by the National Household Consumption Survey – *Inquérito aos Agregados Familiares* (IAF) expenditure surveys in those years, fell from 69.4% in 1996/97 to 54.1% in 2002/03. Consistent with the IAF expenditure survey results, *Trabalho de Inquerito Agricola* (TIA) rural household income surveys showed that mean and median rural household income per adult equivalent increased by 65% and 30% respectively from 1995/96 to 2001/02, and that all income quintiles shared in the income growth. Yet in spite of these impressive gains in household welfare, the majority of the country's population remained below the poverty line in 2002/03 (51.5% in urban areas, 55.3% in rural).

The first objective of this paper is to determine whether the upward trends in household welfare found from 1996 to 2002 have continued from 2002 to 2005, as measured in terms of TIA income and assets.

The second objective of this paper is to use information about the structure of rural household income, asset levels, and access to technology and public goods in TIA 2002 and 2005, to investigate the prospects for continued rural economic growth, as well as the question of whether or not one could expect income growth to continue to be as broad-based as it was from 1996 to 2002. A key insight from the analysis of rural income growth in Mozambique from 1996 to 2002 is that the poorest 80% of rural households derived most of their gains from increases in crop income, which appear to have come primarily from expansion of cultivated area, not improved productivity. To address the first two objectives, we use data from the rural household income survey conducted by the Ministry of Agriculture in 2005, the TIA, which re-surveyed more than 80% of the households included in the previous TIA rural household income survey conducted in 2002, thus generating the first nationally-representative panel household dataset for rural Mozambique.

The third objective of this paper is to provide background information on the methods used to construct the income variables for the TIA 2002-2005 panel and the TIA 2002 and TIA 2005 full cross-sectional datasets. This panel household income dataset has already been used in two related papers, one which investigates household income poverty dynamics from 2002-2005 (Cunguara et al. 2008), and another which uses multivariate panel regression analysis to assess the relative impact on household crop income of changes in household asset levels, input choices, and access to crop production technology and public goods (Mather forthcoming).

With respect to trends in total household income, we find that mean total net household income per adult equivalent (AE) rose 15% from 2002 to 2005, but median income/AE fell by 1%. The distribution of income is thus wider (more unequal) in 2005, relative to 2002. We also find that the poorest households in 2005 are considerably poorer than the poorest households in 2002, while the wealthiest households in 2005 are considerably wealthier than the wealthiest households in 2002. The likely reason for this pattern of income change is worse rainfall conditions in 2005 (relative to 2002) leading to reduced crop income in 2005. Crop income is the main source of income for the majority of rural households, especially the poorest.

Households in the top 20% of total net household income per AE in 2005 (the top income quintile) achieved higher crop and non-farm income/AE compared to households in the top 20% in 2002. However, this computation does not necessarily involve the same households

in both years. When we follow panel households over time, we see that there is rather dramatic relative mobility of households from 2002 to 2005 across quintiles of income/AE computed for each year. These results highlight the variability of income over time, the vulnerability of many rural households to adverse rainfall conditions, and the importance of considering the entire distribution of a given welfare indicator – not simply the mean value, which may be skewed by changes in values at the low or high end of the distribution.

We also consider trends in household asset levels, which offer a more stable indicator of household welfare over time, given that many assets tend to be less variable than income from year to year. Consistent with the positive trends seen from 1996 to 2002/03 in IAF, the Demographic and Health Survey (DHS), and TIA, the TIA 2005 data demonstrate that, on average, rural households in Mozambique have continued to increase their asset holdings from 2002 to 2005, notably in land access and ownership of goods such as bicycles, radios, and durable housing materials. However, we find that tropical livestock units per AE fell from 2002 to 2005, which is most likely due to significant losses of chickens in various parts of the country due to the spread of Newcastle disease.

Schooling levels and literacy are well known to be vital to improving the long-term welfare potential of households and individuals. TIA data show that schooling levels and literacy were still very low for most adults in 2005, and only 43% of household heads are literate. However, recent government investments targeted to increase the number of rural primary schools appear to be paying off, as school attendance rates have improved dramatically since 1996/97, and the gender gap has decreased considerably. The IAF had found that child school current attendance of children 12-17 in rural areas was 51.5% for boys and 33.2% for girls in 1996/97. TIA 2005 finds average attendance rates for children age 12-17 in rural areas are 72.9% for boys and 61.8% for girls.

Although TIA showed some increases in use of improved crop inputs (such as fertilizer, animal traction, and irrigation) from 1996 to 2002, TIA 2005 shows no improvement since then. Some analysts believe that much of the growth in agricultural production and crop income in rural Mozambique since 1994 has primarily come from agricultural extensification (increased area under cultivation) and very little from intensification (increased productivity via higher levels of inputs and/or shifting area into higher-return cash crops). Given that TIA shows that household use of fertilizer (3.5% of households in 2005) and animal traction (8.8% in 2005) – both of which help to improve crop yields and maintain soil fertility – remain very low, it seems doubtful if continued area expansion by manual cultivation will continue to generate growth in crop income over time without some increase in the adoption of improved inputs and/or increased production of higher-value crops.

Structural change is typically understood to involve the shift over time from an economy in which farm production employs most of the population, to one in which non-farm goods and services plays a bigger and bigger role in the economy. This implies a movement away from an economy dominated by subsistence agricultural production, and towards a more specialized, market-driven economy. Evidence of specialization and increased market participation (structural change) is typically observed as increased rural household reliance on income-generating activities such as: a) diversification of farm activities into higher-return commodities such as cash crops and livestock, and b) diversification into non-farm employment and micro-small enterprise (MSE) activities.

The TIA 2005 data does not show much evidence of movement towards greater household reliance on markets, as a majority of rural households remain subsistence or semi-subsistence

farm households, and a majority of rural household income is still derived from the value of food production retained by rural households (the bottom 80% of rural households derived from 51% to 62% of their total household income from the value of retained food crops). Participation in higher-value farm activities declined somewhat since 2002, as only a third of households (31.7%) have sold some high-value crops (field cash crops, tree crops, horticulture) in 2005, and only 26% have sales of livestock products (live animals, meat, eggs/milk). Average household income shares for these activities remained very low (the share of total household income from food crop sales was 5.7% in 2005, 4.8% for high-value crop sales, and 2.4% for livestock product sales), due to low participation rates and to the predominance of food crops in total income.

There is also not much evidence from TIA 2005 of structural change toward higher-value non-farm activities in most provinces. A notable exception was found in the provinces of Sofala and Gaza, where there were rather large increases in household participation in non-farm activity participation from 2002 to 2005. Much of this increase appears to be due to increased participation in higher-return activities, not activities with lower returns such as unskilled non-farm wage labor and natural resource extraction activities. Yet many rural households in Mozambique face insurmountable barriers in their attempts to access such high-return non-farm activities, as suggested by the TIA results above and in studies of income diversification across Africa.

While efforts to reduce barriers to non-farm income opportunities are certainly warranted, the large share of retained food crops in total rural household income suggests that improvements in food crop productivity appear to offer great potential for poverty reduction for a large number of rural households. The government's Green Revolution Strategy, and the action plan to increase agricultural productivity launched by the Ministry of Agriculture in July 2008, both focus on increasing agricultural productivity. But these initiatives will only be sustainable over the long run if improved technology is financially profitable for farmers. Greater attention needs to be given to an analysis of the profitability of improved technology for different crops and regions of the country. Given the importance of rainfed agriculture for the majority of households, and the very high costs of irrigation, greater use should be made of conservation farming practices and animal traction. Conservation agriculture techniques can increase the profitability and reduce the risk of purchased inputs like chemical fertilizer. The lack of access to animal traction in the most productive areas of the country is hindering increases in area cultivated per person as well as yields per unit area. Expansion of animal traction is difficult, due to disease and lack of familiarity with draft animals, but absolutely essential if a significant number of smallholders are to become viable commercial enterprises producing crops for the market. Also, in the absence of a land market, oxen are the best alternative source of collateral to help stimulate viable rural financial markets.

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ACRONYMS

AE	Adult Equivalent
AEC	Consumption Adult Equivalents
AET	Actual Evapotranspiration
AMSU	Advanced Microwave Sounding Unit
ASE	*Acção Social Escolar*
CBSD	Cassava Brown Streak Disease
CCD	cold cloud duration
CLUSA	Cooperative League of the United States of America
CPI	Consumer Price Index
DAP	*Departamento de Análise de Políticas*
DHS	Demographic and Health Survey
DOD	days of drought
GDP	Gross Domestic Product
GIS	geographic information system
GOM	Government of Mozambique
GPS	Global Positioning System
GTS	Global Telecommunication System
HH	Household
IAF	National Household Consumption Survey (*Inquérito aos Agregados Familiares)*
IFPRI	International Food Policy Research Institute
IIAM	Institute of Agricultural Research of Mozambique
INAM	National Institute of Meteorology
INE	National Statistics Institute
IPW	inverse probability weight
MADER	Ministry of Agriculture and Rural Development (now MINAG)
MEC	Ministry of Education and Culture
MINAG	Ministry of Agriculture (*Ministério de Agricultura*)
MPF	Ministry of Planning and Finance of the Government of Mozambique
MSE	Micro-small Enterprise
MSU	Michigan State University
MTN	*Meticais da Nova Familia*
NGO	Non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration
PA	prime-age
PARPA	Mozambican Government's Action Plan for the Reduction of Absolute Poverty
PPI	Producer Price Index
RFE	rainfall estimate
SAW	Soil Available Water
SIMA	Agricultural Market Information System of Mozambique (*Sistema de Informação de Mercados*)
SME	small-medium enterprise
SSM/I	Special Sensor Microwave/Imager
TIA	National Agricultural Sample Survey (*Trabalho do Inquérito Agrícola)*
TLU	Tropical Livestock Units

1. INTRODUCTION

The Mozambican Government's Action Plan for the Reduction of Absolute Poverty 2001-2005 (PARPA I) states that "rapid, sustained, and broad-based growth is essential for the reduction of poverty" (p. 30), which is to be achieved through improvements in education, health, agricultural productivity, and stable macroeconomic environment (GOM 2000). Without question, Mozambique's macroeconomic growth rate has been robust since the onset of macroeconomic reforms beginning in 1987, and later combined with donor assistance and political stability since the multi-party elections in 1994. The PARPA also notes that "the poor do not automatically benefit from good macroeconomic statistics" (p. 30) and that "the (poverty reduction) strategy must ensure that the structure of growth favors the poor." Household indicators demonstrate considerable improvement in rural welfare 1996/97 to 2002/03 in Mozambique. According to results from IAF expenditure surveys in 1996/97 and 2002/05, the national poverty rate fell from 69.4% in 1996/97 to 54.1% in 2002/03 (Ministry of Planning and Finance of the Government of Mozambique (MPF), International Policy Research Institute, and Purdue University 2004), and welfare improvements have been found in both monetary and non-monetary poverty measures over this same time period (Fox, Bardas, and Van den Broeck 2005). Although consumption inequality (as measured by the IAF expenditure surveys) increased slightly from 1996/97 to 2002/03, the distribution of growth from 1996-2002 nevertheless appears to have been relatively broad-based given that consumption at all percentiles increased over the same time period, and consumption inequality across provinces and regions has declined (James, Arndt, and Simler 2005). Consistent with the IAF expenditure survey results for the 1996-2003 period, TIA rural household income surveys showed that mean rural household income per adult equivalent increased 65% from 1995/96 to 2001/02 (median incomes rose 30%), and that all income quintiles shared in the income growth (Boughton et al. 2006).

In spite of these impressive gains, the majority of the country's population remained below the poverty line in 2002/03 (51.5% in urban areas, 55.3% in rural; MPF et al. 2004) and Mozambique remains one of the poorest countries in the world. This begs the question of whether or not rural household welfare in Mozambique has continued to improve since 2002/03. While TIA household income data is not appropriate for the use of establishing national poverty rates comparable to those from IAF (data on household expenditure is the preferred welfare indicator for use in establishing official poverty rates), TIA 2005, nevertheless, provides the most recent data available on rural household income and asset levels. The first objective of this paper is to evaluate levels of rural household income and assets as reported by TIA 2002 and TIA 2005 to see if the upward trends in household welfare found from 1996 to 2002 (in both IAF and TIA data) have continued and are observed in TIA from 2002 to 2005.

Another important question for Mozambican policymakers is whether or not they should expect the drivers of poverty reduction from 1996 to 2002 to continue to drive future poverty reduction. According to TIA rural household income data, the source of rural income growth from 1996 to 2002 among rural small- and medium-holders differed sharply between those in the top 20% of total household income per AE and the bottom 80%; those in the top 20% derived increased income primarily from non-farm skilled wage labor and Micro-small enterprise (MSE) activities, while those in the bottom 80% relied primarily on increases in crop income (Boughton et al. 2006). Given that increases in crop income between 1996 and 2002 appear to have derived primarily from expansion of cultivated area, not improved productivity, these findings beg the question of whether the government should anticipate sustained poverty reduction beyond 2003. That is, does evidence from TIA05 suggest that

the growth in consumption, income, and assets from 1996 to 2002/2003 will be sustained over time, and will it continue to be broad-based? The second objective of this paper is use information about the structure of income, household asset levels, and household access to technology and public goods from TIA 2002 and 2005 in order to investigate the prospects for continued broad-based rural economic growth.

As many researchers and policymakers will likely use the TIA 2005 income data as well as the TIA 2002-05 income panel, the third objective of this paper is to provide background information on the methods used to construct TIA 2005 household income and the TIA 2002-2005 panel income file.[1] We begin the paper by first discussing the background to the TIA panel survey and the construction of household income variables.

[1] The TIA panel household income dataset has already been used in two related papers, one which investigates household income poverty dynamics from 2002-2005 (Cunguara 2008), and another which assesses the relative impact on household crop income of changes in household asset levels, input choices, and access to crop production technology and public goods (Mather forthcoming).

2. DATA

2.1. Sampling

This study uses a 3-year panel of rural household surveys household-level surveys known as the TIA, which were implemented in 2002 and 2005 by the Ministry of Agriculture (MINAG) staff from the Directorate of Economics in collaboration with colleagues from MSU. Employing standards from the National Statistics Institute (INE), the TIA 2002 (TIA02) used a stratified, clustered sample design[2] that is representative of rural small- and medium-holders[3] at the provincial and national levels, and includes 4,908 households from 80 districts (out of 128) across the country. To construct a panel data set and yet also have a sample that remains representative at national and provincial levels, MINAG statisticians and its collaborators designed the TIA 2005 (TIA05) sample to include all TIA02 households (which could be re-interviewed) and yet also includes new households for TIA05 so as to retain a representative sample of the population.[4]

Both the TIA 2002 and TIA 2005 survey instruments covered a range of aspects: agricultural and livestock production, land use, and income sources and services. The survey instruments also included several demographic sections, to capture the characteristics of each current member of the household, and to document new arrivals, departures, deaths, and prolonged illness of household members.

2.2. Sample Attrition

Given that over time, some households move away from a village and others dissolve as part of a typical household life-cycle, panel household surveys typically have to contend with at least some sample attrition over time. In the three-year TIA panel, n=804 households (17.3% between the two surveys, or 5.8% per year) out of the n=4908 TIA02 households were unable to be re-interviewed (Table 1). Overall, the rate of attrition in this sample is relatively low, as compared to other African country surveys described in Alderman et al (2001) and elsewhere (Chapoto 2006, for rural Zambia). Reasons for attrition included dissolution of the household, migration of the household from the enumeration area, and integration of the household into other households through marriage (Table 2).[5]

However, if households which fall out of the sample (i.e., are not re-interviewed) are a non-random sub-sample of the population, then using the re-interviewed households to estimate the means of variables during the 2nd time period (or the change in the variable between the two panels) may result in biased estimates. For example, if household attrition is a function of the head's schooling level in 2002 (i.e., if heads with the highest (or lowest) education levels are the most likely to migrate), then high attrition rates may result in biased estimation of the mean of head's schooling in 2002, 2005, or change from 2002-2005, in the event that

[2] The TIA02 sample was drawn from the sampling frame prepared for the year 2000 agricultural census (covering approximately 22,000 households) with the intention that TIA02 data can be analyzed at the provincial level and by agro-ecological zone.
[3] Medium scale farmers (based on criteria using land and livestock holdings and horticultural production) were expressly over-sampled, to ensure sufficient observations for analysis.
[4] The full TIA05 sample includes all TIA02 households which could be re-interviewed from the 80 TIA02 districts (i.e., the panel households), replacement households for attrited TIA02 households, as well as households from 16 additional districts which were not sampled in TIA02.
[5] Information on reasons for attrition comes from the village head or neighbors and relatives who were asked about the reason for the absence or departure of a household.

the analyst uses only panel households for the computation.[6] Yet, research by Alderman et al. (2001) suggests that even in panels with high attrition, household outcomes and characteristics of re-interviewed households may still not be biased. They recommend various diagnostic tools for use in identifying potential bias. Mather and Donovan (2007) performed these diagnostics on the TIA panel dataset and found evidence of attrition bias in various household characteristics such as demographics, total household income, and asset levels.

Table 1. TIA Sample Households, 2002-2005

	Households interviewed in 2002	Households reinterviewed in 2005	
Province	Number	Number	% of 2002
Niassa	277	215	77.6
C.Delgado	500	406	81.2
Nampula	604	510	84.4
Zambezia	724	603	83.3
Tete	587	482	82.1
Manica	478	392	82.0
Sofala	416	307	73.8
Inhambane	426	372	87.3
Gaza	552	473	85.7
Maputo Province	344	298	86.6
Total	4908	4058	82.7

Source: TIA 2002, TIA 2005.

Table 2. Declared Reasons for Household Attrition between TIA 2002 and TIA 2005

	Attrited sample households	
Declared reason for household attrition[1]	(number)	(%)
Moved away	411	48.4
Members not available at the time of the interview	137	16.1
Household was not found in the household listing of the enumeration area	84	9.9
Death of household head resulted in household dissolution	71	8.4
Reasons not identified	46	5.4
No one knows the household in enumeration area	36	4.2
New listing in enumeration area	21	2.5
Household dissolved	17	2.0
Lost information	12	1.4
UPA not included in 2005	8	0.9
Household refused reinterview	6	0.7
Household classifieed as large scale in 2005	1	0.1
Total	850	100

Source: TIA 2002, TIA 2005

Notes: [1] Neighbors and village leaders were asked for reasons as to why a households could not be located. In some cases, the difficulties were based on logistical constraints for enumerators to arrive.

[6] A typical example of attrition bias is how it affects the returns to schooling in a wage regression. If the highest-educated adults migrate away from rural areas, then we will not observe the high wage offers of these individuals in the 2nd round of the survey, thus the panel returns to schooling in that rural sample will be biased downward.

All panel household analysis in this paper uses sampling weights which have been corrected for attrition bias, using Mather and Donovan's (2007) attrition correction for the TIA panel income dataset.[7]

The importance of using the attrition correction with the panel sampling weights is clearly seen when analyzing the mean household characteristics of various TIA sub-samples (Appendix Table 1). TIA02 households which were not re-interviewed in 2005 (Column B) tended to have younger heads, smaller household size (fewer children, fewer adults of age 15-59, and fewer adults over age 60), smaller landholding, and fewer assets relative to TIA02 households which were re-interviewed (Column C) (Appendix Table 1). This means that, with respect to these characteristics, the panel households by themselves are not a random sub-sample of the 2002 population. However, when we re-compute the means of the panel household sub-sample (Column D), this time using panel weights which are adjusted by the attrition correction factor (which is specific to and computed for each household), these mean household characteristics are nearly identical to those of the full TIA02 sample (Column A) – or at least are considerably closer to the mean of the TIA02 sample (Column A) than to the uncorrected mean (Column C). The relative proximity of the means in Columns A and D demonstrate that the attrition correction factor is working as intended.

The attrition bias correction increases the weights of households which have a higher probability of dropping out of the sample (i.e., not being re-interviewed). This ensures that statistics for 2002 which are computed using only panel households is still representative of the 2002 population, and is thus similar to the value observed when using the complete 2002 TIA sample. However, it should be noted that the attrition bias correction does *not* enable us to use panel households to estimate a statistic for 2005 which is representative of the 2005 rural population. For example, if only a small number of panel households experience a change in their head during the 3-year interval between the two rounds of the TIA panel survey, the average head's age in 2005 should be roughly three years higher than the average head's age in 2002. Note that the difference in the mean age of the household head increases 2.5 years (from 42.08 to 44.45 years) from 2002-05, even when we use the attrition-corrected panel weights. This result shows that the attrition-corrected panel weights give us a statistic for 2002 using panel households which is nearly identical to the 2002 statistic using the full 2002 sample (a mean of 42.04 years of age for the household head). However, it also demonstrates that the 2005 statistic is not representative of the full 2005 population – which we would not necessarily expect considering that we are following most of the 2002 sample through time. More evidence in support of this interpretation is found in nothing that the mean head's age for TIA06 – which uses a different sample from TIA02 and TIA05 – is 42.37 years, which is considerably closer to the value for TIA02 than the value from TIA05.

In addition, it appears that the TIA05 full sample statistics may not be representative of the 2005 population – at least for some demographic and asset-related variables – due to the large portion of the TIA05 sample which comes from the panel. To see why this is likely the case, note that the head's age using the full TIA05 sample is 43.99 years, while that for TIA02 is 42.08 and that for TIA06 is 42.37. This is not a large difference, but simply one to note. One

[7] The inverse probability weight (IPW) method (Wooldridge 2002) is used here to correct for attrition bias (details presented in Mather and Donovan (2007)). The method involves the estimation of a re-interview (probit) model and then using the inverse of predicted probabilities of re-interview to adjust sampling weights for attrition bias. In short, this results in larger weights for households which were more likely to have dropped out of the sample, which in the case of the TIA panel tended to be households with somewhat lower total income and livestock assets in 2002.

would expect this difference to be greater for demographic and asset variables, yet perhaps of no consequence for production statistics. That is, there is reason to believe that following the same households over three years should result in changes in mean demographics (more children, more adults) and assets (more assets due to saving over time), yet given that agricultural production uses so few improved inputs, it is hard to imagine that a household with three more years of experience or saving would produce much more maize, cassava, etc. as before. On the other hand, these households have more mouths to feed, so perhaps this is an issue for further investigation.

2.3. Definition of Total Household Income and Income Components

We define total net household income as net returns to family resources (land, labor, and other assets) from crop and livestock production, small business activities, wage labor of resident members, remittance income received from non-residents, and income from pensions and land rental. Our definition and valuation of household income is largely consistent with earlier work using TIA 2002 income data (Walker et al. 2004), though our figures for TIA02 income will be slightly different from earlier work, most notably with respect to the valuation of retained food crop production.

Details on the definition and valuation of components are as follows:

i. Crop income includes the retained and sold value of food crops (grains, beans, oilseeds, roots/tubers), retained and sold value of cashew and coconut, sales of field cash crops (such as tobacco and cotton), and sales of horticultural and fruit crops. Costs of seed and chemical fertilizers and herbicides are netted out from gross crop income. The price used to value sold quantities of food crops (including cashew and coconut) is the median TIA household farmgate sales price, computed at the district level where there are at least 10 household price observations for a given crop, otherwise at the provincial level. The price used to value retained quantities of food crops is the annual average retail price of that product from the nearest rural retail market with price data reported by the *Sistema de Informacao de Mercados* (SIMA, 2006).[8] We use the farmer's reported value of sales of field cash crops, horticultural crops and fruit (i.e., the price variation across farmers for these crops may well be due to varying quality).[9]
ii. Livestock income consists of the value of live animals sold, as well the sale of meat and dairy products.
iii. Micro-small enterprise (MSE) activities involving natural resource extraction (hunting, fishing, production of coal and firewood, making straw mats, etc.) and MSE activities such as sales and trading of commodities and agricultural inputs, petty trading, crafts, construction, repair, etc. TIA includes information on expenses undertaken on these latter small business activities, which we net out from gross returns.
iv. Wage labor includes income from any farm or non-farm employment. The TIA survey instrument documents various aspects of each employment, such as the sector

[8] Since non-farm income is typically reported in cash terms, sold crops represent cash income, and cash income is an indicator of household consumption potential, then valuing retained food production at retail (rather than farmgate) prices better approximates the 'consumption' value to the household of food production which is retained. In sum, we feel that this valuation method improves the ability of household income to serve as a welfare indicator.
[9] We cap farmer-reported prices of field cash crops at the 20% and 80% marks (i.e., recode the top 20% of prices to the 80 percentile price; the bottom 20% of prices at the 20 percentile price).

of employment (agriculture and non-farm), skill level, location (in the village, out of the village, out of the province, etc.), and duration.[10]

v. The remittance category in this paper includes income received from remittances, pensions, and land rental.

Details on various adjustments we made to the TIA data are found in the appendices. For example, we made adjustments (such as imputation of missing values) to household wage income, income from MSE activities, and parcel area (Appendix A-1), as well as to household cassava production data (Appendix A-2).

To control for differences in household composition over time and space, we also present results for mortality effects on total household income per AEs which were computed using the following scale: adults of either sex = 1.0 AE, children age 0 to 4 years = 0.4 AE; and children age 5 to 14 years = 0.5 AE (Deaton 1997).

2.4. Rural Price Inflators

Prices between the two panels were adjusted so as to inflate 2002 values to 2005 *Meticais da Nova Familia* (MTN), based on rural price deflators constructed from available secondary data.[11] We chose to construct rural deflators rather than use INE's Consumer Price Index (CPI) because the latter is based on urban consumption and urban prices from only three locations (the cities of Maputo, Beira and Nampula), and IAF consumption baskets (MPF et al. 2004) demonstrate that rural prices and consumption patterns can be quite different from those in urban areas. We would expect to also find that urban areas with a port (such as Maputo and Beira) would have better access to imported commodities such as rice, wheat-based products, and cooking oils. For example, in the IAF Sofala/Zambezia poverty regions, the share of rice in food expenditure goes from 11.3% in urban areas to 3.9% in rural ones.

To construct a rural price inflator for each province, we begin with the food portion of the consumption baskets identified by the national expenditure survey (IAF 2002/03) for various rural poverty zones (each IAF poverty zone corresponds to the rural areas of 1-2 provinces) (MPF et al. 2004). First, we revalue this basket using rural retail market price data from the national agricultural market information system (SIMA) which correspond to the time period of income activity covered by the TIA02 survey (October 2001-September 2002).[12] Next, we revalue the cost of this basket for the time period of the TIA05 survey (October 2004-September 2005). The inflator for a given province is simply the ratio of this adjusted IAF basket value in 2005 relative to 2002. We are not able to use the complete IAF food basket from 2002/03 because we can only include commodities in our adjusted baskets which can be revalued in 2005 using SIMA prices (see Appendix Table 2). We are able to retain over 50 to

[10] Some wage income is received from resident members who live away from the household during some or much of the year. However, to prevent potential double-counting (in the wage category and the remittance category) and/or over-reporting of the wage income actually received by the household when the wage laborer lives away from home much of the year, we exclude the wage income of a few household members who live 12 months of the year outside of the province, as any income from these members should be reported in the form or remittances.

[11] While the *Meticais da Nova Familia* (MTN) was not introduced until 2006, all values in this report are reported in MTN for the convenience of readers, and converted at the rate of 1000 *meticais* (adjusted to constant 2005 values) = 1 MTN.

[12] Because we have to use SIMA prices to value the 2002 basket at 2005 prices, we use SIMA data from 2002 to revalue the 2002 cost of the basket (for consistency – IAF and SIMA prices for the same year are not always similar, and consistency suggests using a price series from the same location over time rather than a price from one location in one year and then a price from a different location for the second year).

60% of the IAF food basket in the north and central provinces, though only 35 to 43% in the south (because the south has a higher expenditure shares on goods not tracked by SIMA price data such as fish and wheat-based bread).

We also constructed an alternative inflator, a TIA producer price index, which measures price inflation via the increase in value of fixed basket of TIA crop production from 2002 to 2005 (columns A and B, Appendix Table 3). The advantage of the IAF-based inflator is that it is conceptually tied to changes in the cost of living over time (not just farmgate prices), and in practice, it is also more in line with price inflation as measured by the INE urban CPI (Appendix Table 3), and much less variable between neighboring provinces relative to the TIA producer price index (PPI). For these reasons, we use the IAF-based inflators (column B in Appendix Table 3) for the analysis in this paper. However, our inflators show no price inflation in Sofala and Tete. The reason for this is that the SIMA price of both maize grain and flour fell in rural markets of these provinces from 2002 to 2005, and maize grain and flour account for 50% of our food basket in Sofala and 60% in Tete.[13]

Two types of inflators are typically constructed to adjust for the price inflation over time: fixed and flexible. The fixed inflator (which we use here) assumes that the quantities in the consumption basket do not change over time, thus it assumes that consumers cannot respond to changes over time in relative commodity prices (they can not substitute one commodity for another but continue to purchase the same quantities of each good as they did in the base year). The implication of using a fixed inflator is that this will tend to overestimate the price inflation from 2002 to 2005, and thus may tend to underestimate increases in real income from 2002 to 2005.

Price inflation from our inflators over the October 2001 to September 2005 period is of similar magnitude that reported in INE's urban CPI for Maputo, Beira and Nampula (which is also based on fixed consumption bundles – Appendix Table 3), though our inflation is a bit higher in the south and north (as might be expected in rural areas where markets are thinner and market integration is relatively poorer).

The flexible inflator assumes that consumers are able to substitute away from commodities whose relative prices increase, thus the quantities in their baskets may change over time. The implication is that the cost of the consumption basket for a flexible inflator does not increase as much as the cost as estimated by the fixed inflator. Price inflation from a flexible inflator is subsequently lower, which leads to larger increases in real income over time (or larger gains in poverty reduction). We do not construct a flexible inflator due to the lack of consumption data for 2005. Additional details on the inflators and their construction are presented in Appendix A-3.

It should be noted for future poverty research in Mozambique that a recent review of methodologies for the construction of consumer price indices (Schultze 2003) recommends

[13] Nominal maize prices fell from 2002 to 2005 for various reasons, but in general, maize prices throughout southern Africa in 2002 were among the highest in years (FEWSNET 2002). Mozambican maize prices in 2004/05 (during the TIA recall period of October 2004 to September 2005) were lower relative to those of 2001/02 because 2003/04 had been a bumper crop year for most of the north and center of Mozambique, thus prices never rose during the lean season (first quarter) of 2005 to the extent that they did in 2002 (which were high because stocks were low even before the poor 2001/02 season). While it may seem paradoxical that maize production fell dramatically from TIA02 to TIA05 yet maize prices also fell from 2002 to 2005, consider the following: although the 2004/05 maize production was lower than that for 2001/02 due to worse rainfall in the former year, the time period for which we are creating price inflators is not the 2004/05 maize marketing year (April 2005 to March 2004) but rather the period of TIA income recall (October 2004 to September 2005).

against choosing between the fixed or the flexible inflator, but rather to use the average of the two. They argue that the assumptions underlying either of them are unreasonably strong: the fixed inflator assumes no substitution effects, and the flexible assumes perhaps more substitution than is reasonable under developed country contexts (Schultze 2003). For example, just because consumer theory predicts that a consumer would choose to substitute from one commodity to another given changes in relative prices over time does not mean that, in reality, they are able to obtain the desired quantity of that substitute commodity in their local village market throughout the year. Where access to substitutes is costly or infeasible, the use of a flexible inflator will underestimate inflation and overestimate real income increases. The IAF02/03 poverty assessment (MPF et al. 2004) used flexible inflators for their preferred results (which are the results most often cited), thus their choice of inflator implies that the extent of poverty reduction which they report for Mozambique from 1996-2002 might be considered a high-end estimate.

2.5. Rainfall

Given that poorest 80% of rural Mozambican households obtain more than 60% of their total net household income from crop production (Boughton et al. 2006), and since nearly all crop production in Mozambique is rainfed, it is important to consider rainfall variation over time when analyzing crop production and income data over time. We fed district-level estimates of dekadal rainfall (derived from satellite imagery) into a water balance model in order to estimate the number of days of drought in each province during the principal maize growing season, from 1996 to 2006 (see Appendix A-4 for details). Our estimates show that, relative to 2002, days of drought in 2005 were considerably higher in the north, though the same or worse in the center and south (Table 3). However, *both* years of the TIA panel experienced more drought days than the 5-year average, with the exception of a favorable season in 2002 in the north. As will be shown later in this paper, poor rainfall in 2005 relative to 2002 rainfall is likely to be the principal cause of declines in median household crop income (and total net household income) from 2002 to 2005.

2.6. Use of Income and Assets as Welfare Indicators

While indicators are used to measure welfare, among those related to achievement of basic consumption needs, it is generally understood that household expenditure data is a preferable indicator of household welfare relative to household income for various reasons. First, expenditure represents attained consumption, whereas income is more accurately described as representing consumption potential. Secondly, expenditure data involves recall during a one to two-week time period, whereas most income surveys (such as this one) involve recall of farm production and non-farm income earned over the previous 12 months. Third, it is argued that expenditure data is less variable than income data due to consumption smoothing. The idea is that households facing low income in a given year can either borrow cash or sell assets in order to maintain a stable expenditure level over time. Households which enjoy a year of high income typically do not expend all such income, but rather expend at their typical level, and convert the remainder of their cash income into assets (livestock, farm equipment, school fees, etc.) which can both improve future productivity as well as serve as sources of cash in years of low income.

However, while it is generally accepted by economists on the basis of theory and evidence that rural household income does indeed fluctuate more than household expenditure,

available evidence does not support the theory of lifecycle consumption, which suggests that households are able to perfectly smooth their consumption across seasons and years, in a context such as Mozambique's. In fact, evidence suggests that expenditure levels of rural households are considerably more volatile than some economists assume.[14] There are reasons to suspect that the same could be said of expenditure in rural Mozambique. First, credit markets in rural Mozambique are quite weak and incomplete (only 3.5% of rural households have access to credit); second, nearly three-quarters of rural household income is derived from rainfed crop production, on average (see Table 13 below); and third, household livestock assets are quite low relative to neighboring countries.

Due to the expected variability of household income over time, we also look at household levels of physical and human capital assets (which are not as prone to the wide fluctuations over time due to drought, flooding, animal/plant disease, etc.), including the number of adults (as a proxy of labor availability), total land area[15] (which includes area cultivated to annual crops, permanent crops, in fallow, and in pasture) and livestock.[16] Household assets such as human capital (education, experience) and physical capital in the form of landholdings and materials used in house construction, are unlikely to vary substantially from year to year (and even less so within a given year). Other physical assets such as livestock, radios, bicycles, etc. are inherently less fixed, and might be liquidated in a poor agricultural season (such as livestock, radio, bikes, etc.).

2.7. Use of Data on Income Activities

One of the analytical strengths of income data collected by TIA is the ability to see which activities contribute the most to total household income (the structure of income) by region and income quintile. The TIA also collects information such as reliable measurement of landholding, livestock, farm assets, and use of improved technology such as fertilizer, animal traction, access to extension, price information, etc. This information can help analysts understand why some households have access to high-return activities while others do not, as well as the variance in returns. Such information can often result in more policy-relevant, investment-specific recommendations for poverty reduction than what is typically available from expenditure datasets (Walker et al. 2006).

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[14] According to the 'lifecycle theory of consumption', households facing variable income will borrow/save over time in order to ensure stable consumption levels over time. However, the empirical reality of many developing country households constrains their ability to completely smooth consumption over time. For example, weak or incomplete financial markets deny many households the opportunity to borrow/save in times of adverse (positive) income shocks, and evidence from inter-seasonal panel expenditure surveys suggests that household expenditure levels vary significantly across the year and between years in response to adverse shocks, as households often prefer to reduce expenditures (food, schooling expenses, etc.) rather than sell one or more of their few assets (Dercon and Krishnan 2000).

[15] TIA enumerators used global positioning systems (GPS) units to measure one machamba (parcel) per household for 25% of TIA households. Coefficients from a regression of TIA05 measured machamba area on the TIA05 area declared by the household for that machamba, the household head's education, and district dummies were used to adjust declared machamba area for household which did not have a machamba measured by TIA enumerators.

[16] TIA collects information on housing quality (type of walls and type of roof) and ownership of the more common household goods such as radios, bicycles, and lanterns, as well as ownership of some types of farm equipment (ploughs, carts, etc.), however, farm equipment ownership is quite low, and TIA does not provide information for valuing household goods or farm equipment.

Table 3. Average Number of Drought Days per Province during the Primary Maize Growing Season, 1996-2006

Province	**1996**	1997	1998	1999	2000	2001	**2002**	2003	2004	**2005**	2006	average 1996-06	average 2002-06
Niassa	**51.8**	33.3	41.4	0.0	21.5	0.5	**3.1**	0.5	5.2	**22.5**	3.2	16.6	5.8
C.Delgado	**31.0**	15.8	18.6	0.9	7.3	4.4	**3.0**	4.4	3.4	**17.1**	3.0	9.9	5.9
Nampula	**18.6**	4.9	11.8	2.9	8.1	1.4	**1.6**	2.0	3.4	**24.4**	9.1	8.0	7.0
Zambezia	**5.4**	9.8	14.9	0.0	4.6	0.4	**14.0**	0.9	2.0	**43.1**	2.7	8.9	10.5
Tete	**32.4**	13.5	56.0	9.4	14.6	7.7	**44.2**	14.8	14.1	**45.5**	8.8	23.7	22.5
Manica	**6.2**	5.0	37.7	4.0	10.7	20.2	**56.5**	12.9	11.7	**63.4**	17.4	22.4	30.4
Sofala	**2.0**	3.7	15.6	0.3	17.5	14.1	**41.9**	4.5	8.0	**41.6**	2.4	13.8	18.7
Inhambane	**31.9**	27.7	53.8	7.1	18.1	9.5	**82.9**		36.5	**79.7**	17.5	36.5	45.2
Gaza	**17.4**	32.9	79.4	18.5	0.0	32.0	**105.9**	30.8	70.2	**112.9**	39.1	49.0	65.2
Maputo Prov	**66.0**	37.5	84.5	26.3	1.0	89.9	**73.4**	93.4	26.0	**93.8**	37.3	57.2	69.0

Source: authors' computations of drought days per dekadal, using FEWSNET dekadal rainfall estimates from satellite imagery, and the water balance model described in Appendix A-4.

While household expenditure data is considered by economists to provide a more reliable measure of household welfare than household income data (i.e., expenditure is the preferred measure of the dependent variable of interest to poverty research – household welfare), expenditure surveys often do not collect much household data which helps to explain why a given household has high or low expenditure (i.e., the independent variables). By contrast, data on income activities provide information on which specific activities are most important to poorer households, which activities are common among higher-income households (and thus indicative of higher returns), and how returns to the activities vary by household asset levels, access and use of technology, and village characteristics. Income data, therefore, enables analysis of specific income-generating activities and how to potentially improve returns to assets in specific activities.

3. LEVELS OF RURAL HOUSEHOLD ASSETS, ACCESS TO PUBLIC GOODS, AND TECHNOLOGY USE 2002-05

3.1. Basic Household Demographics and Indicators of Adult and Child Education Levels

The first objective of this paper is use welfare indicators available in the TIA 2002 and 2005 data to determine if rural household welfare in Mozambique has continued to improve beyond 2002. We begin by looking first at household asset levels, as these tend to fluctuate less over time than income.

In order to more appropriately compare households across time and space, many of the results in this paper use per capita or per AE measures. We first consider basic household demographics in 2002 and 2005, given the extensive use of household size in numbers and AEs as a numeraire in this paper, and given that family labor is the principal input into farm and non-farm activities for most rural households. The average household in rural Mozambique in 2005 contained 5.3 individuals, of which 2 to 3 individuals were prime-age adults (aged 15-59) and 2 to 3 were dependents – either children age 0-14 or adults over the age of 60 (Table 4). While the panel data show that average household size appears to have increased slightly from 5.0 members in 2002 to 5.3 in 2005, this should not be interpreted as evidence that household size in the population is increasing over time, as explained in more detail in the section on attrition above.

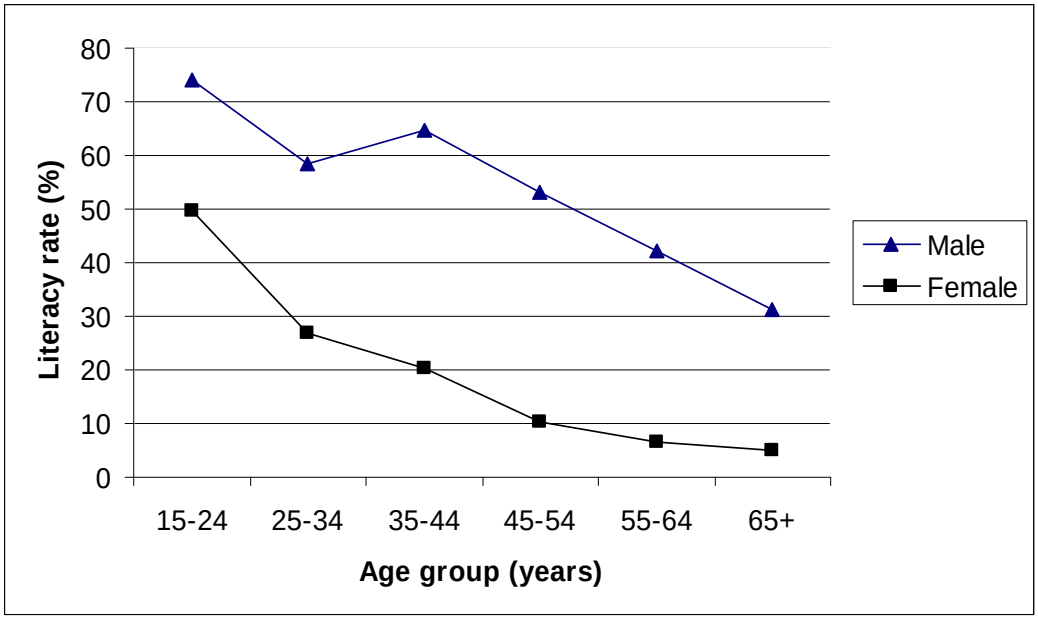
Demographic characteristics such as the gender of household head and dependency ratios are sometimes used as proxies for vulnerability, as conventional wisdom holds that female- and widow-headed households tend to have fewer economic opportunities and lower asset levels. The TIA panel results show that both female- and widow-headed households are more likely found in the lower income quintiles (Table 4). Poorer households tend to have slightly higher dependency ratios, though dependency ratios have remained roughly constant over time at an average of 1.2 dependents per prime-age adult. With respect to changes from 2002 to 2005, there has been a slight increase in the proportion of female-headed households (from 24 to 27%), yet we do not see an increase in proportion of widow-headed households (Table 4).[17]

We next look at human capital in the form of head's education level, maximum education level in the household, and various indicators of child schooling. Adult education is known to be an important determinant of long-term household and individual welfare, and has been shown in many developing countries to have an important effect on long-term household income by improving the probability of adoption of improved farm technologies and management practices, as well as improving household access to non-farm employment and self-employment opportunities. For example, previous research in Mozambique has shown head's education to be a significant factor in determining non-farm income (Walker et al. 2004), household expenditure levels (IAF), participation in cash cropping of cotton and tobacco (Benfica 2005) and, among tobacco growers, the sales value of tobacco (Boughton et al. 2007).

[17] While it is possible that some widow-headed households may have dropped out of the panel sample due to household dissolution, our attrition bias correction over-weights households which had prime-age (PA) illness or PA death in 2002, and thus likely corrects to some extent for the fact that widow-headed households are more likely to dissolve than other households.

The TIA05 instrument asked about the literacy status and highest schooling level achieved of all individuals over the age of 10. Based on these data, it appears that individuals require somewhere between 3-4 years of schooling to become literate.[18] TIA05 shows that the highest schooling grade achieved is still very low among heads in 2005 (average of 2.0 years in Table 4), and only 43% of heads are literate. However, heads' education levels should improve over time, as information on literacy by age shows that young adults age 15-24 are much more likely to be literate than adults just 10 years older (Figure 1), as about 75% of males and 50% of females age 15-24 are literate. This demonstrates that while child education has improved remarkably in the past 10 years, many rural Mozambican adults over age 25 remain illiterate, and the gender differential in adult literacy is quite large. Given that few individuals receive education as adults, it is likely that the increase in the average maximum education level achieved in the household from 3.2 to 3.6 years from 2002-05 (Table 4) is due to recent improvements in grade completion of children.

Figure 1. Adult Literacy Rates by Age Group, Rural Mozambique, 2005



Source: TIA05

[18] Our comparison of the literacy and years of schooling of all individuals over 10 abstracts from the reality that the quality of education may change over time, thus if schools improve, then it may take fewer years of schooling achievement to become literate.

Table 4. Rural Household Demographics and Education Levels of TIA 2002-05 Panel Households (Means and Percentages)

Quintiles of total net HH income/AE, 2002 & 2005	HH size (no.)		HH size (AE)		No. of prime-age adults (age 15-59)		Dependency ratio[1]		Head's age (yrs)	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
1-low	5.4	5.6	4.0	4.2	2.5	2.6	1.3	1.3	42.8	45.6
2	5.3	5.5	3.9	4.1	2.5	2.5	1.3	1.3	42.4	44.6
3-mid	5.0	5.2	3.7	3.9	2.4	2.5	1.2	1.2	42.0	43.6
4	4.5	5.0	3.5	3.8	2.3	2.5	1.0	1.1	41.3	45.0
5-high	4.6	5.1	3.5	3.9	2.4	2.5	1.0	1.2	41.8	43.7
total	5.0	5.3	3.7	4.0	2.4	2.5	1.2	1.2	42.0	44.5

Quintiles of total net HH income/AE, 2002 & 2005	Female-headed household (%)		Widow-headed household (%)		Head's years of education (yrs)		Maximum education in the HH (years)		School attendance of 10-11 year olds in 2005 (%)	
	2002	2005	2002	2005	2002	2005	2002	2005	Boys	Girls
1-low	32.8	35.6	14.0	12.6	1.8	1.4	2.9	3.2	71.2	67.5
2	28.2	28.3	10.6	8.4	1.8	1.7	3.0	3.4	69.9	69.8
3-mid	20.8	27.9	7.3	9.7	2.0	1.9	2.9	3.5	76.5	77.9
4	20.2	21.8	8.8	8.2	2.4	2.1	3.3	3.5	76.2	65.0
5-high	19.1	22.9	5.5	7.9	3.2	3.1	4.0	4.6	78.8	81.4
total	24.2	27.3	9.3	9.4	2.2	2.0	3.2	3.6	74.3	72.0

Quintiles of total net HH income/AE, 2002 & 2005	School attendance of 12-17 year olds in 2005 (%)		School advancement[2] of 10-14 year old boys		School advancement[2] of 10-14 year old girls		Years of education of 10 year old boys (years)		Years of education of 10 year old girls (years)	
	Boys	Girls	2002	2005	2002	2005	2002	2005	2002	2005
1-low	69.1	59.7	0.39	0.42	0.33	0.40	1.4	1.4	1.1	1.8
2	70.2	58.9	0.40	0.43	0.31	0.40	1.5	1.9	1.3	1.5
3-mid	75.3	60.7	0.41	0.46	0.32	0.39	2.0	2.0	1.0	1.6
4	72.2	61.8	0.40	0.45	0.32	0.43	1.8	1.7	1.6	1.7
5-high	78.0	68.6	0.45	0.53	0.39	0.48	2.2	2.2	1.8	2.0
total	72.9	61.8	0.41	0.46	0.34	0.42	1.7	1.8	1.4	1.7

Source: TIA02, TIA05

Notes: 1) Dependency ratio = (children age 0-14 + adults age 60 and over) / adults age 15-59); 2) School advancement = grade level achieved / (age - 6)

We next look at child schooling, which is well known to be vital to improving the long-term welfare of households and individuals. Studies from other African countries have shown that there are many factors which influence household decisions regarding whether or not their children attend school, remain in school over time, and achieve grade advancement every year of attendance. Without going into a complete review of this literature, some factors are related to the supply of education (from the perspective of a given household in a rural village), namely the distance from the village to the nearest school and the quality of instruction. Other factors are related to the household demand for child education, which is essentially a household investment decision in which the financial benefits of educated children (which are received only in the long-term) are compared with the extent and level of school fees as well as the household's estimation of the opportunity costs of the children's time, which could be used for household chores and farm activities. With respect to these demand-side factors, studies from other African countries have generally found that the decision with respect to each child is a function of household wealth level and preferences, which typically shows the following results:

- a positive correlation between child schooling and household wealth: children from wealthier families are more likely to attend school in a given year and to achieve higher grade levels prior to stopping schooling; this is often due to the higher opportunity cost of children's time for poorer households, which may chose to pull the children out of school so that they can complete household labor tasks; and
- a gender differential in attendance and schooling levels: boys are more likely to attend school than girls and to reach higher grade levels.

For example, using IAF 2002/03 data for rural Mozambique, Handa, Simler, and Harrower (2004), found that the probability that a child age 7-14 has ever attended school attends school increases with household wealth levels, decreases for girls, and falls dramatically as the distance from the village to the school increases. The wealth result is likely due to the opportunity cost of the child's time in household economy activities (helping with crop production, fetching water or firewood, etc.), which tends to be higher among poorer households, and the distance result is likely due to safety concerns (for younger children) as well as the higher opportunity cost for children of spending the extra time traveling to school.

There are several reasons to expect that child schooling indicators may have improved from 2002 to 2005. First, Ministry of Education data show that the number of primary schools in rural areas almost doubled from 1996 to 2005 (including an increase of 16% from 2002-2005) (World Bank 2007). Second, gross and net enrollment rates for primary school grades 1-2 (EP1) have improved from 40% to 83% from 1996 to 2006, according to the Ministry data (World Bank 2007).[19] Enrollment data from IAF household expenditure surveys confirm that there has been a a large increase in primary school enrollment in rural areas between 1996/97 and 2002/03 (World Bank 2007). Third, in 2004, the Mozambican government issued a ministerial decree abolishing the *Acção Social Escolar* (ASE) and all other fees and levies in primary education, beginning in the 2005 school year. While public primary schools charged a matriculation fee of about $5/year per child (prior to 2005), this amount still represented a serious constraint for many rural households, as 38% of communities in the 1996/97 IAF survey with a school in their village reported that some children did not attend school because it was too expensive (Handa, Simler, and Harrower 2004). Thus, the removal of the matriculation fee may well improve school attendance, as observed in TIA05.

There are various measures of child schooling, including: attendance rates, years attending school, highest grade completed, and school advancement. TIA collected information on child schooling of children age 10 or older, including grade level achieved in both TIA02 and TIA05, and attendance in TIA05. Beginning with attendance rates, we first consider attendance of 10-11 year olds in 2005, as studies from many developing countries have shown that, if a child is to be sent to school, it is more likely that he/she attends at younger ages, when they are less likely to be able to contribute substantially to household income activities. We see that the gap between attendance of 10-11 year old boys (74% in school) and 10 year old girls (72%) is perhaps not as large as one would expect (Table 4). As we might expect, average attendance rates are somewhat lower for boys (72.9%) and girls (61.8%) age 12-17, as families begin to demand their labor effort at older ages. To get a sense of just how much child schooling has improved in rural areas, consider that IAF found that child school current attendance of children 12-17 in rural areas was 51.5% for boys and

[19] As reported by World Bank (2007), these data are from the Ministry of Education and Culture (MEC) administrative data base; they may be somewhat higher than what would have been measured by household surveys.

33.2% for girls in 1996/97. When we look at attendance across groupings of fewer years, we see that attendance drops off considerably after age 14-15 for both boys and girls, though the decline is much faster for girls (Figure 2). This is consistent with findings in IAF and the Ministry data that show that secondary school attendance was very low as recently as 2002/03.

School advancement serves as a good summary of cumulative investment in each child's schooling as it encompasses various aspects of cumulative educational achievement: age at which the child begins school, school attendance, and efficiency of grade completion. School advancement is defined as follows:

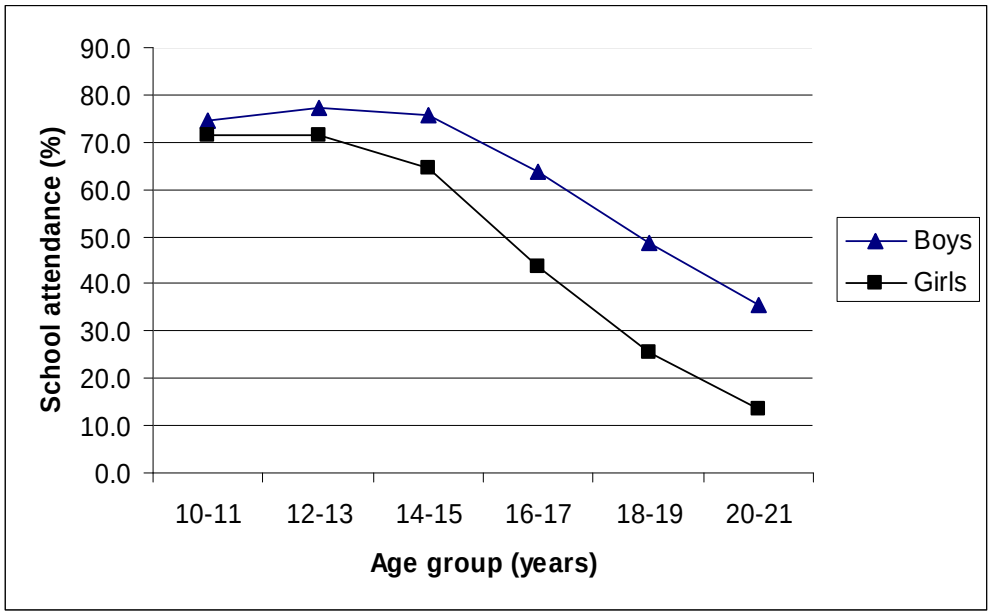
$$\text{School advancement}_k = \text{achieved grade level of child}_k \,/\, (\text{age of child}_k - 6) \qquad (1)$$

Where k= 1…m children aged 10-14 in the rural population

This school advancement indicator assumes that children should ideally begin school at age 7, and advance one grade level per year. Thus, a 10-year old who began school at age 7 and advanced one grade per year should be in the 4th grade by age 10, and would thus have a school advancement ratio of 1.0. A school advancement ratio lower than 1.0 indicates one or more of the following: the child started school late (at age 8 or older), did not advance one grade per year; or the child did not attend school continuously.

In our analysis, we only consider children between the ages of 10 and 14 because the TIA does not collect education data on children age 0-9, and we know from the attendance data (Figure 2) that school attendance begins to drop quickly for both boys and girls age 15 or above. The TIA data show that average school advancement ratio of all boys and girls age 10-14 increased from 2002 to 2005 (Table 4), which suggests that rural household investment in child schooling improved over this time period (although as noted above, household demand for schooling is but one of various factors which influence schooling outcomes).

Figure 2. Current School Attendance by Age Group, Rural Mozambique, 2005



Source: TIA05

While this is good news, the results also demonstrate that there is still much room for improvement: the fact that the average advancement ratio is 0.46 for boys and 0.42 for girls indicates that the majority of children are not starting school on time (at age 7), nor advancing one grade per year.

Consistent with findings from many other developing countries, the TIA education data show that children from wealthier households in rural Mozambique are more likely to attend school, have higher completed grade levels on average, and have higher school advancement (Table 4). It should be noted that because household income is endogenous to the child schooling decision in a given time period, more precise estimation of the relationship between household income or wealth levels and child schooling outcomes is warranted via regression analysis.[20] Nevertheless, the bi-variate evidence here (Table 4) strongly suggests that household income (wealth) is positively correlated with child schooling outcomes. While the extensive government effort to improve the supply of education (number of schools and teachers) is vital to improving child education outcomes in rural Mozambique, improving household incomes will also play an important role as well – to help poor households avoid having to choose between sending their children to school and achieving a reasonable level of household welfare in the near-term (or in other words, the decision between enjoying the benefits of greater access to non-farm employment and better farm management practices realized in the longer-term, versus the immediate short-term benefits of employing the child in farm or home production activities).

3.2. Household Health and Food Security Indicators

We next consider some of the household health and food security indicators which are collected by TIA. TIA was not designed specifically with the goal of establishing trends in various health indicators, as this is typically the job of the DHS. However, TIA has included some health indicators in recent surveys due to the interrelations between household health and household income, expenditure, and assets. For example, there is an abundance of literature that has demonstrated that healthier individuals (i.e., those which enjoy better nutrition and less illness and disease) are more productive in their economic activities. In recognition of the growing consensus across Sub-Saharan Africa that HIV/AIDS is not solely a health sector issue, but an issue of concern for economic development strategy as well, the TIA 2002 and 2005 survey instruments included a module which collected data on adult mortality and morbidity (neither of which is collected by DHS for all adults in Mozambique).

Analysis of the effects of adult mortality on household demographics, income and assets using the TIA panel data is beyond the scope of this paper, and is presented elsewhere (Mather and Donovan 2007; Mather et al. 2004). Our interest in this paper is simply to see if there is a noticeable trend in the incidence of PA chronic illness and PA death due to illness

[20] Endogeneity of income in child schooling decisions may stem from either the likely simultaneity of schooling and income activity decisions, as well as observable and unobservable household characteristics which reflect household opportunity costs and preferences for child schooling. We might expect that the endogeneity of household income to the child schooling decision would tend to bias the positive correlation (observed in the table) downwards, because poor households which choose to pull their children out of school may well improve their incomes as a result of the additional child labor.

Table 5. Health and Food Security-Related Indicators and Assets, TIA 2002-05 Panel Households

Quintiles of total net HH income/AE, 2002 & 2005	HHs with prime-age chronic illness[1] (%)		HHs with prime-age death due to illness[2] (%)		HHs with prime-age chronic illness or death (%)		HH has a latrine (%)	
	2002	2005	1999-02	2002-05	2002	2005	2002	2005
1-low	2.8	6.4	3.8	5.9	6.6	11.9	25.4	31.0
2	2.8	5.9	5.0	4.6	7.6	10.3	35.6	30.9
3-mid	2.9	6.5	4.1	4.2	6.8	10.4	34.1	40.8
4	2.9	3.4	3.6	4.6	6.0	8.0	39.4	42.9
5-high	2.0	4.1	3.6	6.5	4.9	10.3	56.2	61.0
total	2.7	5.3	4.0	5.2	6.4	10.2	38.1	41.3

Quintiles of total net HH income/AE, 2005	HH owns improved silo, 2005 (%)	No. of months of reserves of HH's basic food, 2005 (%)	HH had difficulty feeding family at some point in previous 12 months, 2005 (%)	No. of HH meals per day during lean season, 2005 (%)
1-low	8.6	4.8	52.4	1.9
2	9.6	6.1	40.7	1.9
3-mid	14.4	6.7	37.3	2.0
4	14.8	6.7	34.5	2.0
5-high	17.6	6.4	28.3	2.1
total	13.0	6.2	38.7	2.0

Source: TIA02, TIA05

Notes: 1) Prime-age chronic illness refers to a 15-59 year old household member who was ill for 3+ months within the previous 12 months. 2) Prime-age death in this table refers to an illness-related death of a 15-59 year old household member during the period 1999-2002 (for the 2002 column) or 2002-2005 (the 2005 column).

from 2002 to 2005, and whether or not incidence appears to vary by household income.[21] The TIA data show that both incidence of PA illness cases and PA death due to illness are increasing from 2002 to 2005 (Table 5).[22] This result is consistent with findings from the only seroprevalence data in Mozambique (antenatal clinic data), which indicate rising HIV/AIDS prevalence in many areas of the country in recent years. Nearly 10% of households reported either the death of a PA adult due to illness, or a chronically-ill PA adult member, during the 12 months prior to the TIA 2005 interview. In contrast to research from other countries which has found that HIV-related death and illness is associated with higher household wealth (i.e., those with money and mobility are more likely to have more sexual partners), and in other countries with poverty (i.e., poorer women who may agree to exchange sex for food, cash, etc.), there appears to be no clear bi-variate correlation between household income and PA illness and death in rural Mozambique.[23]

[21] Prime-age chronic illness is defined as an adult whom is ill for 3 or more months in the past 12 months of the 2002 and 2005 surveys; a PA death in 2002 is defined as a PA death due to illness which is occurred between 1999 and 2000, and a PA death 2005 indicates a PA death due to illness which occurred between 2002 and 2005.

[22] The TIA did not include seroprevalence sampling, thus cannot tell us whether illness-related deaths were due to HIV/AIDS or some other illness. However, it is clear from cross-country analysis of HIV prevalence and adult mortality that countries with higher HIV prevalence are experiencing higher and higher adult mortality rates (Ngom and Clark 2003).

[23] See Mather and Donovan (2007) for a more in-depth consideration of the potential correlation between ex ante and ex post household income.

Latrine ownership is an important health-related household asset which is recorded by TIA. DHS surveys show that the number of rural Mozambican households with latrines increased from 26% in 1997 to 36% in 2003. TIA data show that 38% of rural households had a latrine in 2002, and that this number increased to 41% in 2005. As one might expect, households in the highest income quintile are much more likely to have a latrine (61%) than those in the lowest quintile (31%). Two additional household or village-level assets which have been shown to have significant effects on health outcomes (but not collected by TIA) include distance to safe water and distance to the nearest health post. Such variables are likely to also be of use for analyses of rural income activities. For example, the distance from a village to the nearest source of safe water is likely to have a significant effect on the household demand for women and children's time spent on domestic tasks such as water gathering. As the time it takes for women and children to complete these domestic tasks increases, the probability that women participate in high-return crop or non-farm activities will likely decline, as will the probability of child school attendance.[24]

TIA05 included a range of food security indicators, a few of which are shown here by quintiles of household income/AE (Table 5). Food security is typically defined for a household or individual as access all the time to sufficient food and nutrition for a healthy and productive life. In rural Mozambique, individuals typically access food via own production, social networks, payment-in-kind for wage labor, and/or market purchase. Because the value of food crop production accounts for a majority of rural household income in Mozambique, we would expect that households with higher income/AE would be more likely to be food secure (because their crop production value is relatively high). We would also expect households with higher income/AE to be more likely to have the cash or assets required to purchase food in markets, when necessary. Thus, the correlations between each of the TIA05 food security indicators shown and household income/AE are as we would expect. There is a positive correlation between household income/AE and *household owns an improved silo in 2005*, *number of months of reserves of household's basic staple food in 2005*, and *number of household meals per day in lean season in 2005*. As we would expect, there is a negative correlation between income/AE and *household had difficulty feeding family during lean season in 2005*. It is important to note that these correlations cannot tell us the direction of causality between income and each food security indicator. For example, a household which owns an improved silo is more likely to be relatively wealthy to begin with (i.e., initial household wealth might cause a household to purchase an improved silo), though owning an improved silo can improve a household's income, as effective grain storage can help a household avoid the large margin between farmgate grain prices at harvest and retail grain prices during the lean season (i.e., owning an improved silo might cause household income to increase).

3.3. Household Physical Farm Assets

Apart from labor, land is the primary physical asset used by rural Mozambican households for food production and income generation. Rural households in Mozambique gain access to

[24] These variables were probably not collected by TIA because they are considered to be of principal relevance to the 'health sector'. However, the examples given here suggest that some basic information regarding access of households to safe water, health posts, primary schools, etc. would be quite useful when combined with TIA data on income, assets, and activity choices.

land not through title but through use rights to parcels in and around the village.[25] While there may be more than one source to which a household in a given village might appeal for use rights to a specific parcel, such use rights are typically given to small holders by the local village leader(s) and/or the head of the household's lineage (extended family) in the area (Marrule 1998). Within the framework of the predominant lineage system in the area (matrilineal or patrilineal), parcel allocation is usually based upon household size (consumption requirements and the ability to maintain cultivation), though other factors can include social connections to village leadership and the political strength of the household's lineage (Marrule 1998). There is essentially no land rental market in Mozambique, as fewer than 5% of parcels in the TIA 2002 sample were reported to be rented.

While TIA collects data on land use by parcel, our consideration here is with total household landholding, which is the aggregation of parcel area cultivated to annual and perennial crops as well as area in fallow. Given that TIA02 found that some 85% of households declared that it was 'easy to obtain additional land' in their village, and that household size increased by 0.3 members on average from 2002 to 2005, it is perhaps not surprising that we find that average household landholding increased from 2002 to 2005 for most households, with the exception of those in the top income quintile (Table 6). After adjusting landholding by AE, we see that land access/AE among rural households stayed approximately constant from 2002 to 2005, on average. However, the average land access/AE increased among households in the lower four quintiles (note that these quintiles are computed for each year, thus they do not track household by 2002 quintile over time), while the average for the top quintile fell. Another physical asset of great importance to many rural households is livestock, which are primarily used for home consumption and income generating activities (sales of live animals, meat, or products such as milk, eggs, etc.). Some households may also invest in livestock as a form of insurance against adverse events such as drought and floods which may cause crop failure. We convert the number of cattle, donkeys, pigs, goats, sheep, chicken, geese, and rabbits owned by each household into tropical livestock units (TLU) (using TLU conversion ratios from FAO).[26] We find that TLU/AE fell from 2002 to 2005 (Table 6), which is most likely due to significant losses of chickens in various parts of the country in 2005 due to the spread of Newcastle disease (this is confirmed by TIA data which records losses of chickens due to illness). The percentage of households which own cattle remains very low, those with medium-size livestock (pigs, goats, or sheep) remained the same at around 36%, and those with poultry fell considerably from 70% to 59%. Given that chickens are the livestock which are most easily accessible by poorer rural households, the widespread loss of poultry from 2002 to 2005, already targeted for further research, is likely to be an issue of concern for policymakers.[27]

Consistent with the positive trends seen from 1996 to 2002/03 in IAF, DHS, and TIA, the TIA panel data demonstrate that, on average, rural households in Mozambique have continued to increase their asset holdings from 2002 to 2005, notably in land access and

[25] Technically, all land in Mozambique is owned by the State. In addition, the TIA surveys of 2002 and 2005 include information on the source of each parcel which a given household uses, and this information shows that less than 15% of parcels are obtained through government programs and through purchases, usually without a title (Walker et al. 2004).

[26] One cow = 1 TLU; pigs = 0.4 TLU; sheep/goats = 0.2 TLU; chickens = 0.02; turkeys/geese/ducks = 0.06; rabbits = 0.04 TLU as per FAO (2007).

[27] A few NGOs began distribution of vaccinations to reduce the spread of Newcastle disease in chickens in several provinces in 2004. An ongoing study by the Institute of Agricultural Research of Mozambique (IIAM/ MSU) seeks to estimate the extent of vaccination use, the farm level costs and benefits of vaccine use, and the overall economic impact of these vaccination programs.

Table 6. Physical Assets of Rural Households, TIA 2002-05 Panel Households

Quintiles of total net HH income/AE, 2002 & 2005	Total landholding (ha)		Total landholding/AE (ha/AE)		Tropical Livestock Units/AE (#/AE)		HH owns cattle (%)		HH owns pigs, sheep or goats (%)	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
1-low	1.45	1.63	0.378	0.432	0.185	0.150	4.4	5.1	33.3	30.3
2	1.63	1.84	0.454	0.499	0.187	0.180	3.4	3.5	34.7	36.4
3-mid	1.84	1.91	0.539	0.557	0.200	0.177	3.4	2.8	36.3	34.6
4	1.94	2.18	0.609	0.670	0.265	0.224	3.6	4.7	37.8	39.2
5-high	2.59	2.41	0.875	0.723	0.471	0.477	6.1	7.2	42.4	43.7
total	1.89	1.99	0.571	0.576	0.262	0.242	4.2	4.7	36.9	36.8

Quintiles of total net HH income/AE, 2002 & 2005	HH owns chickens, ducks, geese or turkeys (%)		HH's house has durable walls (%)		HH's house has durable roof (%)		HH owns a bicycle (%)		HH owns a radio (%)	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
1-low	61.4	51.4	29.0	41.6	8.9	9.9	12.7	20.9	35.2	36.7
2	70.3	59.3	35.7	46.4	9.7	10.6	20.4	27.8	43.5	45.1
3-mid	71.4	58.5	37.2	43.5	8.6	10.8	25.5	31.8	50.1	51.0
4	72.4	59.8	40.9	45.5	9.2	14.9	25.5	36.9	53.7	59.9
5-high	74.2	65.2	43.7	43.6	22.0	28.5	32.2	37.2	66.7	73.0
total	70.0	58.8	37.3	44.1	11.7	14.9	23.2	30.9	49.8	53.1

Source: TIA02, TIA05

Notes: Durable walls are made of zinc plates or luzalite tiles; durable roof is made of clay, concrete or zinc. One cow = 1 TLU; pigs = 0.4 TLU; sheep/goats = 0.2 TLU; chickens = 0.02; turkeys/geese = 0.06; rabbits = 0.04 TLU as per FAO (2007).

ownership of goods such as bicycles, radios, and have improved the durability of their houses (Table 6). As mentioned above, the 2005 statistics from panel households (or from the entire TIA02 sample) are not strictly representative of the whole population in 2005 (even though we have corrected for panel attrition bias), although they are likely to be quite close to population values.

3.4. Household Access to Public Goods

So far we have considered levels of rural household assets, and the extent to which these levels have changed over time. We next consider factors which can significantly increase the returns to household assets: household access to public goods and to new and improved technologies. We concentrate here on public goods and use of improved agricultural technology with respect to crop production, as crop income is the principal component of total household income among the majority of rural households in Mozambique (Table 13). TIA collects information on several public goods which help facilitate the smooth functioning of markets of both crop inputs and outputs, such as rural road infrastructure, radio broadcasts of market price information, and public agricultural research and extension.

Road infrastructure plays an important role in fostering market development and household market participation by driving down the costs of trade across villages, districts, provinces, and even countries. Rural roads are a classic public good because the costs of excluding potential users of the road are often prohibitive. Our measure of road infrastructure is a district-level measure of the kilometers of total roads (i.e., both primary and secondary roads) per 1,000 square kilometers which is derived from geographic information system data

(GIS).[28] When we match this district-level variable with TIA data on rural household incomes, we see a positive association between household income and total road density (Table 7). While there are good reasons to think that higher road density may be causing household incomes to increase, road construction in many countries has been shown to have been targeted to wealthier areas (and thus endogenous to household incomes). Thus, without more sophisticated analysis and additional data (i.e., observations of road density for more than one year – which we have not been able to find), it is not clear if the positive association between household incomes and road density seen here is due to the intentional construction of roads in areas with higher agroecological potential, or whether the presence of roads has improved household incomes.

Agricultural extension messages often have public good qualities as well, given that an extension agent who gives a specific farmer advice on crop management practices such as crop rotation, line sowing, soil management, etc. would face high costs of excluding that information from other neighboring farmers. For example, even assuming that farmers would be willing and able to pay for such advice, a private firm would have trouble selling such extension information to farmers given that only one farmer per village would likely pay for it, because the others could avoid paying the fee and just ask the farmer what he heard. The same logic also extends to the research cost which is required to discover which set of crop management practices make the most sense by economic and agronomic criteria for farmers in a given area (which often entails research using on-farm trials) – such research would not likely be undertaken by a private firm because the firm would not be able to exclude non-paying farmers from obtaining the information about the recommended crop management practices, once a few paid customers had discovered it.

The TIA survey instruments asked households in both 2002 and 2005 if they received an extension agent within the previous 12 months. Unfortunately, the question does not ask the respondent to distinguish between different types of extension agents – such as those from government, Non-governmental Organizations (NGOs), and firms, although the TIA05 questionnaire asked the respondent about the content of the extension advice (i.e., was the extension visit related to crop production, livestock, etc.). The TIA panel shows that 13 % of households received extension in 2002, and 14.8% in 2005 (Table 7). However, just looking at the percent of households which receive extension advice in a given year may not tell us the extent of extension coverage over the 3-year panel, if different households are visited in the two years, and if the benefits of an extension visit are not exclusive to the year of the visit. That is, if an extension visit in 2002 results in a farmer adopting a new crop management technique, or a new input purchased from a private input dealer or output firm, then it is possible that the farmer will continue with that new technique or input in following years, regardless of whether the farmer receives another extension visit.[29] The TIA panel data show that 26% of households received an extension visit in either or both years,[30] while 74% did not receive an agent in either year.

We see a clear positive relationship between extension access and household income. However, as in the case of road density, we have to consider the challenging methodological issue of the direction of causality – are extension workers targeting the wealthier farmers, or

[28] This GIS road infrastructure data was obtained by an International Food Policy Research Institute (IFPRI) researcher from the Ministry of Transportation, but the ministry officials did not know the year of the data.
[29] Whether or not an extension visit results in a change in the farmers' input decisions in subsequent years depends upon the nature of the technology and whether or not the extension agent offered a subsidy for adoption in the first year which is not offered in subsequent years.
[30] The TIA panel data show that 10% of households received an extension visit in 2002 yet none in 2005, 12% received a visit in 2005 but not in 2002, 3.6% received a visit in both 2002 and 2005.

does the extension advice result in higher incomes for households which meet with an extension agent? There is considerable evidence from other developing countries that extension is often targeted to wealthier farmers, often for a variety of reasons. First, if wealthier farmers are more likely to live closer to accessible roads, extension agents with severe transportation budget constraints may target wealthier farmers simply because it costs less in terms of time and fuel to reach them. Second, targeting extension to wealthier farmers is sometimes an intentional strategic decision of the extension program, as wealthier farmers are more likely to be able to adopt the extension recommendations, and may intentionally be used as model or demonstration farmers, which can play a valuable role serving as a local example for other farmers who are less able to take the initial risk of adopting a new technology or technique.

Table 7. Rural Household Farm Input Use and Access to Public Goods, TIA 2002-05 Households

Quintiles of total net HH income/AE, 2002 & 2005	HH used animal traction (%)		HH used chemical fertilizer (%)		HH has non-manual irrigation system (%)[a]		HH hired temporary labor (%)	
	2002	2005	2002	2005	2002	2005	2002	2005
1-low	8.4	6.2	1.5	1.7	0.4	0.4	4.6	6.5
2	10.3	7.6	3.1	3.0	1.1	0.7	8.3	9.5
3-mid	9.1	7.6	2.3	4.0	1.7	1.1	13.9	14.6
4	9.7	9.0	4.2	3.1	0.7	1.3	18.5	21.1
5-high	18.6	16.1	7.5	6.7	2.2	2.0	32.2	36.3
total	11.2	9.3	3.7	3.7	1.2	1.1	15.5	17.6

Quintiles of total net HH income/AE, 2002 & 2005	Total road density (km roads per 1000 km^2)[b]		HH received price information (%)		HH received extension agent (%)		HH belongs to farm association (%)	
	2002	2005	2002	2005	2002	2005	2002	2005
1-low	48.5	49.1	24.0	28.0	8.7	10.5	1.5	4.1
2	48.9	49.0	29.5	36.6	12.3	11.0	2.4	4.6
3-mid	50.1	50.7	36.8	42.3	14.1	14.6	5.1	7.0
4	51.1	50.2	41.6	46.2	15.8	18.8	3.7	8.2
5-high	53.1	52.8	40.7	48.4	16.8	18.8	5.7	8.0
total	50.3	50.3	34.5	40.3	13.5	14.8	3.7	6.4

Quintiles of total net HH income/AE, 2005	HH used improved food crop variety, 2005 (%)	HH cultivated in rows, 2005 (%)	HH practiced crop rotation, 2005 (%)	HH obtained credit from NGO, govt or firm, 2005 (%)
1-low	4.7	34.3	34.0	1.9
2	4.8	38.6	36.0	2.9
3-mid	6.6	39.7	38.3	3.2
4	7.3	46.8	37.9	3.9
5-high	9.7	51.2	39.6	5.8
total	6.6	42.1	37.2	3.5

Source: TIA02, TIA05

Notes: a) Non-manual irrigation = HH owns pump equipment or gravity irrigation system; b) Total roads is a district-level measure of both primary (year-round) and secondary roads

The availability of panel data on both household incomes and extension visits enables us control for initial levels of household wealth, and thus to sort out the direction of causality between household income and extension access. The results from multivariate regression analysis of the effects of an extension visit on crop income are mixed (Mather forthcoming); preliminary results suggest that there are some significant and positive effects of extension access, though they are more likely found over time (i.e., not in the year of the extension visit) and are larger for farmers growing cash crops. Thus, while it appears that extension agents may be targeting wealthier farmers in some regions, there is also evidence that extension visits have a positive effect on crop income over time.

Basic market price information also has the qualities typically associated with a public good because the collection of market prices requires large fixed costs, the costs of dissemination are relatively small, and exclusion costs are very high. In other words, once the high fixed cost of collecting the market price information is paid, it costs very little to disseminate this information, and it would be prohibitively costly for the seller of such price information to try and prevent any given buyer from sharing such information with their neighbors at no cost. For example, dissemination of market price information requires some cost, such as paying for space in a newspaper or air-time on a radio show (neither of which are costless). But once the information is published in a paper or broadcast over the radio, it is prohibitively costly for the provider to ensure that every individual who receives the information pays something for it. As print media coverage is low in Mozambique and radio broadcasts do not reach all villages (and some households which do not have radios may not receive such information from their neighbors who have radios), coverage is far from universal. However, TIA data shows that coverage appears to be increasing (Table 7), as the percentage of households which received price information (via radio, newspaper, NGO, farmer association) increased from 34% in 2002 to 40% in 2005.

Public dissemination of market price information can improve market in various ways. First, it can lower the entry costs for traders/assemblers and thus increase the number of such traders/assemblers and thereby help ensure that small groups of traders (oligopolies) are not able to collude in such a way as to depress prices paid to farmers below prices which would prevail under a scenario of perfect competition (i.e., costless information for all participants, and large numbers of both buyers and sellers). Second, from the perspective of a rural household producer, market price information generally enables farmers to obtain higher prices from intermediaries than they would have obtained in the absence of publicly-available market price information (because otherwise, these farmers would incur search costs for price information, which often may be prohibitive). Third, from a societal perspective, market price information facilitates broad-based household participation in markets; often recognized as one of the key drivers of growth and prosperity.

As with the other public goods, household receipt of price information is positively correlated with household income. While we might expect wealthier households to have better access to price information (because they own a radio), a recent regression analysis – which uses a panel econometric technique which enables us to control for initial household wealth levels (Mather forthcoming) – finds that receipt of price information had a significant, positive effect on household crop income in the Center and South regions in 2002-2005.

Household membership in a farmers' association is considered by economists to be a club good, in which benefits are obtained through collective action but accrue only to members (i.e., the club can exclude non-members from enjoying the benefits). A typical example would be a cooperative in which members join together to obtain financing and better prices

for inputs and outputs (both by reducing transaction costs and offering enough volume – as buyers or sellers – to give them more market power than they would have as individual farmers).

Some have argued that farmer associations provide a key to improving farmer access to new and improved technology (inputs such as improved seed, fertilizer, animal traction; and management practices) and output markets. Perhaps with these goals in mind, some farmer associations in Mozambique have received financial assistance from the government and/or training assistance provided by non-profit organizations like the Cooperative League of the United States of America (CLUSA) and World Vision. Given the interest in and support of farmer associations, it begs the question of whether TIA data can help test the effect of a household's participation in such an association has a significant effect on the household's crop income.

Rural household participation in farmer associations was 6.4% in 2005, though this percentage varied widely by province, ranging from 3.6% in Inhambane to 17.6% in Maputo Province (Appendix Table 4). Participation increased from 3.9 to 6.4% nationally from 2002 to 2005, although a few provinces accounted for much of this increase: Niassa (3.2 to 12.9%), Gaza (3.5 to 11.2%) and Maputo Province (12.4 to 17.6%) (Appendix Table 4). As with the other public goods, the TIA data show a positive correlation between membership in a farmers' association and household income. The results from multivariate regression analysis (Mather forthcoming) which controls for initial wealth levels finds that membership in a farmer associations does not have a significant, positive effect on crop income in the South and Center. This implies that households which tend to join such associations in these regions tend to be wealthier prior to joining. However, the analysis did find significant positive effects of farmer association membership in the North region in 2002-2005.

3.5. Household Use of Improved Agricultural Technology

Household adoption of improved agricultural technologies is vital to improving the returns to land and labor over time. For both 2002 and 2005, TIA has information on household use and ownership of animal traction, ownership of non-manual irrigation equipment, and use of chemical fertilizer, pesticides, and herbicides. For 2005 only, TIA has information on household use of improved varieties and management practices such as crop rotation, row planting, and intercropping.

While the use of animal traction increased from 7% of households in 1996 to 10% in 2002, it fell to 9.3% in 2005 (Table 7). There is virtually no use of animal traction in the northern provinces due to higher animal disease and pest pressure (Appendix Table 4). While use of animal traction is associated with higher household income (Table 7), regression analysis (Mather forthcoming) which controls for initial wealth levels has found that use of animal traction increased crop income by 31% in the Center in 2002-2005. Because this analysis controlled for landholding over time, we can interpret this result to mean that animal traction use not only increases landholding (Mather forthcoming) – which is positively correlated with both total income and crop income – but it also has a significant, positive effect on crop productivity, perhaps due to improved soil aeration and weed control.

Use of chemical fertilizer increased from 1% of households in 1996 to 3.7% in 2002, but remained at that same level in 2005 (Table 7). The majority of this fertilizer is used on tobacco, obtained on credit from tobacco companies; Tete and Niassa are the location of most

tobacco producers, and also where most fertilizer is used (Appendix Table 4). Only 3.5% of households received credit from an NGO, government or firm. As with fertilizer, most credit access is in Niassa and Tete and thus is likely derived from farmer contracts with tobacco firms.

Use of non-manual irrigation equipment did not increase from 2002-05, and remains very low at 1.1% of households (Table 7). Nearly all of this irrigation is in Gaza, most likely near Chokwe (Appendix Table 4). In 2005, only 6.6% of households purchased seed of an improved food crop variety (Table 7).[31] Many of the improved inputs and management techniques (cultivating in rows, crop rotation) are positively correlated with household income, though as with the public goods above, more analysis is required to determine the direction of causality between household crop input decisions and household income.

In sum, TIA showed some increases in input use from 1996 to 2002 (Boughton et al. 2006), but there has been no improvement since then. Given that improved input use remains very low, there is little reason to expect crop productivity to have improved since 2002. In fact, given the very low levels of use of animal traction and chemical or organic fertilizers, there is reason to suspect that, in the absence of adoption of improved inputs, food crop productivity may decline as soils begin to tire.

3.6. Implications of Findings on Household Asset Levels, Access to Public Goods, and Input Use

Some analysts believe that much of the growth in agricultural production and crop income in rural Mozambique since 1994 has primarily come from agricultural extensification (increasing area cultivated) and very little from intensification (increased productivity via higher levels of inputs and/or shifting area into higher-return cash crops) (World Bank 2007). Given the continued low levels of fertilizer and animal traction use (both of which help to improve crop yields and maintain soil fertility), it seems doubtful if continued area expansion by manual cultivation will continue to generate growth in crop income over time, without some increase in the adoption of improved inputs and/or increased production of higher-value crops.

[31] While it is possible that a larger number of households is using improved varieties of food crops, TIA05 only asked about varietal source if the seed was purchased.

4. HOUSEHOLD INCOME LEVELS

4.1. Variation in Household Income Levels over Time

Because the distribution of rural household income in Mozambique has a large positive skew, the mean of 3,344 MTN/AE is nearly double the median of 1,715 MTN/AE in 2005 (the same skew is seen in 2002 income) (Table 8). This positive skewness is perhaps best portrayed by a histogram of total net household income/AE from 2005 (Figure 3), which shows that even though this paper uses household survey data from only small and medium-size farm households in rural Mozambique, that there is a small group of rural households which earn considerably more income than the majority, and thus pull the mean of the income distribution well above the median.[32] Therefore, the mean value of income figures from TIA is less indicative of the welfare situation of the majority of households than the median because the computation of the mean makes it highly sensitive to extreme values.

When we compare mean and median household incomes over time, we see that the mean of total net household income per AE of panel households rose 15% from 2002 to 2005, but median income/AE fell -1% (Table 8). Given that we observe a rising mean and a falling median, we look in more depth at the distribution of income and income change. Mean household income/AE of households in the top income quintile (Table 9a) for each year (the top 20% of households ranked by income in 2002 and in 2005) increased 25% from 2002 to 2005, while that of households in the lowest income quintile in each year (the bottom 20%) fell -22%. In other words, the distribution of income became wider in 2005, as the poorest households in 2005 are considerably poorer than the poorest households in 2002, while the wealthiest households in 2005 are considerably wealthier than the wealthiest households in 2002. However, the sample mean increased over time because the increases at the top of the distribution were larger than the declines at the bottom of the distribution.

This result does not mean that the poor in 2002 became even poorer in 2005 (while the wealthier in 2002 became even wealthier in 2005) because these tables are not tracking the same households over time. Ranking households by their 2002 quintiles of income/AE and then considering their income in 2002 and 2005 (Table 9b and 9c) demonstrates that when we track the same households over time using the TIA panel data, the poorest households in 2002 enjoy increases in income (on average) from 2002-05, while the wealthier households in 2002 experienced reductions in income from 2002-05. While this at first appears to indicate poverty reduction from 2002-05, recall that the poorest households in 2005 have lower average income than the poorest households in 2002.

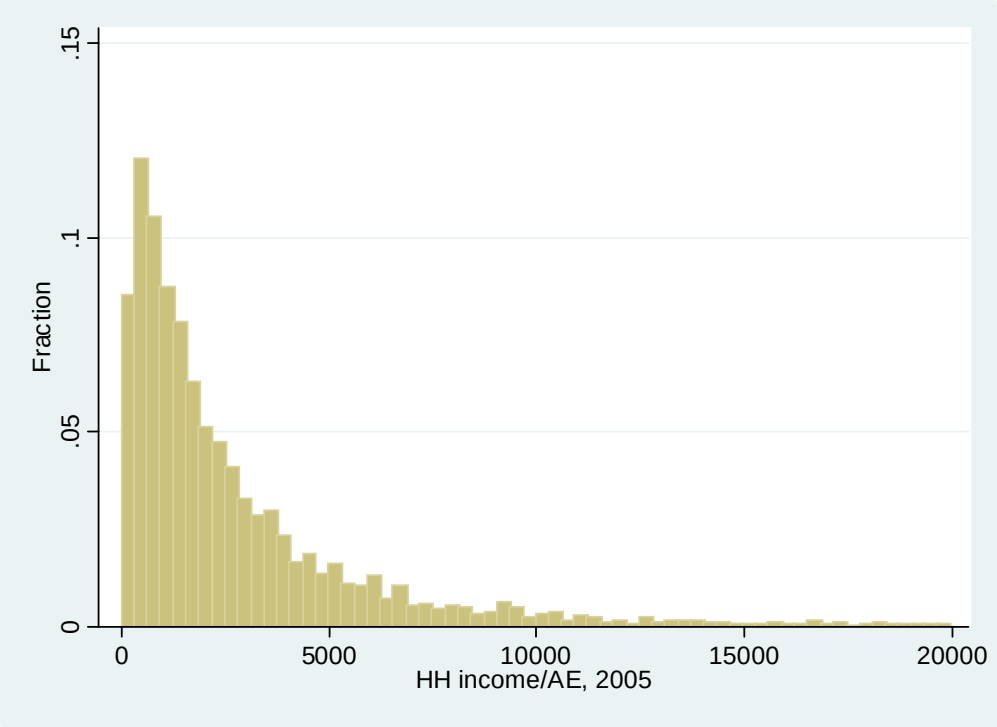
[32] The mean is not being pulled up simply by the presence of medium-size farms (which tend to have higher income than small farms), because these cases receive considerably smaller sampling weights in any statistical analysis here (as they represent a much smaller proportion of the population than small farmers)

Table 8. Mean/MedianTotal Net Rural Household Income by Province, 2002-05 (2005 MTN)

	Means				Medians		
Province	Total Net HH Income per AE, 2002	Total Net HH Income per AE, 2005	% change in means, 2002-05	Province	Total Net HH Income per AE, 2002	Total Net HH Income per AE, 2005	% change in medians, 2002-05
Niassa	3,437	3,530	3%	Niassa	2,059	2,289	11%
C.Delgado	2,675	3,446	29%	C.Delgado	1,720	1,870	9%
Nampula	2,923	2,864	-2%	Nampula	2,032	1,485	-27%
Zambezia	2,333	2,186	-6%	Zambezia	1,399	1,303	-7%
Tete	2,944	3,436	17%	Tete	1,644	1,559	-5%
Manica	2,201	3,153	43%	Manica	1,381	1,583	15%
Sofala	1,993	3,892	95%	Sofala	1,281	1,954	53%
Inhambane	4,541	5,004	10%	Inhambane	2,512	2,734	9%
Gaza	3,489	4,601	32%	Gaza	1,577	2,676	70%
Maputo Prov	5,377	7,145	33%	Maputo Prov	3,354	3,343	0%
Total	2,920	3,344	15%	Total	1,750	1,715	-2%

Source: TIA02, TIA05

Figure 3. Frequency Distribution of Total Net Household Income per Adult Equivalent, Rural Mozambique, 2005



Source: TIA05
Notes: mean = 3,344 MTN/AE, median = 1,715 MTN/AE; figure excludes the top 1% of cases.

Table 9a. Mean/Median Total Net Household Income/AE by 2002 and 2005 Income Quintiles, 2002-05 (Panel Households; 2005 MTN)

	Mean				Median		
	2002	2005	2002-05		2002	2005	2002-05
2002 & 2005 Quintiles of net HH Income/AE	Total Net HH Income per AE	Total Net HH Income per AE	% change in means	2002 & 2005 Quintiles of net HH Income/AE	Total Net HH Income per AE	Total Net HH Income per AE	% change in medians
1 - low	445	347	-22%	1 - low	466	351	-25%
2	1,053	924	-12%	2	1,052	908	-14%
3	1,766	1,739	-2%	3	1,749	1,723	-1%
4	2,855	3,178	11%	4	2,771	3,077	11%
5 - high	8,420	10,573	26%	5 - high	5,854	6,853	17%
Total	2,908	3,351	15%	Total	1,749	1,723	-1%

Table 9b. Mean/Median Total Net Household Income/AE by 2002 Income Quintile, 2002-05 (Panel Households; 2005 MTN)

	Mean				Median		
	2002	2005	2002-05		2002	2005	2002-05
2002 quintiles of net HH Income/AE	Total Net HH Income per AE	Total Net HH Income per AE	% change in means	2002 quintiles of net HH Income/AE	Total Net HH Income per AE	Total Net HH Income per AE	% change in medians
1 - low	445	2,016	353%	1 - low	466	1,032	121%
2	1,053	2,139	103%	2	1,052	1,417	35%
3	1,766	2,909	65%	3	1,749	1,585	-9%
4	2,855	3,376	18%	4	2,771	2,066	-25%
5 - high	8,420	6,316	-25%	5 - high	5,854	3,111	-47%
Total	2,908	3,351	15%	Total	1,749	1,723	-1%

Table 9c. Mean/Median Total Net Household Income/AE by 2005 Income Quintile, 2002-05 (Panel Households; 2005 MTN)

	Mean				Median		
	2002	2005	2002-05		2002	2005	2002-05
2005 quintiles of net HH Income/AE	Total Net HH Income per AE	Total Net HH Income per AE	% change in means	2005 quintiles of net HH Income/AE	Total Net HH Income per AE	Total Net HH Income per AE	% change in medians
1 - low	1,991	347	-83%	1 - low	1,164	351	-70%
2	2,381	924	-61%	2	1,543	908	-41%
3	2,297	1,739	-24%	3	1,583	1,723	9%
4	2,993	3,178	6%	4	2,105	3,077	46%
5 - high	4,876	10,573	117%	5 - high	2,730	6,853	151%
Total	2,908	3,351	15%	Total	1,749	1,723	-1%

Source: TIA02, TIA05; panel households

When we follow panel households over time (Table 10a), we see that there is rather dramatic relative mobility of households from 2002 to 2005 across quintiles of income/AE computed for each year. In the interest of controlling for potential measurement error or one-time household-specific increases or decreases in household income (due to unobserved factors), we regress household income/AE on household assets and district dummies and then re-compute household quintiles using predicted income/AE for each year. We still find that 25-40% of households in a given 2002 income/AE quintile are still in that quintile in 2005 (Table 10b).[33] In other words, there is a substantial amount of income mobility both upwards and downwards across the two years of observed income data.

Table 10a. Crosstab of Panel Household Mobility Across 2002 and 2005 Quintiles of Income/AE

2002 quintiles of ln(net HH Income/AE)	2005 quintiles of ln(net HH Income/AE)					
	1 - low	2	3	4	5 - high	Row total
1 - low	34.0	22.7	18.1	13.8	11.5	100.0
2	22.9	22.1	25.3	19.6	10.1	100.0
3	20.0	20.3	23.2	18.6	18.0	100.0
4	12.7	22.2	19.2	24.1	21.9	100.0
5 - high	11.3	13.2	14.6	23.7	37.2	100.0
Total	20.1	20.1	20.1	20.0	19.7	100.0

Table 10b. Crosstab of Panel Household Mobility across 2002 and 2005 Quintiles of Predicted Income

2002 quintiles of predicted ln(net HH Income/AE)	2005 quintiles of predicted ln(net HH Income/AE)					
	1 - low	2	3	4	5 - high	Row total
1 - low	48.4	24.0	13.2	10.3	4.1	100.0
2	24.2	25.2	23.0	17.0	10.6	100.0
3	15.0	20.2	25.1	20.8	19.0	100.0
4	9.7	20.4	23.1	23.4	23.4	100.0
5 - high	4.2	10.6	15.1	28.4	41.7	100.0
Total	20.1	20.0	19.9	20.1	20.0	100.0

Source: TIA02, TIA05

The household income mobility matrix (Table 10a) demonstrates empirically one of the disadvantages of using income as a welfare indicator in an economy dominated by rainfed agriculture, as a given household may have high (low) income on average over a range of years, but when we observe their income at only one or two points in time, we might happen to observe a relatively poor (good) rainfall year for that household, in which their income falls (increases) sharply for that given year. An analyst looking at observed household income from that poor (good) year may have no way of knowing whether the observation represents that household's income in a typical or average year or not. While household expenditure data is also subject to fluctuation during a given year and across years (Dercon 2000), household expenditure tends to be less variable than income, which is why economists

[33] The reason why household predicted income is still quite variable from year to year is because the prediction uses the district average income for each year, and this varied significantly for most of the 80 TIA districts, which highlights the inherent volatility of household income in a rural economy dominated by rainfed agriculture.

prefer to construct poverty lines and poverty rates using household expenditure data. Nevertheless, household income provides a valuable household welfare indicator as a measure of potential for consumption realization for a given point in time.

The TIA panel is quite valuable for other reasons; first, there has not been an expenditure survey since 2002/03. Second, tracking the same households over time permits analysts to differentiate between transitional and chronic poverty. Third, panel data enables analysts to employ statistical techniques not available for use with cross-sectional datasets, as demonstrated below. The strength of income data, and in particular that provided by the TIA, is that it gives analysts information on each household's various income components. When combined with information on each household's individual and village-level characteristics, the TIA income data enables analysts to help policymakers better understand factors which enable some households to improve their welfare, productivity, etc., while others are unable to do so.

We next seek to explain why the income distribution widened in both directions (upward and downward) in 2005 by considering both rainfall data and changes over time in the various components of total net household income by income quintiles. The rainfall data shown earlier (Table 3) demonstrates that the main 2004/05 agricultural season (November/ December to March/April) had considerably more days of drought than that for 2001/02 in the center and north (note, however, that both years experienced years of drought above the 10-year average). Because 2005 rainfall was poorer than that in 2002, we would expect to see a decline in crop income in 2005, and thus a decline in household income for households which depend heavily upon crop income (which is most households). This is precisely what we find in the TIA data; median crop income/AE fell -23.9% from 2002-05 (Table 11a), a result driven by the -30.3% reduction in retained food crop income. The only households which did not suffer a reduction in median crop income/AE were those in the top quintile of total household income/AE (Table 12). When we consider that retained food crop income accounted for an average of 62% or more of total household income for the bottom 80% of the population (Table 13) in 2002 (a year with rainfall closer to normal than 2005), it is clear just how sensitive total household income is to changes in rainfall in rural Mozambique.

While changes in rainfall and lower crop income explains why the bottom part of the income distribution fell in 2005, we need to look at the distributional results a bit further to explain why the top part of the income distribution rose from 2002 to 2005. Households in the top income quintile derive an average of 45% (in 2002) to 51% (in 2005) of their total income from non-farm sources (Table 13), and median non-farm income/AE among the top quintile increased 19% from 2002 to 2005. These households also enjoyed an increase in farm income/AE from 2002 to 2005, which explains why the top part of the income distribution increased from 2002 to 2005. In sum, worse rainfall conditions in 2005 appear to have reduced crop income in 2005, which had a large effect on most rural households given that crop income is their principal source of total household income. By contrast, households in the top income quintile enjoyed increases in both crop and non-farm income/AE from 2002 to 2005, and thus their incomes increased.

4.2. Variation in Household Income Changes across Regions

While changes in mean and median total income/AE varied considerably across provinces, we focus here only on the more extreme cases. For example, Sofala and Gaza saw large increases from 2002 to 2005 53% and 70%, respectively, in median total income/AE. The

large increase in median total income/AE in Sofala appears to be driven by large increases in household participation (Table 14) in relatively high-return non-farm activities; household participation in (MSE-low) activities with low returns jumped from 19 to 36%, MSE activities with high returns (MSE-high) increased from 17.5 to 30.2%, and receipt of remittances increased from 13.5 to 29.4%. In addition, Sofala was one of the few provinces which had a positive change (14.5%) in median net farm income/AE.[34] The large increase in median total income/AE in Gaza of 70% is remarkable given that the mean increased 32%. This increase appears to be the result of increased participation (Table 14) in high-return non-farm activities such as skilled non-farm labor (from 10.2% in 2002 to 21.1% in 2005), and remittance receipt (39.8% to 50%). In addition, while median farm income/AE fell, median income/AE for most of the non-farm activities increased in Gaza.[35]

At the other end of the spectrum is Nampula, which suffered a decline of -27% in median total household income/AE. This decline appears to be the result of the reduction in net crop income of -46%, which is driven by the loss of net food retained crop income/AE of -55% (Table 11a). Given that retained crop income represents 70.8% of total income for the average household in Nampula (Table 15), it would take a large increase in both participation and returns to non-farm income to compensate for such an income loss. This large decline in crop income from 2002 to 2005 is most likely due to drought; the north had negligible drought in 2002 but considerable drought in 2005 (Table 3). In addition, production losses also due to drought were also exacerbated by Cassava Brown Streak Disease (CBSD), particularly in Nampula and Zambezia. Although household participation in some non-farm activities increased somewhat in Nampula, a look at the levels of non-farm income in Nampula demonstrates the large difference in livelihood options between the north and the center/south – the median non-farm income/AE in Nampula of 370 MTN/AE (2005) is half that of Sofala at 775, and a third that of Gaza at 1,053 (Table 11b).

[34] Sofala also saw an increase in household participation from 13.6 to 42.3% in unskilled farm labor markets. While this is an enormous increase in participation, unskilled farm wages tend to be quite low in general (though are considerably higher for unskilled labor working for formal sector agribusiness companies which pay the statutory minimum agricultural wage, such as in the sugar industry), thus further inquiry is necessary to investigate the role unskilled farm wages have played in driving the increase in total household incomes in Sofala.

[35] While it is tempting to think of income/AE from a given component as the 'returns to that activity', note that the denominator is simply adult equivalents, and not a measure of time devoted to the activity. Thus, without hourly data on income activities, it is difficult to know if productivity is changing over time in various activities. Second, we compute the median income/AE of each activity among only the participants (because only retained crop income has extensive household participation), thus increased participation may well change the median income/AE even if the actual productivity remained constant. Third, although we have disaggregated the non-farm activities into several categories, this categorization still aggregates over a wide range of activity types, and even considering a specific non-farm activity, there is surely a wide range of effort expended by various households on a given activity. Finally, because the TIA does collect information on the number of months of payment from a given activity, it might be fruitful to investigate the income/months of effort of some specific non-farm activities.

Table 11a. Median Net Household Farm Income/AE by Component, 2002 and 2005, Computed Using only Households with the Component (2005 MTN)

	Net crop income/AE		% change in	Net food crop income retained/AE		% change in	Net food crop income sold/AE		% change in	Net cash crop income/AE		% change in
Province	2002	2005	medians	2002	2005	medians	2002	2005	medians	2002	2005	medians
Niassa	1,595	1,403	-12.0%	1,458	943	-35.3%	133	174	31.4%	83	345	315.8%
C.Delgado	1,204	1,294	7.5%	1,076	1,111	3.3%	94	163	73.8%	107	106	-0.8%
Nampula	1,698	914	-46.2%	1,457	655	-55.0%	121	156	28.4%	293	147	-49.7%
Zambezia	986	729	-26.1%	866	583	-32.7%	64	90	40.3%	33	59	78.2%
Tete	890	790	-11.2%	757	609	-19.6%	113	144	27.1%	83	284	242.5%
Manica	735	767	4.4%	606	606	0.1%	85	106	25.5%	22	155	618.0%
Sofala	683	609	-10.8%	653	487	-25.3%	59	86	45.0%	36	100	176.7%
Inhambane	1,214	1,614	33.0%	1,000	1,451	45.2%	125	70	-43.9%	51	139	174.1%
Gaza	788	585	-25.8%	770	522	-32.2%	59	80	34.9%	9	100	1045.5%
Maputo Prov	1,079	569	-47.3%	1,021	534	-47.7%	140	622	342.9%	3	143	4837.4%
Total	1,151	876	-23.9%	1,012	705	-30.3%	91	116	27.0%	58	113	96.0%

	Livestock product sales/AE		% change in	Unskilled farm wage labor/AE		% change in	Net farm income/AE		% change in
Province	2002	2005	medians	2002	2005	medians	2002	2005	medians
Niassa	65	44	-32.1%	901	179	-80.1%	1,665	1,453	-12.8%
C.Delgado	58	47	-19.1%	1,153	83	-92.8%	1,224	1,327	8.4%
Nampula	57	51	-9.5%	59	97	64.4%	1,740	998	-42.7%
Zambezia	46	38	-17.6%	145	139	-4.2%	1,051	789	-24.9%
Tete	60	125	107.4%	211	136	-35.7%	1,041	1,034	-0.7%
Manica	65	68	3.3%	256	190	-25.6%	868	863	-0.5%
Sofala	51	114	123.5%	924	203	-78.0%	796	911	14.5%
Inhambane	106	118	11.1%	663	96	-85.6%	1,255	1,779	41.7%
Gaza	68	240	252.3%	965	502	-47.9%	913	709	-22.4%
Maputo Prov	155	181	16.4%	1,915	923	-51.8%	1,240	757	-38.9%
Total	59	58	-0.4%	220	144	-34.4%	1,227	988	-19.5%

Notes: Each figure computed using only households with the income source in that year.

Table 11b. Median Net Household Non-Farm Income/AE by Component, 2002 and 2005, Computed Using only Households with the Component (2005 MTN)

	Unskilled non-farm wage income/AE		% change in	Skilled non-farm wage income/AE		% change in	MSE Nat Res/AE		% change in	MSE other - low/AE		% change in
Province	2002	2005	medians	2002	2005	medians	2002	2005	medians	2002	2005	medians
Niassa	1,932	847	-56.2%	2,965	1,918	-35.3%	126	190	50.1%	156	145	-6.9%
C.Delgado	1,800	89	-95.1%	3,329	2,013	-39.5%	273	214	-21.6%	197	325	65.0%
Nampula	891	386	-56.7%	2,882	3,000	4.1%	286	163	-43.0%	246	189	-23.4%
Zambezia	1,132	636	-43.8%	2,682	938	-65.0%	192	136	-29.0%	152	268	76.8%
Tete	196	218	11.0%	2,531	2,424	-4.2%	266	461	72.9%	190	273	43.5%
Manica	1,314	182	-86.2%	3,398	3,390	-0.2%	154	427	177.9%	203	104	-48.7%
Sofala	800	1,412	76.6%	2,794	3,508	25.5%	72	165	128.9%	149	260	74.6%
Inhambane	1,770	2,130	20.3%	3,423	3,667	7.1%	365	293	-19.5%	315	274	-13.1%
Gaza	1,446	1,135	-21.6%	2,688	3,442	28.1%	334	474	41.6%	175	200	14.0%
Maputo Prov	1,677	2,644	57.6%	3,424	4,469	30.5%	847	1,038	22.7%	486	516	6.3%
Total	1,229	792	-35.5%	3,074	2,667	-13.2%	231	242	5.1%	190	238	25.2%

	MSE other - high/AE		% change in	Remittances/AE		% change in	Non-farm income/AE		% change in
Province	2002	2005	medians	2002	2005	medians	2002	2005	medians
Niassa	249	106	-57.4%	62	171	175.6%	404	519	28.4%
C.Delgado	482	374	-22.5%	75	117	55.5%	338	463	37.1%
Nampula	722	603	-16.4%	68	69	1.4%	286	370	29.5%
Zambezia	442	476	7.7%	61	132	118.7%	281	460	63.5%
Tete	718	606	-15.6%	95	220	131.1%	400	518	29.3%
Manica	197	644	226.6%	178	316	77.9%	475	920	93.7%
Sofala	184	350	89.8%	147	190	29.2%	499	775	55.4%
Inhambane	609	338	-44.5%	253	340	34.3%	740	793	7.2%
Gaza	475	624	31.4%	334	314	-6.1%	694	1,053	51.7%
Maputo Prov	635	1,071	68.7%	481	533	11.0%	1,791	1,989	11.1%
Total	470	493	4.8%	122	186	52.5%	423	558	31.9%

Notes: Each figure computed using only households with the income source in that year.

Table 12. Median Net Household Income/AE by Component and Income Quintile, 2002 and 2005 (2005 MTN)

Quintiles of 2002 & 2005 income/AE	Net crop income/AE		% change in medians	Net food crop income retained/AE		% change in medians	Net food crop income sold/AE		% change in medians	Net cash crop income/AE		% change in medians
	2002	2005		2002	2005		2002	2005		2002	2005	
1-low	387	252	-34.9%	343	210	-38.8%	36	46	28.8%	21	41	97.9%
2	908	676	-25.6%	802	561	-30.1%	59	88	48.0%	37	85	129.6%
3-mid	1,474	1,215	-17.6%	1,355	946	-30.2%	87	113	29.4%	42	125	195.6%
4	2,250	2,100	-6.7%	1,905	1,603	-15.8%	144	177	22.6%	78	143	82.3%
5-high	3,192	3,521	10.3%	2,504	2,507	0.2%	218	272	25.2%	152	278	82.8%
total	1,151	876	-23.9%	1,012	705	-30.3%	91	116	27.0%	58	113	96.0%

Quintiles of 2002 & 2005 income/AE	Livestock product sales/AE		% change in medians	Unskilled farm wage labor/AE		% change in medians	Net farm income/AE		% change in medians
	2002	2005		2002	2005		2002	2005	
1-low	35	27	-23.2%	49	75	54.3%	404	286	-29.2%
2	35	46	32.9%	138	118	-14.5%	935	753	-19.5%
3-mid	59	70	18.7%	312	183	-41.3%	1,553	1,329	-14.4%
4	78	60	-22.8%	427	253	-40.6%	2,352	2,330	-0.9%
5-high	111	118	6.0%	993	335	-66.3%	3,592	3,981	10.8%
total	59	58	-0.4%	220	144	-34.4%	1,227	988	-19.5%

Quintiles of 2002 & 2005 income/AE	Unskilled non-farm wage income/AE		% change in medians	Skilled non-farm wage income/AE		% change in medians	SME Nat Res/AE		% change in medians	SME other - low/AE		% change in medians
	2002	2005		2002	2005		2002	2005		2002	2005	
1-low	113	99	-12.0%	51	290	469.8%	63	44	-30.3%	73	50	-31.1%
2	438	400	-8.7%	768	384	-50.1%	169	131	-22.7%	98	143	45.4%
3-mid	949	640	-32.6%	1,228	771	-37.3%	380	279	-26.4%	187	288	53.4%
4	1,446	1,707	18.0%	2,236	2,100	-6.1%	334	364	9.0%	286	303	5.9%
5-high	2,494	2,743	10.0%	4,229	4,909	16.1%	1,136	1,000	-12.0%	640	543	-15.2%
total	1,229	792	-35.5%	3,074	2,667	-13.2%	231	242	5.1%	190	238	25.2%

Quintiles of 2002 & 2005 income/AE	SME other - high/AE		% change in medians	Remittances/AE		% change in medians	Non-farm income/AE		% change in medians
	2002	2005		2002	2005		2002	2005	
1-low	50	83	67.5%	55	80	45.4%	90	76	-15.5%
2	185	129	-30.2%	85	111	30.6%	176	257	46.0%
3-mid	320	291	-9.2%	102	198	94.8%	420	558	32.8%
4	544	773	42.1%	129	224	73.5%	707	1,118	58.2%
5-high	2,476	2,433	-1.7%	261	400	53.5%	3,420	4,080	19.3%
total	470	493	4.8%	122	186	52.5%	423	558	31.9%

Notes: Each figure computed using only households with the income source in that year.

Table 13. Mean Household Shares of Components in Total Net Household Income by Income Quintile, 2002 and 2005

Quintiles of total net HH income/AE, 2002 & 2005	Crop production		Retained food crops		Food crop sales		High-value crops		Livestock sales		Unskilled farm labor		Farm income	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
	shares of income component in total net HH income (%)													
1-low	82.5	71.8	73.8	61.6	4.5	6.7	3.7	3.8	3.8	3.3	1.4	5.6	87.1	80.7
2	80.8	70.3	72.6	58.7	4.3	6.8	3.9	4.9	2.5	2.6	1.6	4.5	84.9	77.3
3-mid	78.3	65.8	70.0	54.7	4.9	6.0	3.4	5.3	2.6	2.9	2.2	3.4	83.2	72.1
4	71.2	61.2	61.9	50.7	4.8	5.1	4.4	5.2	2.4	2.1	2.9	3.5	76.4	66.7
5-high	51.3	46.4	42.8	37.5	3.9	3.8	4.7	4.8	2.1	1.3	1.9	1.7	55.3	49.4
total	72.8	63.1	64.2	52.6	4.5	5.7	4.0	4.8	2.7	2.4	2.0	3.7	77.4	69.3

Quintiles of total net HH income/AE, 2002 & 2005	Unskilled nonfarm wage		Skilled nonfarm wage		SME natural resource ext		SME other - low		SME other - high		Remittance/ pension		Non-farm income	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
	shares of income component in total net HH income (%)													
1-low	0.6	0.7	0.1	0.9	3.3	3.3	2.8	4.9	1.9	2.7	3.3	5.5	12.0	18.0
2	1.3	2.0	0.5	1.3	3.6	5.1	2.9	5.6	3.0	3.4	3.8	5.2	15.1	22.5
3-mid	2.5	3.4	1.5	3.2	3.6	5.6	4.0	6.3	2.7	5.0	2.5	4.5	16.8	27.8
4	3.0	3.7	4.8	7.1	3.6	4.7	4.9	5.5	4.3	7.9	3.1	4.5	23.6	33.3
5-high	2.7	3.0	12.8	16.5	5.0	5.3	6.1	5.4	13.2	15.6	4.8	5.0	44.7	50.8
total	2.0	2.5	4.0	5.8	3.8	4.8	4.1	5.5	5.0	6.9	3.5	4.9	22.4	30.5

Source: TIA02, TIA05

Table 14. Household Participation in Income Activities, 2002 and 2005

Province	Crop production 2002	Crop production 2005	Retained food crops 2002	Retained food crops 2005	Sold food crops 2002	Sold food crops 2005	Sold high-value crops 2002	Sold high-value crops 2005	Livestock sales 2002	Livestock sales 2005	Unskilled farm labor 2002	Unskilled farm labor 2005	Farm income 2002	Farm income 2005
Niassa	100.0	98.6	99.7	98.3	60.7	45.0	44.0	41.3	30.2	28.8	0.4	11.6	100.0	98.9
C.Delgado	98.6	96.4	97.9	96.2	53.9	48.2	38.3	26.8	33.7	24.3	1.5	11.5	98.9	96.6
Nampula	98.4	95.6	98.2	95.1	67.5	66.2	26.7	33.3	28.5	27.4	4.1	18.8	98.6	95.8
Zambezia	99.5	99.3	98.9	99.3	57.6	55.9	40.1	33.1	27.1	23.3	11.4	19.0	99.5	99.6
Tete	98.8	97.6	98.7	96.7	48.1	35.6	48.4	36.1	43.4	28.7	9.7	22.9	99.6	98.5
Manica	99.3	97.5	99.3	97.4	49.9	40.8	49.3	30.2	43.7	38.9	11.3	19.0	99.9	98.5
Sofala	97.9	95.4	97.8	93.4	28.3	40.6	30.6	31.5	35.1	41.2	13.6	42.3	98.2	97.2
Inhambane	98.5	98.2	98.1	97.6	39.0	38.5	45.1	34.6	27.9	19.2	1.6	9.0	98.5	98.9
Gaza	98.0	89.3	97.7	88.1	22.0	28.0	18.2	19.5	20.5	16.7	5.9	13.5	98.5	92.0
Maputo Prov	96.5	84.7	95.3	83.7	15.1	15.7	23.6	19.1	14.8	16.1	9.2	18.6	97.6	87.7
National	98.8	96.5	98.4	96.0	51.5	48.7	36.5	31.7	30.6	26.0	6.9	18.1	99.0	97.2

	Unskilled nonfarm wage 2002	Unskilled nonfarm wage 2005	Skilled nonfarm wage 2002	Skilled nonfarm wage 2005	SME natural resource ext 2002	SME natural resource ext 2005	SME other - low 2002	SME other - low 2005	SME other - high 2002	SME other - high 2005	Remittance/ pension 2002	Remittance/ pension 2005	Non-farm income 2002	Non-farm income 2005
Niassa	5.4	6.1	5.8	11.3	13.7	19.2	14.4	22.1	10.8	17.8	9.2	22.0	41.9	67.9
C.Delgado	0.9	2.3	2.4	7.1	23.4	26.5	28.0	29.9	11.4	21.3	17.2	21.7	60.6	73.6
Nampula	2.5	5.2	5.0	8.1	5.8	17.6	16.6	27.6	10.0	19.1	17.3	24.8	46.8	70.7
Zambezia	2.5	7.6	4.5	7.6	18.0	15.2	22.1	29.5	19.7	20.9	16.2	13.0	56.1	66.4
Tete	5.0	4.0	3.6	4.4	20.3	18.8	22.0	20.3	20.0	16.2	18.2	14.1	62.4	57.9
Manica	6.0	4.3	7.3	12.1	14.9	10.9	26.7	18.9	18.7	20.8	15.2	14.9	60.9	60.0
Sofala	10.2	6.8	8.4	10.7	13.4	20.3	19.0	36.0	17.5	30.2	13.5	29.4	53.7	82.2
Inhambane	7.8	8.6	10.0	11.1	13.3	16.1	18.1	23.7	24.1	22.7	35.3	31.8	72.2	73.5
Gaza	5.8	8.0	10.2	21.1	13.2	17.7	15.4	15.8	15.7	21.3	39.8	50.2	66.1	84.3
Maputo Prov	11.1	11.2	21.8	18.9	24.6	21.5	16.8	14.2	17.7	18.1	31.1	38.6	73.4	80.4
National	4.2	6.1	6.0	9.6	14.9	17.9	20.4	25.7	16.1	20.6	19.7	23.1	57.0	70.2

Source: TIA02, TIA05

5. STRUCTURE OF RURAL HOUSEHOLD INCOMES

5.1. Using Data on Income Components

One of the analytical strengths of the TIA income data is that it gives detailed information on how rural households choose to allocate their assets (land, labor, human capital, livestock, farm equipment, etc.) in various specific economic activities, as well as the returns to each of these activities. In this section, we group activities into several farm and non-farm categories or components, and then investigate the shares of each of these components in total household income. This paper goes beyond Boughton et al.'s (2006) analysis of the structure of income not just by using more recent TIA data, but by disaggregating income components further, so as to distinguish higher-return activities from those with lower returns, and between crop production which is for home consumption relative to that intended for sale. For example, we distinguish between the value of retained food crops relative to sold food crops, and sales of higher-value crops (non-traditional cash crops). We also disaggregate wage labor into skilled and unskilled categories (which have very different returns), separate natural resource extraction MSE from other MSE, and distinguish between other MSE activities with low vs high entry barriers (i.e., operating costs) (See appendix A-5 for further details on these components). The structure of rural household income involves household participation in different economic activities and the share of each activity in total household income.

An empirical understanding of the structure of income is valuable for several reasons. First, it tells us the economic activities of most importance to households by poverty wealth level and by region. For example, when we then look at these average component shares in total household income by province, it is clear that households in every province earn a substantial share of total income from farm activities, while those in the south rely on non-farm income sources more than those in the center or north (Table 15). Let us assume that households are pursuing a mix of income activities which gives them the highest income which they can achieve, subject to constraints such as:

a) Subsistence requirement – meeting basic food consumption requirements through own food and animal production, purchase, or receipt of food as wages paid in-kind;
b) Risk management – in the absence of sufficient ability to borrow cash (i.e., well-functioning rural credit market), households often face a tradeoff between choosing farm activities with the highest average returns (e.g., tobacco, dairy) and protecting against drought which could cause their own crop to fail and/or local food market failure, any of which would increase the probability of not meeting their subsistence requirements; and
c) Entry barriers to income activities – some activities have very low entry barriers (in terms of physical assets, education levels, access to cash/credit), such as food crop production or firewood collection, and thus are pursued by many households. Other activities have considerably higher entry barriers, such as cash cropping or nonfarm wage labor which typically require higher education levels.

Given these constraints, some households either do not have access to certain activities (such as cash cropping or high-return non-farm activities) or choose to focus their attention on meeting subsistence food requirements through own food production and managing food crop

Table 15. Mean Household Shares of Components in Total Net Household Income, by Province, 2002 and 2005

	Crop production		Retained food crops		Food crop sales		High-value crops		Livestock sales		Unskilled farm labor		Farm income	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
Province	mean shares of income component in total net HH income (%)													
Niassa	83.3	71.3	72.7	56.0	5.0	5.4	5.6	9.8	2.2	1.6	0.1	1.4	85.5	74.2
C.Delgado	76.5	69.8	67.0	60.6	4.9	5.7	4.0	3.6	1.9	1.3	0.8	1.6	78.6	72.6
Nampula	82.1	67.4	70.8	52.0	6.5	9.7	4.7	5.7	1.6	1.6	0.5	2.7	84.0	71.7
Zambezia	75.8	68.0	68.6	58.0	4.5	6.2	2.7	3.6	2.2	1.2	2.6	3.7	80.6	72.9
Tete	64.1	63.9	53.1	51.1	4.1	3.9	7.0	9.1	6.0	4.9	3.8	6.3	73.9	75.2
Manica	67.9	61.6	58.2	52.6	5.1	4.2	4.7	4.7	5.2	4.6	2.7	4.4	75.8	70.5
Sofala	65.2	47.3	57.0	38.3	2.6	3.7	5.5	5.1	3.3	5.7	6.2	10.3	74.5	63.2
Inhambane	64.4	64.7	58.0	59.8	3.5	2.2	2.9	2.7	2.2	2.0	0.6	1.6	67.2	68.3
Gaza	60.7	38.9	58.2	35.0	0.9	2.2	1.8	1.6	2.7	4.4	2.7	4.5	66.1	47.8
Maputo Prov	46.6	35.8	44.2	30.1	0.8	2.2	1.6	3.5	1.6	2.7	5.3	7.3	53.5	45.8
National	72.8	63.1	64.2	52.6	4.5	5.7	4.0	4.8	2.7	2.4	2.0	3.7	77.4	69.3

	Unskilled nonfarm wage		Skilled nonfarm wage		SME natural resource ext		SME other - low		SME other - high		Remittance/ pension		Non-farm income	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
Province	mean shares of income component in total net HH income (%)													
Niassa	3.6	2.8	3.4	6.6	1.4	4.1	2.6	3.4	2.0	3.9	1.6	4.9	14.4	25.7
C.Delgado	0.4	0.5	2.0	4.2	6.9	6.4	5.2	5.2	4.2	6.7	2.0	4.3	20.6	27.2
Nampula	1.4	2.2	3.3	4.9	1.5	5.0	3.6	6.3	4.1	6.6	1.9	3.2	15.7	28.1
Zambezia	1.1	3.3	2.8	4.0	3.7	3.8	3.7	6.6	6.0	6.6	2.2	2.7	19.4	27.0
Tete	1.4	1.6	2.2	2.6	7.3	5.5	4.8	4.9	6.5	5.9	3.7	3.0	26.0	23.6
Manica	3.1	0.8	5.2	8.1	2.7	3.6	5.4	4.6	4.7	8.0	3.0	3.9	24.0	28.9
Sofala	5.6	3.5	5.3	6.6	2.9	3.3	4.2	6.8	4.1	9.2	3.0	7.4	25.1	36.7
Inhambane	3.4	3.4	7.1	5.9	3.4	3.5	4.8	5.0	7.1	7.2	7.0	6.7	32.8	31.7
Gaza	2.9	3.7	6.6	13.9	4.3	6.4	3.7	3.5	4.8	10.0	11.4	14.8	33.7	52.3
Maputo Prov	4.9	6.6	13.6	13.0	10.2	10.0	4.2	4.6	5.3	7.0	8.3	12.6	46.4	53.7
National	2.0	2.5	4.0	5.8	3.8	4.8	4.1	5.5	5.0	6.9	3.5	4.9	22.4	30.5

Source: TIA02, TIA05

risk by growing not just the crop with the highest returns but a mix of various crops. All of this is to say that we assume that, given their resources and constraints, rural households are doing the best that they can to improve their income levels while also managing income risk. Thus, because households in the north rely overwhelmingly on crop income, poverty reduction strategies in the north would need to focus not just on improving household access to higher-return activities such as cash cropping and higher-return non-farm activities, but on improving crop productivity, since that is the activity of most economic importance to the vast majority of rural households, and one in which every household is already engaged.

When we consider component shares by quartiles of total household income/AE in 2005, we see that the wealthiest 20% of households rely on non-farm income for an average of 50% of their total income in 2005, whereas the poorest households (those in the bottom four quintiles) rely on farm income for an average of 66.7 to 80.7% of their total income (Table 13). This pattern is similar to that reported for 2002 by Boughton et al. (2006), though our more recent figures demonstrate that, even in a poor agricultural year such as 2005, farm income remains the dominant income source for the vast majority of rural households. Our increased disaggregation of income components demonstrates that the value of retained food crops represent 50-62% of total household income/AE for the bottom 80% of rural households (even in a poor rainfall year) (Table 13). This strongly suggests that achieving wide-spread improvements in food crop productivity is vital for continued broad-based economic growth and poverty reduction.

Whereas Boughton et al. (2006) already demonstrated just how important food crops were to total income shares in 2002, this disaggregation demonstrates the extent of subsistence orientation of most rural households, and thus just how much remains to be done to entice these households to increase their market engagement as both producers and consumers. For example, even though the Mozambican government has liberalized food and input markets to a greater extent than most of southern Africa, the evidence from TIA02 and TIA05 suggests that market liberalization alone is likely to be insufficient to enable and entice rural households to engage the market (i.e., in economist's terms, the expected supply response to market liberalization is not forthcoming). As the Mozambican government has begun to acknowledge, market-led development for a country at an early stage of economic development requires not only steps toward market liberalization, but also policies and investments in public goods which promote and foster market participation (such as investment in rural roads, agricultural research and extension, market information, etc.).

A second reason for studying the structure of income is to assess the extent to which the economy is experiencing structural change over time. Structural change is typically understood to involve the shift over time from an economy in which farm production employs most people, to one in which non-farm goods and services plays a bigger and bigger role in the economy. This implies a movement away from an economy dominated by subsistence agricultural production (where most if not all of household economic activity is focused on the production of food and consumer goods for home consumption), and toward a more specialized, market-driven economy (where the household produces less and less food and consumer goods/services for its own consumption, and instead concentrates its labor, land, and other assets on production of a fewer number goods which are sold in markets, including the sale of household labor to other farms, businesses, etc.). Evidence of structural change would imply increased shares of higher-return farm and non-farm activities. Among farm activities, this would be evidenced by increased participation and/or productivity in cash cropping and livestock production. Among non-farm activities, structural change would imply increased participation and/or productivity in higher-return activities (such as

production and trading of farm inputs such as fertilizer, farm equipment, etc.); and marketing of crop/livestock products, adding value to food and livestock products through processing, production and trading of consumer goods (such as clothing, housing, etc.).

This understanding of structural change implies several caveats to the interpretation of changes in mean household component shares over time. First, structural change does not simply imply higher non-farm shares, as some non-farm activities have very low returns and are not necessarily a precursor to higher incomes but rather a source of income for households outside of the main agricultural season(s), as well as a means of diversifying income so as to manage the inherent volatility of rural income which is dominated by rainfed agriculture. In other words, not all income diversification into non-farm activities implies an improvement in welfare levels, though diversification of income sources will generally enable households to reduce their income variability across the year and over time. Thus, structural change implies higher participation and returns to higher-return activities. For lower-return activities such as food crop production, structural change implies an increased percentage of households which are able to produce a surplus for the market (which is difficult to test by comparing 2002 with 2005, given the poor rainfall of 2005). In sum, simply observing an increase in non-farm share for a given household (or the mean among the sample) may not necessarily imply that the given household is on a pathway out of structural poverty.

Second, the difference in rainfall between 2002 and 2005 will undoubtedly affect farm and non-farm income shares, whether or not structural change actually occurred. For example, given that rainfall in 2005 was considerably worse in the center and north, and that improved input use has not changed since 2002, we would expect crop income to fall due to the poorer 2005 rainfall. Thus, even if we assume that non-farm income stayed constant from 2002 to 2005, a subsequent decline in crop income from 2002 to 2005 will, by construction, coincide with an increase in non-farm shares. Therefore, we argue that without some more sophisticated analysis (not undertaken here), interpretation of shares from 2002 and 2005 should be undertaken with caution, and focus not simply on non-farm shares but also on participation and returns to specific farm and non-farm activities (those with higher returns). Third, studies which investigate drivers of structural change using household survey data tend to have a longer gap between surveys than the three years of the TIA panel.

5.2. Participation and Shares of Farm Income Components

Nearly all rural households have some form of crop production (Table 10). While half of all rural Mozambican households have sold at least some portion of their food crop production (grains, beans, groundnuts, and roots/tubers), the quantities sold are very small for the vast majority of sellers. For example, Jayne, Mather, and Mghenyi (forthcoming) observes a very high concentration of maize sales in 2002, where 1% of maize growers in Mozambique were responsible for 50% of the aggregate value of national maize sold. A similar pattern of high sales concentration is seen in TIA 2002 across all the major food crops (Abdula and Arlindo, 2005). These results, combined with the fact that a majority of rural Mozambican households are net buyers of maize (Tschirley, Abdula, and Weber 2006), suggests that many households with food crop sales are not necessarily selling food production because they have produced more than their consumption requirements, but rather use food crop sales as a means to access credit (i.e., acquire immediate cash – even though they essentially buy back this food

at a later time in the year, at much higher prices).[36] The implication of this is that household participation rates in making food market sales do not necessarily indicate whether or not households are becoming more reliant upon markets due to specialization (i.e., a household specializes in a few crops, sells those crops, and buys food from the market) and/or increased productivity (i.e., a household sells grain because their high productivity leaves them with production which is surplus to consumption requirements) or whether they simply use food markets as an indirect way to access credit. The first two scenarios indicate structural change, while the third does not. Given the high concentration of grain sales and the very small quantities which are sold by the majority of sellers of each crop, the TIA figures cited here suggest that the majority of rural households have remained subsistence or semi-subsistence farm households. However, further investigation with the panel data is warranted which could investigate household mobility in market position, changes in market sales over time, etc. Such an analysis might locate households which are becoming more (less) market-oriented, quantify the size of such a group(s), and investigate the determinants of their increased (decreased) market reliance.

There is also not much evidence from 2005 of any structural change toward higher-value farm activities. In fact, participation in higher-value farm activities declined somewhat since 2002, as only a third (31.7%) have sold some high-value crops (field cash crops, tree crops, horticulture) in 2005, and 26% have sales of livestock products (live animals, meat, eggs/milk).[37] Average shares for these activities remained very low, given both low participation rates and the predominance of food crops in total income.

In 2002, only 6.9% of households had income from unskilled farm labor, as most labor in crop production is family labor. However, this figure rose sharply to 18% in 2005. In an economy where nearly every rural household has access to land (and given that 85% of households in TIA02 say they can get more land if they wanted it), what is implied by observing a decline in crop production at the same time that participation in unskilled labor markets increases dramatically? Rather than suggesting that this implies an increase in labor demanded by commercial farmers, the context suggests that this increase is not necessarily a good economic indicator; households facing crop shortfalls in 2005 are likely selling their labor to other farmers in the pursuit of immediate cash, even if it means that they may not spend as much labor on their own crop production (as they would if rural credit were available). An exception to this may have occurred in Sofala, which alone among the provinces enjoyed a large increase (33%) in median crop income/AE from 2002-05 (Table 11a).

When we consider shares of farm components by quintiles of total household income/AE, we see that poorer households depend very heavily on farm income, which is dominated by the value of retained food crops (Table 13). While participation data by income level (Table 8)

[36] This phenomena is termed a "displaced distortion" by Barrett (2005). He argues that due to weak and/or imperfect credit markets in rural areas, households which are unable to borrow cash for immediate needs will instead borrow cash from the output (food) market by selling grain today (to acquire cash) that the household will simply have to buy back later (at a much higher price) for consumption needs.

[37] Following Boughton et al. (2006), we use sales of live animals and meat as an indicator of livestock income, due to data limitations with respect to the valuation of a given households animal stocks. Future TIAs should consider improving the survey instrument's valuation of livestock so as to enable analysts to quantify the net change in livestock value in a given 12 month recall period. This could be helpful because 2005 livestock sales may include many cases in which households are not simply selling off their fattened animals, but rather are liquidating some of their livestock assets in response to crop failure (i.e., selling business assets may show up as income growth this year, but implies limited prospects for income from that business next year). Thus, sales of live animals and meat may be less reliable as an indicator of livestock income growth in a drought year.

demonstrates that wealthier households are more likely to participate in higher-value activities such as sales of high-value crops and livestock (and food sales), there appear to be very few wealthy households which accrue much income from these activities, as the shares for these high value activities are still very low for households in the top 20% of income/AE (Table 13). However, even though the wealthier households depend less on farm income than the poorer households, median income/AE from farm income for the top quintile (3,981 MTN/AE) is about nearly 14 times higher than that earned by the bottom quintile (286 MTN/AE) (Table 12).

Note that this result is not simply due to skewness at the very top of the distribution, as we are reporting medians for each quintile, not means, and that the figures in this table for any given income component in this table are only computed among households with income from that component. Also note that, relative to the lowest quintile, the middle income quintile's median farm income/AE is six times higher, while that of the 2nd lowest quintile is still three times higher (Table 12). There are likely to be many factors which explain the difference in median retained crop income/AE among the quintiles; some of which have already been shown in the earlier section on assets and input use: wealthier households have larger land endowments, higher education levels (a potential proxy for management skills), and are more likely to use improved farm inputs such as animal traction, and have access to public goods such as extension advice. There are likely to be other advantages enjoyed by wealthier households (such as access to parcels with better soils/slopes, etc.); factors which are unobserved by most surveys, including TIA.

5.3. Participation and Shares of Non-farm Income Components

In 2002, the percentage of households with any non-farm income activity varied considerably from north to south, ranging from 41.9% of households in Niassa to 73% in Maputo Province. The most prevalent non-farm activity in the north and center was family-operated MSE, while that in the south is receipt of remittances (pensions are also included, but this entails few cases). While this general spatial pattern held for 2005, there were rather large increases in household participation in non-farm activity participation from 2002 to 2005 in the north, in Sofala, and in Gaza (Table 14). It is encouraging to note that much of this increase appears to be due to increased participation in higher-return activities, not activities with lower returns such as unskilled non-farm wage labor and MSE natural resource extraction. Nampula, which suffered some of the largest crop losses in 2005, is the only province with a sizeable increase in MSE natural resource activities, which might be a response to drought. However, even Nampula enjoyed increased participation in the other MSE activities and remittances. Sofala's spectacular income growth from 2002 to 2005 might be explained by the large increases in participation in all MSE activities and remittances, as well as the fact that it was the only province with a sizeable increase (33%) in median crop income/AE from 2002 to 2005 (Table 11a).

While increased participation in higher-return non-farm activities suggests favorable structural change for some households, more in-depth analysis of the specific activities is warranted, in order to surmise whether or not we might expect households to continue with such activities in future years. Our caution is in part motivated by observing that many of the provinces of the country which received the biggest decline in rainfall (the north) are the provinces with the largest increase in non-farm participation. An exception to this is Gaza, which had drought in both 2002 and 2005, yet saw an increase in non-farm participation from 66 to 84%, and an increase in the non-farm share from 33 to 52%. Sofala's large increase in

non-farm participation from 53% to 83% of households (an increase of 30 percentage points) did not have as large an effect on the non-farm share, which only increased from 25% to 37% (an increase of 12 percentage points). Secondly, preliminary investigation of changes over time in participation in different income sources (among panel households only) shows that there is considerable variation in component use when we track the same households across the two years of the panel. For example, while there were generally more new adopters of non-farm components in 2005 (i.e., households which did not access the component in 2002, but did so in 2005) than disadopters (households which had the component in 2002 but not in 2005), there was still considerable fluctuation of households in and out of these components across the two years of the panel (Appendix Table 5).

Non-farm income is considerably higher for wealthier households – note that the top income quintile earns median non-farm income/AE which is 53 times higher than that of the lowest quintile (Table 12 – notice that the figures in this table for any given component are computed only for households which participated in that activity). This disparity in non-farm income across income quintiles is not merely due to differences in access to and returns from specific non-farm income components, for even with our relatively disaggregated non-farm income component categories, there is still a large range of income from within a given component across households with that component. For example, even if we look at a higher-returns activity such as MSE other-high, we see that the median income/AE from this activity is 2,433 MTN/AE for the top quintile, 291 for the middle quintile, and only 83 MTN/AE for the bottom quintile (Table 12). This demonstrates that there is considerable heterogeneity among household earnings from within these components (not just across components). One explanation for this heterogeneity could be large differences in returns per hour for jobs within the same category – such as between that received by a government official and a truck driver – both of which we categorize as skilled labor. Another explanation could be differences in the number of hours worked; a truck driver with an established business may work fulltime, 12 months a year, while one with a less-established business may only obtain intermittent work. This demonstrates why simply observing an increase in the percentage of households participating in a given non-farm income source does not necessarily mean that those households are able to subsequently increase their total income.

These vast differentials in non-farm returns, and the high correlation between non-farm shares and returns and total household income, are consistent with Reardon's (1997) review of non-farm shares from household survey data across Sub-Saharan Africa. He found that while non-farm income activities are correlated with higher incomes, there are often substantial barriers to entry in many of the higher-return niches. Likewise, Barrett (2005) demonstrate evidence from household income data from various African countries of such barriers to entry to higher-return farm and non-farm activities. The implication of this non-farm literature for the TIA results is that observing an increase in non-farm shares in and of themselves does not imply that such households are enjoying higher incomes, as some non-farm opportunities are pursued by households which are pushed by desperation or vulnerability into such activities, rather than being pulled by the lure of higher-returns per labor hour expended (Barrett, Reardon, and Webb 2001).

5.4. Policy Implications of Share Results for Rural Growth Strategies

The Mozambican government's PARPA lists policy goals for both agriculture (improved productivity of small producers in rural family agriculture) and non-agricultural activities (the

acceleration of job creation and opportunities for non-farm income generating activities) among the four critical components of their poverty reduction strategy (GOM 2000). In practice, some rural investments such as those in health, primary education, and rural infrastructure will tend to benefit both agricultural and non-agricultural activities. However, the government faces an inevitable tradeoff with respect to other investments which are more specific toward promoting agricultural or non-agricultural activities. For example, agricultural research, extension, and market information are more specific to agriculture, while micro-finance promotion tends to be targeted toward non-farm activities. This methods and focus of this paper are not appropriate for an in-depth analysis of the relative tradeoffs in terms of poverty reduction which may come from specific investments in either agriculture or non-farm rural economy. However, in this section, we combine the findings on the structure of income above with recent literature to offer evidence which suggests the relative importance of agricultural-specific investments for poverty reduction.

The pathways from poverty which are most commonly cited in development literature tend to include: a) diversification of farm activities into higher-returning commodities such as cash crops and livestock; and b) diversification into non-farm employment and MSE activities. Many rural households in Mozambique face insurmountable barriers in their attempts to access such high-return activities, as suggested by the TIA results above and in studies of income diversification across Africa (Reardon 1997; Barrett et al. 2005). While efforts to reduce these barriers are certainly warranted, what does not appear to receive as much attention by donors and governments is the role which improved food crop productivity plays not only in poverty reduction, but also in improving household access to higher-return activities. There are several means by which improved crop productivity facilitates uptake of higher-return activities.

First, failure to improve crop productivity over time can in fact hamper household access to both of these pathways out of poverty (higher-return farm and non-farm activities). For example, theoretical work by de Janvry, Fafchamps, and Sadoulet (1991) and Fafchamps (1992) shows that a combination of low productivity in food crop production and food market failure results in significant constraints to household participation in cash crop markets. This result was empirically confirmed in a range of situations by von Braun, Kennedy, and Bouis (1989). Likewise, in the presence of highly stochastic income, risk preferences and/or subsistence constraints may cause poor households to trade off higher returns for lower income and consumption risk, resulting in very low savings rates and thus negligible asset accumulation over time among the poorest households (Zimmerman and Carter 2003; Rosenzweig and Binswanger 1993).

Second, even if a household is able to overcome subsistence and asset constraints to enter higher-return activities in the non-farm sector, demand for non-farm labor must continue to grow over time in order for the non-farm sector to absorb an increasing number of workers. Improved agricultural productivity plays an important role here as well. African spending patterns support far less rural non-farm activity than do those in Asia, as African consumers spend far more of their average and marginal income on rurally produced foods, a result due to low income levels as well as lower population and road density (Haggblade, Hazell, and Brown 1989). In addition, note that above we demonstrated that two-thirds of rural Mozambican households derive most of their total income from retained food crops. What this implies is that rural Mozambicans are spending much of their limited cash on food items, not non-farm goods and services – the reason being that their home production of food is not sufficient. Widespread productivity increases in food crops would, therefore, release labor and capital from food crop production – for large numbers of households, especially the

poorest – making them available for the production of higher-value crops and non-farm activities such as manufacturing and services. This is likely to not only increase the food consumption of poor households but, as incomes grow, should also eventually increase the portion of household disposable cash income that is spent on non-staple foods and consumer goods, as per Engel's law. An increase in demand for rural nonfarm goods and services will, in turn, increase the derived demand for rural non-farm labor. Improved agricultural productivity also fosters derived demand for rural (and urban) non-farm labor by keeping the cost of food low, and thus helping to avoid excessive rural wage inflation.

Third, Christiaensen, Demery, and Kuhl (2006) present recent micro-level and cross-country evidence that the indirect or growth linkage effects from agriculture to non-agriculture appear "quantitatively large and at least as large as the reverse feedback effect (the indirect effects of non-agricultural growth on agricultural growth)." In sum, there appear to be both theoretical and empirical justification for assuming that improved food crop productivity plays an important role in fostering the non-farm economy.

There is also evidence which suggests that improved agricultural productivity plays an important role in poverty reduction in general. First, Christiaensen, Demery, and Kuhl (2006) find that the participation effect from agriculture on the poverty head count is on average 2.2 times larger than the participation effect from non-agriculture. This difference is not primarily derived from the large share of agriculture in total GDP of the economies which they studied, but rather from the larger elasticities of poverty to agricultural GDP, relative to the elasticities of poverty to non-agricultural GDP. Therefore, because the poorest households in developing countries often participate much more in growth in the agricultural sector than other sectors, improvements in agricultural income often has a large effect on aggregate poverty reduction (Christiaensen, Demery, and Kuhl 2006). Second, history suggests the necessity of productivity increases in agriculture for sustained poverty reduction: except in the cases of a handful of city-states, there are virtually no examples of mass poverty reduction since 1700 that did not start with sharp rises in employment and self-employment income due to higher productivity in small family farms (Lipton 2005). Within the agricultural sector, there are inevitable tradeoffs between investing scarce agricultural research funds in developing staple crops versus non-traditional cash crops. While both staple and cash crops play a vital role in fostering rural economic growth, recent empirical work suggests that broad-based agricultural growth in the staple food sectors reduces poverty more than growth driven by agricultural exports, which tends to bypass smaller farms (Diao et al. 2006).

6. CONCLUSIONS

The first objective of this paper is to investigate whether the upward trends in household welfare found from 1996 to 2002 in rural Mozambique have continued from 2002 to 2005, as measured in terms of TIA income and assets. While average total household income per AE increased 15% between 2002 and 2005, median income/AE fell 1%. Thus, the dispersion of incomes grew wider from 2002 to 2005, as the poorest households in 2005 are considerably poorer than the poorest households in 2002, while the wealthiest households in 2005 are considerably wealthier than the wealthiest households in 2002. The likely reason for this pattern of income change is worse rainfall conditions in 2005 (relative to 2002) leading to reduced crop income in 2005, combined with the high dependence of rural households (especially the poorest) on income from rainfed crop production.

More encouraging results in welfare trends are found in household assets. The TIA data reveal continued accumulation of household assets (such as land, livestock, and bicycles) between 2002 and 2005, with the notable exception of a decline in poultry. There has been a very significant increase in education participation by both boys and girls, with the gap between them narrowing.

The second objective of this paper is to use information about the structure of rural household income, asset levels, and access to technology and public goods in TIA 2002 and 2005, to investigate the prospects for continued rural economic growth, as well as the question of whether or not one could expect income growth to continue to be as broad-based as it was from 1996 to 2002. Although TIA showed some increases in use of improved crop inputs (such as fertilizer, animal traction, and irrigation) from 1996 to 2002, TIA 2005 shows no improvement since then. Some analysts believe that much of the growth in agricultural production and crop income in rural Mozambique since 1994 has primarily come from agricultural extensification (increased area under cultivation) and very little from intensification (increased productivity via higher levels of inputs and/or shifting area into higher-return cash crops). Given that TIA shows that household use of fertilizer (3.5% of households in 2005) and animal traction (8.8% in 2005) – both of which help to improve crop yields and maintain soil fertility – remain very low, it seems doubtful if continued area expansion by manual cultivation will continue to generate growth in crop income over time without some increase in the adoption of improved inputs and/or increased production of higher-value crops.

Structural change is typically understood to involve the shift over time from an economy in which farm production employs most of the population, to one in which non-farm goods and services plays a bigger and bigger role in the economy. This implies a movement away from an economy dominated by subsistence agricultural production, and towards a more specialized, market-driven economy. The TIA 2005 data does not show much evidence of movement towards greater household reliance on markets, as a majority of rural households remain subsistence or semi-subsistence farm households, and a majority of rural household income is still derived from the value of food production retained by rural households (the bottom 80% of rural households derived from 51 to 62% of their total household income from the value of retained food crops). Participation in higher-value farm activities declined somewhat since 2002, as only a third of household (31.7%) have sold some high-value crops (field cash crops, tree crops, horticulture) in 2005, and only 26% have sales of livestock products (live animals, meat, eggs/milk). Average household income shares for higher-value farm activities (field cash crops, tree crops, horticulture; sales of live animals, meat, eggs/milk) remained very low (the share of total household income from food crop sales was

5.7% in 2005, 4.8% for high-value crop sales, and 2.4% for livestock product sales), due both to low participation rates and to the predominance of food crops in total income.

There is also not much evidence from TIA 2005 of structural change toward higher-value non-farm activities in most provinces. A notable exception was found in the provinces of Sofala and Gaza, where there were rather large increases in household participation in non-farm activity participation from 2002 to 2005. Much of this increase appears to be due to increased participation in higher-return activities, not activities with lower returns such as unskilled non-farm wage labor and MSE natural resource extraction activities. Many rural households in Mozambique face insurmountable barriers in their attempts to access such high-return non-farm activities, as suggested by the TIA results above and in studies of income diversification across Africa.

While efforts to reduce barriers to non-farm income opportunities are certainly warranted, the large share of retained food crops in total rural household income suggest that improvements in food crop productivity appear to offer great potential for poverty reduction for a large number of rural households. The government's Green Revolution Strategy, and the action plan to increase agricultural productivity launched by the Ministry of Agriculture in July 2008, both focus on increasing agricultural productivity. But these initiatives will only be sustainable over the long run if improved technology is financially profitable for farmers. Greater attention needs to be given to an analysis of the profitability of improved technology for different crops and regions of the country.

A tempting conclusion for the Government's development strategy would be to avoid dependence on rainfed crops by investing in irrigation or non-agriculture livelihood sources. But the sheer number of households that rely on rainfed agriculture (98.9% of households in 2002), and the very high investment costs of irrigation and non-agricultural economic activities, imply that the majority of rural households will continue to depend on rainfed agriculture for a large part of their income, as well as their food security, for at least a generation or more. Therefore, increasing the productivity of rainfed agriculture, and making it less vulnerable to rainfall variability through more resilient varieties and conservation agricultural management practices, should be at the heart of the Government's Green Revolution Strategy and agricultural action plans.

Increases in rainfed crop productivity are certainly possible in the short run in Mozambique, but they require more than improved access to crop varieties and chemical fertilizers. While Mozambique has made great progress in variety testing for key crops like maize and cassava, research and extension to promote soil and water conservation agriculture techniques lags behind the efforts of neighboring countries such as Zambia. Conservation agriculture techniques can increase the profitability and reduce the risk of purchased inputs like chemical fertilizer. Furthermore, the lack of access to animal traction in the most productive areas of the country is also hindering an increase in area cultivated per person as well as yields per unit area. Expansion of animal traction is difficult, due to disease and lack of familiarity with draft animals, but absolutely essential if a significant number of smallholders are to become viable commercial enterprises producing crops for the market. Also, in the absence of a land market, oxen are the best alternative source of collateral to help stimulate viable rural financial markets.

APPENDICES

APPENDIX A-1: ADJUSTMENTS TO HOUSEHOLD WAGE INCOME, INCOME FROM OWN BUSINESS ACTIVITIES, AND PARCEL AREA

1.1. Imputation of Missing Wage Income Data

TIA recorded information on the wage income earned by households within the previous 12 months. This information was collected by wage type, differentiating between twelve different wage income activities, some involving less skilled work (such as agricultural laborer on a smallholder farm, domestic worker, day laborer, etc.) and others more skilled (mechanic, miner, teacher, etc.). Some households reported information on wage type, but not information on earnings per month. For example, of the 3,126 households in TIA05 which reported wage income during the previous 12 months, we do not have data on the earnings per month for 508 of these households (in TIA02, 402 out of 1477 cases which reported wage income activity reported wage type but no earning information; however, we did not include all 402 of these cases of imputed wage income in computing household income, because 298 of these cases did not meet the residence criteria described in the section above). To impute values for this missing earnings data, we first computed the average annual earning per household by wage type (among those with that wage type). We then used the average by wage type to impute the missing information (by wage type). For example, for a household which reports that it earned wage income from a household member which worked as an agricultural laborer on a smallholder farm, but did not report the actual earnings, we imputed a value for this missing earnings data by using the average household income from agricultural wage labor (on smallholder farms) as computed among households with observed agricultural wage labor earnings.

1.2. Excluded Wage Income

Following Boughton et al's (2006) work comparing household income from TIA96 and TIA02, we exclude salary income earned outside the country, unless it was: a) earned by the household head; b) the head worked at that job less than 12 months of the year; and c) the head resided in the household at the start of the agricultural season. The reason for this exclusion is that for the purposes of this paper (and other TIA income analyses), income is intended to serve as an indicator of the potential consumption (i.e., welfare) of the individuals residing in the household. Because income which the household receives from individuals living permanently outside the province should have been reported in the form of remittances, a danger in using wage income from such an individual is that there could be double-counting if remittances were also reported. Secondly, remittance income is defined as the income received by the household, whereas wage income is defined as the income earned by that individual, thus an individual which resides the whole year outside of the province would not likely send his/her entire wage income to the TIA respondent household (i.e., that individual would surely have some living expenses wherever he/she resides).

In the case of TIA02, the implication of this restriction is that, out of a total of 3,094 individuals with reported wage income, we excluded reported wage income from 465 individuals (most of these 465 cases had missing data, thus we had imputed wage earnings for them).

1.3. Imputation of Missing Data on Small-to-medium Enterprise Activity

TIA02 and TIA05 collected data on income generated by the household in the previous twelve months from own business activities (micro-small enterprise, or MSE). One MSE module asked households about income (revenue) from own businesses involving forest and fishing products (i.e., producing charcoal, collecting firewood, hunting, fishing, making mats/hats, etc.); the other MSE module asked about income (revenue and costs) from all other types of own businesses (i.e., trading, carpentry, mechanic, brick-making, etc.). In each module, TIA collected information on revenues by type of activity, asking for the months in which the household received 'high', 'low', and zero earnings (and to indicate an amount representing 'high' monthly earnings, and the amount representing a 'low' earning month).

In the case where households indicated the number of high/low months of a given activity but where revenue data was missing, we imputed revenue based on the average monthly revenue (by high/low month). For example, for the forestry/fishing MSE activities in TIA05, six households indicated months of activities and levels of activity, but gave no revenue levels associated with high/low revenue months. We imputed a monthly earning for this missing revenue data using the average revenue for households with MSE activity of that type.

1.4. Adjustments to Declared Parcel Area

The TIA02 and TIA05 instruments asked respondents to declare the area of each machamba (parcel) which the household owned, controlled, rented, etc. for agricultural seasons during the time period covered by that TIA (i.e., the previous 12 months). For about 25% of the sample households in both TIA02 and TIA05, enumerators used GPS units to measure at least one of the household's machamba (i.e., measured area), in addition to recording the farmer's declared area of each machamba. In constructing TIA household datasets, *Departamento de Análises de Políticas* (DAP)/MSU has typically used measured area (when available) to define a household's land area. For machambas without measured area, DAP/MSU has used the sample of measured machambas to quantify the relationship between measured and declared area, and thus to adjust un-measured machambas for potential respondent error. For example, to mitigate potential respondent error in declared area of a machamba for a given TIA, DAP/MSU uses data on machambas which have been measured (i.e., for which TIA has recorded both a measured and declared area for that machamba), and runs a machamba-level regression of measured area of a machamba on its declared area plus household characteristics associated with that machamba, such as the education of the household head, and other factors such as district (which helps control for potential differences across enumeration teams, as well as spatial differences in how farmers perceive their machamba area). Using the coefficients from this regression, we then impute an adjusted machamba area for machambas which were not measured.

In the interest of ensuring the highest degree of comparability between TIA02 and TIA05 landholding, we redid the TIA02 area adjustments, applying to TIA02 area data those adjustment factors which we computed for TIA05 (we assumed that the TIA05 enumerator team likely did a better job with the GPS units than those from TIA02, due to learning over time). For this reason, the TIA02 machamba area in the TIA02-05 income file will be slightly different from that reported in the original TIA02 income file. The importance of such comparability cannot be underestimated, especially in the context of research intended to compare the TIA02 and TIA05 full samples, or changes in household landholding among 2002-05 panel households. For example, by using a common set of area adjustment factors, we avoid the possibility of finding changes in household landholding which are due to

differences in adjustment factors over time (i.e., changes in method) and not actual changes in household landholding.

APPENDIX A-2: ADJUSTMENTS TO HOUSEHOLD CASSAVA PRODUCTION DATA

The TIA05 survey instrument asked respondents to report cassava production by major and minor harvesting months, and by one of three harvesting frequencies: monthly, weekly, or daily harvesting. However, the TIA02 instrument only included two harvesting frequencies: monthly and weekly. This difference in the two survey instruments is significant because aggregating daily harvesting to a monthly total (daily quantity harvested*24 days/month) which is considerably larger than similar monthly totals for households with monthly or weekly reporting. Thus, the analysis which follows was done to adjust TIA02 cassava production (upward) for households which we believe would have reported daily harvesting had they had the option.

2.1. Step 1: Adjust Household Cassava Production Due to Changes in the Survey Instrument from TIA02 to TIA05

The first step is to estimate the difference between cassava production under weekly reporting relative to daily reporting. Using only households with positive cassava production (not including imputed cases in TIA02) in both 2002 and 2005, as well as capped production in 2002 and 2005, we regress the household change in cassava production 2002-05 over district dummies, change in household size 2002-05, and various dummies to capture changes in the household's frequency of harvesting from 2002 to 2005 (monthly (2002) to daily (2005), monthly to weekly, and weekly to daily). We assume that the only households which might have reported daily in TIA02 given the option would be those households which went from weekly to daily reporting. The coefficient on the weekly to daily dummy is significant and +985 kg.

The second step is to figure out which households – from among those which moved from weekly to daily harvesting - would have likely reported daily harvesting in TIA02 had they had the option. We first define a dummy variable *moveup1* =1 if the household produced cassava in both 2002 and 2005 (not including households with imputed cases in 2002), and which changed their reporting of cassava harvesting frequency (in major month of harvesting) upwards from TIA02 to TIA05 (from monthly in TIA02 to weekly in TIA05; monthly to daily; or weekly to daily). As the means below demonstrate, a majority of cassava-growing households increased their reported frequency of harvesting (major harvest) from TIA02 to TIA05.

```
mean moveup1 [pw=wgt], over(prov)
        Over |       Mean   Std. Err.     [95% Conf. Interval]
-------------+----------------------------------------------
moveup1      |
      niassa |   .5536365   .0895334      .3779893    .7292837
   c.delgado |   .6315775   .0416258      .5499157    .7132393
     nampula |   .7786546    .035816      .7083904    .8489187
    zambezia |   .6272906   .0301317      .5681781    .6864031
        tete |   .7651125   .1134405      .5425642    .9876608
      manica |   .5625848    .063465      .4380789    .6870908
      sofala |   .5111321   .0866153      .3412096    .6810546
   inhambane |   .3759962   .0352506      .3068414    .4451511
        gaza |   .5613803   .0466778      .4698075     .652953
      maputo |     .38055   .0453759      .2915313    .4695688
```

However, the increased household frequency of cassava harvesting evident above could be due to either: a) actual household intensification of cassava production, or b) a change in the survey instrument.

To address this question, we run the following probit:
*moveup1 (*which = 1 if the household increased frequency of cassava harvesting)
= f (no constant, district dummies, change in household size 2002-05, change in cassava area 2002-05).

The results show that, controlling for change in household size 2002-05, the coefficient on change in cassava area is significant and positively associated with increased frequency of cassava harvesting – thus increases in cassava area can serve as an indicator of intensification of cassava production. Therefore, we assume that households which did not increase their cassava area (technically, those with a change which was less than the median change, since the median change is positive) are households which were more likely (relative to other households) to have reported daily harvesting in TIA02 had they been given the option. That is, we assume that these households did not change their intensification of harvesting over time.

Under this assumption, we add 985 kg of cassava production to the total cassava production observed in TIA02 for the n=101 households which changed their cassava area less than the median sample household change (this only includes households which reported weekly in TIA02 and then daily in TIA05).

2.2. Step 2: Impute Production for TIA02 Cassava Growers Who Report Growing the Crop but no Production

About one-third of cassava growers in TIA02 reported growing the crop (praticou=1) but did not report production (many in Nampula). The original TIA02 producao.sav file included imputed production for these growers (regression detail in Boughton et al. 2006). The imputed amount was computed using coefficients from a regression (of observed cassava production) of observed TIA02 cassava production as a function of district dummies, household area in cassava, and household area in mandioca squared. We revised this regression for this paper, building on the first one by adding household size (consumption AEs) as a regressor, and using area variables which are adjusted using the panel area adjustments discussed above.

2.3. Step 3: Place a Cap on Household Retained Production in 2002 and 2005

The original TIA02 and TIA05 data contain some observations in which cassava retained production (net of sales over the previous 12 months) is many, many times larger than what the household would reasonably consume by itself. One explanation could be that sales are underestimated, yet sales information is collected over the previous 12 months, and TIA02 shows that most cassava sellers sell from July to September – sales which should be captured by TIA02. In an effort to reasonably handle what appear to be outlying observations of retained cassava production, we therefore assume that a household will not realistically produce more than 5 times the maximum daily cassava consumption per capita (400 kg/per capita) in a given year, net of reported household cassava sales. Thus, we place a cap of 2,000 kg/per Consumption Adult Equivalents (AECs) on household retained cassava

production. There were 147 households over the 2,000 kg/capita cap in TIA05 (116 of which reported daily harvesting), and 77 households over the cap in TIA02 (47 of which reported daily harvesting in TIA05).

APPENDIX A-3. CONSTRUCTION OF PRICE INFLATORS FOR TIA02-TIA05 PANEL INCOME DATASET

3.1. Summary

We use IAF 2002/03 consumption quantities (flexible adjusted) from the food consumption basket of each IAF poverty region. These quantities are valued using 2002 SIMA retail prices, then the basket is revalued with 2005 SIMA prices to update the cost of an identical (fixed) consumption basket. The consumption quantities are therefore the weights for the commodity prices. The inflators which we create are fixed because the weights are not allowed to change over time (relative to flexible inflators, fixed inflators which will tend to overestimate inflation, thus underestimating growth).

3.2. For Commodity 1 (Maize)

Q1j = grams consumed/day of commodity maize from IAF 2002/03 food basket for region j
P1j = SIMA 2001/02 rural retail market price/gram for region j

The share of this commodity's value in the total value of consumption (at the poverty line) is = $Q1j*P1j / \sum_i (Qij*Pij)$ – where i is commodity (from 1 to n) and j is the province or poverty region. The quantities in a given region's basket varies by IAF poverty region (some regions contain two province), though the prices vary by province in some cases.

- Step 1: Convert IAF02 quantities consumption of quantities with SIMA price data covered by SIMA into quantities covered by SIMA (where possible).

- Step 2: For IAF02 commodities for which we have SIMA price data, revalue the commodity basket using SIMA 2002 prices, computing $P1j^{02}*Q1j^{02}$ for 2002, where Pij^{02} is the annual average SIMA retail price/gram for commodity i for that province j (or region if a price for that province is not available). The sum value of <u>this subset</u> of IAF basket commodities for a given region j is $\sum_i (Pij^{02}*Qij^{02})$. This is the cost of a consumption basket in 2002, for province j.

- Step 3: For that same subset of commodities, compute $Pij^{05}*Qij^{02}$ for 2005, where Pij^{05} is the annual average SIMA retail price/gram for commodity i for that province j (or region if a price for that province is not available). The sum value of these commodities is $\sum_i (Pij^{05}*Qij^{02})$. This is the cost of a consumption basket in 2005, for province j.

- Step 4: Compute the ratio $\sum_i (Pij^{05}*Qij^{02}) / \sum_i (Pij^{02}*Qij^{02})$; this is our price inflator (PIj) for province j. If we want our panel values to be in 2002 prices, we divide TIA05 income by PIj. If we want to the panel values to be in 2005 prices, we multiply TIA02 income by PIj.

3.3. Computing the Annual Average SIMA Retail Price

We compute an annual average SIMA rural retail price (nominal) for 2001/2, and one for 2004/5, for each province (or IAF poverty region). IAF consumption quantities and prices reflect the period of IAF implementation July 2002 – June 2003. The first wave of the TIA

panel was implemented in the fall of 2002, and collected recall data for the period October 2001 – September 2002 (the 2001/02 agricultural year). The second wave was implemented in the fall of 2005, and collected recall data for the period October 2004 – September 2005 (the 2004/05 agricultural year). Since we want to control for price inflation between the TIA panel surveys, we compute an annual price where the year is defined as October – September (Oct 2001 – Sept 2002; Oct 2004 – Sept 2005) to correspond with the TIA recall periods.

SIMA collects weekly price data from three traders in a given market. For the given commodity and rural retail market, we first take the mean of the three trader prices for a given week at that market. Second, we compute the median (nominal) price for each quarter of the year for each market (the first quarter of TIA recall is October – December). Third, if there is more than one market in a given region, we compute the mean quarterly price across the markets in that region. Fourth, we compute the annual price as the mean of the quarterly prices for that commodity in the given region. Computing quarterly prices (step 2) before the annual price ensures that we are not weighting too heavily quarters of the year in which there happen to be more observations. If a province does not have price observations for a given commodity, we use the price from the neighboring IAF poverty region province (for example, C.Delgado and Niassa are in the same IAF poverty region).

There are several aspects of this method which are less than ideal, but which we still find preferable to using the INE urban CPI from Maputo, Beira, and Nampula. First, the SIMA prices we use do not correspond temporally to the reported quantities consumed in IAF given that the IAF 2002/03 survey covers a different period of time relative to TIA 2001/02. If we were to use prices from the IAF period then we might underestimate price inflation from 2002 to 2005, since IAF prices represent a period which occurred nearly a year after the TIA02 recall period. Second, while the SIMA prices are from the same region as the IAF quantities, they technically do not correspond spatially to the IAF quantities. We choose not to update the IAF food basket values using SIMA prices only for 2005, since the SIMA and IAF prices (even if they were for the same year, which they are not) would likely be somewhat different given differences in the location and method of price reporting between IAF and SIMA. IAF prices are derived from the reported retail value of retail-purchased or home consumption of commodities. MPF analysts bounded these household prices by price observations from the nearest village market taken at the same time as the household survey. By contrast, while there are many fewer observations of SIMA prices per province (only 1-3 rural markets per province), the SIMA price data itself is likely to have less measurement error given that it is measured directly by SIMA staff as well as recollection collected using SIMA-standardized methods (i.e., standard containers) to ensure accurate quantity conversion (to a kilogram price). This rationale is not meant to criticize IAF price data, but rather simply to demonstrate why we chose not to value the IAF 2002 quantity using an IAF price for 2002 and a SIMA price for 2005.

To ensure that we are able to capture price seasonality throughout the year, we only use data from SIMA markets which have recorded at least one price for each quarter of the year (this is the case of the majority of SIMA markets). If a market is missing just one quarter out of the four for a given year, we use price inflation by quarter for that product in that region to impute the missing price for the product/market in that quarter. For example, if a Niassa rural market is missing a maize price for the 3rd quarter, we use the average price inflation in the north for maize between the 2nd and 3rd quarter to inflate the observed Niassa rural market maize price in the 2nd quarter and thus impute a 3rd quarter price. In all but one or two cases, this was the only price missing for the 8 quarters of price data (i.e., the two years of the TIA panel), and a majority of markets had complete price data for all 4 quarters for both years. As

follows are the number of SIMA rural markets used relative to those with incomplete price data: (number of markets with one quarter missing/number of markets used) = Milho em grao (1/7), farinha de milho (2/6), feijao nhemba (2/6), feijao manteiga (2/9), arroz (2/8), oleo (1/6), amendoim pequena (2/5), amendoim grande (3/5), and azucar (2/6).

3.4. IAF Basket Commodities Used in Our Baskets

We use the 2002/03 adjusted flexible quantities of each commodity in the IAF food baskets for each IAF poverty region (obtained from MPF et al. 2004), and use only those commodities for which we can match a SIMA price (or an imputed price, in the case of batata doce).

IAF commodity name = SIMA commodity name
Milho branca em grao = Grao de milho branco nacional
Farinha de milho branca com farela, nacional = Farinha de milho branca nacional com farela
Farinha de mandioca = (converted to fresca)
Mandioca fresca = mandioca fresca
Feijao nhemba = feijao nhemba
Feijao manteiga = feijao manteiga nacional
Arroz corrente = arroz corrente
Oleo = Oleo alg/avul
Amendoim pequena = amendoim pequena
Azucar nacional = azucar castanho nacional
B.Doce = imputed retail price

IAF consumption baskets often include consumption of the same commodity in different states/forms (i.e., farinha, em casca, em grao, seca/fresca, etc.). Since we tend to only have SIMA price data for one of the product forms, we convert the IAF quantities of some commodities to the form for which we have SIMA price data, using TIA commodity conversion factors as constructed for TIA02.

SIMA's coverage of farinha de mandioca and mandioca fresca is geographically very sparse (we only have 4 quarters of price data for Mocuba). However, we have a considerable number of farmgate mandioca prices from TIA across all regions. We compute the marketing margin (%) between the SIMA farinha price and the TIA farmgate mandioca price for Mocuba. We then apply this marketing margin to the TIA farmgate mandioca price data by region to impute retail mandioca prices for each region.

SIMA does not collect price data for every commodity in the IAF consumption baskets. Most of these commodities we simply must drop from the IAF consumption basket. Column F in Appendix Table 2 shows how much of the total IAF expenditure basket for a given region is covered by the commodities in our adjusted baskets. However, for sweet potato, we impute a 2002 retail price by applying the mandioca marketing margin to the TIA farmgate price data on sweet potato.

APPENDIX A-4. WATER BALANCE MODEL

In order to estimate the quality of rainfall for the principal agricultural season, we obtained district-level dekadal (10-day) rainfall estimates (RFE) from the Famine Early Warning System (FEWS), and fed these estimates into a water balance model in order to estimate the number of days of drought in each province during the principal maize growing season. We computed this for each year from 1996 to 2006. This appendix provides more detail regarding the data and methods we used to construct the days of drought variable.

4.1. FEWS Rainfall Estimates (RFE)

The National Oceanic and Atmospheric Administration (NOAA) obtains blended satellite-gauge rainfall estimate (RFE) images for the African continent at 0.1-degree (~10 km) spatial resolution. Rainfall images are produced using an interpolation method that combines data from Meteosat cold cloud duration (CCD), the Special Sensor Microwave/Imager (SSM/I) of the Defense Meteorological Satellite Program, the Advanced Microwave Sounding Unit (AMSU) on board the NOAA-15 polar orbiter, and reporting rain gauge data from Global Telecommunication System (GTS) (Xie and Arkin 1997). FEWS uses this information within an algorithm to provide RFE (10-day rainfall in millimeters) at an approximate horizontal resolution of 10 km. The main use of these data is to provide input for hydrological and agrometeorological models as well as to provide climate information e.g. compare the current state of rainfall with previous time periods. For Mozambique, FEWS decadal rainfall estimates are available at the district level throughout the months which precede and contain the main growing season, and go back at least ten years.

4.2. Estimation of the Days of Drought for a Given District

a) Choice of Rainfall Estimate Data: We use the district-level dekadal rainfall estimates from FEWS. While the National Institute of Meteorology (INAM) has daily rainfall estimates, we prefer the FEWS estimates because INAM's rain stations are primarily urban or peri-urban, and there are very few rain stations in key agricultural provinces. For example, INAM has only 2-3 rain stations in Zambezia, which were near Sofala.

b) Defining the dates of the principal growing season for each district: We first assumed that the principal growing season lasts 150 days (based on maize production). Second, using our estimates of the Soil Available Water for a given district (SAW – see next section), we defined the start of the season as the decadal when SAW reached a critical threshold. For most districts, this occurs sometime after 1 November and by early January. That is, if the observed SAW has not reached the threshold level by early January, we assume that they planted at that time. Third, we checked our estimated planting dates by region against those reported in FEWSNET bulletins.

c) Days of Drought derived from Soil Available Water Model: We use this FEWS district-level decadal Rainfall Estimates (RFE) a Soil Available Water model, which enables us to compute the days of drought during the 150-day principal maize growing season. This model is modified slightly from that used by Boughton et al (2006), who computed days of drought for the 1995/96 and 2001/02 principal agricultural seasons using monthly rainfall estimates. Days of drought are computed from the following equations:

Potential Evapotranspiration (PET)

$PET_t = 5*d$

where d is the number of days in the dekadal (10). We assume that PET = 5 mm per day, thus PET for a decadal is 5 mm per day * 10 days = 50 mm.

Soil Available Water (SAW)

$SAW_t = RFE_t + SAW_{t-1} - PET_t$

Where SAW is not allowed to exceed 150 mm

Actual Evapotranspiration (AET)

$AET_t = SAW_{t-1} + RFE_t$

We bound AET_t : AET = PET if AET>=5.0

Drought Stress (daily) = 1 - (AET/PET)

Days of Drought = sum of drought stress days over the 150-day season

d) Data Coverage: The dekadal FEWS rainfall data and the days of drought (DOD) computation gives us seasonal DOD yields estimates days of drought estimates for nearly all districts for most of the last ten years. If a district is missing considerable rainfall data for a given month in the season, we use the provincial average DOD for that year.

APPENDIX A-5. DEFINITION OF INCOME COMPONENTS

Components are defined as follows:

Total income = farm income + non-farm income

Farm income = crop income + sales of livestock products + unskilled farm wage labor
  Crop income = retained food crops + sold food crops + sold high-value crops

Non-farm income = non-farm wage labor + MSE activities + remittances/pensions
  Non-farm wage labor = unskilled non-farm labor + skilled non-farm labor
    MSE activities = MSE natural resource extraction activities + MSE other activities with low cost entry barriers + MSE other activities with high cost entry barriers

Notes:

- Food crops are distinguished between value retained and sold, and include: cereals, oilseeds (groundnuts, sesame, sunflower), beans, roots/tubers, and production of cashew (castanha) and coconut (coco).
- High value crops include: field cash crops (cotton, tobacco, tea, etc.), sales of horticultural crops (vegetables, fruits, sugar cane), and sales of cashew and coconut value-added products (aguardiente, lanho, and copra).
- Unskilled non-farm labor includes: housekeeping and non-specialized day labor.
- Skilled non-farm labor includes: government officials, teachers, extensionists, NGOs, miners, drivers, and a few cases of skilled farm labor (i.e., veterinarians, ingeniero agronomos).
- MSE natural resource extraction includes: hunting, fishing, making charcoal, collecting firewood, etc.
- MSE other-low includes: sale of homemade beverages; handicrafts/carpentry/masonry; radio/bicycle repair; brick production/laying, etc.
- MSE other-high includes: purchase and sale of beverages, food, fish; purchase and sale of livestock; agro-processing, etc.

Appendix Table 1. Comparison of Mean Household Characteristics by TIA Sample and Sub-sample, With and Without Application of Panel Attrition Bias Correction Factor

	---------- 2002 ----------				--------- 2005 ---------			2006
Sample information								
Sample used	TIA 02 all HHs	TIA 02 non-panel HHs	TIA 02-05 panel HHs	TIA 02-05 panel HHs	TIA 05 all HHs	TIA 02-05 panel HHs	TIA 02-05 panel HHs	TIA 06 all HHs
	A	B	C	D	E	F	G	H
No. of households	4,908	804	4,104	4,104	6,139	4,096	4,096	
Weight used	TIA02	TIA02	TIA panel	TIA panel with IPW	TIA05	TIA panel	TIA panel with IPW	TIA06
Variable name of weight used	wgt02	wgt02	wgt02[1]	wgt02ipw	wgt05	wg 02[1]	wgt02ipw	wgt06
Attrition correction applied	no	no	no	yes	no	no	yes	no
Household demographics								
Head's age (years)	42.04	39.85	42.48	42.08	43.99	44.85	44.45	42.37
Household size (#)	4.97	4.40	5.08	4 97	5.28	5.36	5.28	5.06
No. of children age 0-4	0.83	0.74	0.85	0 83	0.83	0.80	0.80	
No. of children age 5-14	1.48	1.23	1.53	1.48	1.67	1.73	1.69	
No. of adults age 15-59	2.42	2.24	2.45	2.42	2.52	2.55	2.52	
No. of adults age 60+	0.23	0.19	0.24	0.23	0.26	0.28	0.27	
Household income and assets								
Total net HH income (contos)	10,492	9,473	10,697	10,504	12,359	12,247	13,476	
Total net HH income/AE (contos/AE)	2,920	2,945	2,915	2,987	3,344	3,316	3,661	
Total landholding (ha)	1.86	1.64	1.90	1.86	1.88	1.97	1.94	
1=HH owns a bicycle (%)	0.23	0.21	0.23	0.23	0.30	0.31	0.31	
1=HH roof is of good material (%)	0.12	0.08	0.13	0.12	0.14	0.14	0.13	

Source: TIA02, TIA05, TIA06; panel attrition correction computed by Mather and Donovan (2007)

Notes: 1) The TIA panel weights as computed by David Megill and Ellen Payongayong are nearly identical to the TIA02 weights.

Appendix Table 2. IAF-SIMA Rural Consumption Baskets Used for Price Inflation of TIA Panel Income, 2002-2005

Province	Product	IAF rural quantity consumed 2002, original (kg)	IAF rural quantity consumed 2002, flexible (kg)[1]	IAF rural retail price (contos/ kg)[2]	IAF expenditure basket share[1]	SIMA rural retail price, 2002 (contos/ kg)	SIMA rural retail price, 2005 (contos/ kg)	Expenditure basket, IAF adjusted quantity, valued at SIMA price (contos/kg)		IAF-SIMA expenditure basket share	
								2002	2005	2002	2005
Niassa	Arroz corrente	30.71	33.58	8.99	0.056	8.76	11.21	294.05	376.46	0.090	0.092
Niassa	Farinha de milho branca com farela,	233.26	257.92	6.98	0.331	6.49	7.41	1,673.00	1,911.20	0.509	0.468
Niassa	Farinha de mandioca	133.86	99.50	4.13	0.076	3.55	3.33	353.24	331.66	0.108	0.081
Niassa	Amendoim pequena	19.92	27.95	10.93	0.056	12.44	22.90	347.79	640.05	0.106	0.157
Niassa	Feijao manteiga	10.91	16.57	7.67	0.023	11.19	20.15	185.38	333.75	0.056	0.082
Niassa	Feijao nhemba	29.92	36.18	6.32	0.042	9.39	9.85	339.89	356.37	0.103	0.087
Niassa	Mandioca fresca	79.00	66.30	1.38	0.017	1.38	2.06	91.22	136.83	0.028	0.033
C.Delgado	Arroz corrente	30.71	33.58	8.99	0.056	8.98	10.25	301.44	344.04	0.081	0.070
C.Delgado	Farinha de milho branca com farela,	233.26	257.92	6.98	0.331	7.90	10.01	2,037.63	2,582.06	0.546	0.527
C.Delgado	Farinha de mandioca	133.86	99.50	4.13	0.076	3.55	3.33	353.24	331.66	0.095	0.068
C.Delgado	Amendoim pequena	19.92	27.95	10.93	0.056	12.44	22.90	347.79	640.05	0.093	0.131
C.Delgado	Feijao manteiga	10.91	16.57	7.67	0.023	12.88	26.06	213.35	431.74	0.057	0.088
C.Delgado	Feijao nhemba	29.92	36.18	6.32	0.042	10.67	10.67	386.19	385.89	0.104	0.079
C.Delgado	Mandioca fresca	79.00	66.30	1.38	0.017	1.38	2.75	91.22	182.32	0.024	0.037
Nampula	Arroz corrente	5.67	16.34	5.70	0.021	8.63	8.63	140.95	140.95	0.044	0.032
Nampula	Milho branca em grao	18.87	17.51	3.09	0.012	3.30	3.43	57.80	60.03	0.018	0.014
Nampula	Farinha de milho branca com farela,	27.71	93.63	5.22	0.109	8.58	8.11	803.61	758.96	0.250	0.173
Nampula	Farinha de mandioca	183.96	128.49	3.36	0.097	3.55	3.33	456.14	428.28	0.142	0.098
Nampula	Amendoim pequena	19.45	75.92	6.62	0.112	12.44	22.90	944.61	1,738.38	0.294	0.397
Nampula	Feijao nhemba	48.78	106.94	4.02	0.096	6.43	10.17	687.46	1,087.62	0.214	0.248
Nampula	B.Doce	8.53	15.36	1.35	0.005	1.38	2.07	21.20	31.80	0.007	0.007
Nampula	Mandioca fresca	51.14	45.85	2.54	0.026	0.93	1.16	42.44	53.05	0.013	0.012
Nampula	Mandioca seca	374.62	68.53	2.06	0.017	0.93	1.16	63.43	79.29	0.020	0.018

Zambezia	Arroz corrente	20.62	20.99	7.73	0.039	8.65	11.69	181.50	245.45	0.078	0.096
Zambezia	Milho branca em grao	27.70	28.91	2.76	0.019	3.86	3.12	111.49	90.31	0.048	0.035
Zambezia	Farinha de milho branca com farela,	152.60	201.59	5.27	0.256	5.78	6.11	1,165.12	1,231.62	0.501	0.481
Zambezia	Farinha de mandioca	154.14	107.96	4.88	0.127	3.55	3.33	383.27	359.85	0.165	0.141
Zambezia	Amendoim pequena	3.79	5.59	9.31	0.013	12.44	22.90	69.58	128.04	0.030	0.050
Zambezia	Feijao manteiga	5.36	10.85	6.27	0.016	10.35	17.19	112.22	186.45	0.048	0.073
Zambezia	Feijao nhemba	6.66	9.34	5.24	0.012	8.11	9.03	75.80	84.39	0.033	0.033
Zambezia	B.Doce	41.00	52.08	1.25	0.016	1.38	2.07	71.89	107.83	0.031	0.042
Zambezia	Mandioca fresca	104.76	104.41	1.23	0.031	1.23	0.99	128.79	103.68	0.055	0.041
Zambezia	Mandioca seca	31.25	20.49	1.94	0.005	1.23	0.99	25.28	20.35	0.011	0.008
Tete	Arroz corrente	8.24	6.85	9.17	0.011	10.05	11.42	68.79	78.22	0.019	0.023
Tete	Milho branca em grao	45.74	144.34	2.89	0.074	4.10	3.05	591.98	440.27	0.165	0.131
Tete	Farinha de milho branca com farela,	349.27	302.48	8.75	0.470	7.82	6.90	2,366.63	2,087.78	0.659	0.620
Tete	Oleo	2.60	1.71	31.07	0.009	32.64	41.46	55.77	70.84	0.016	0.021
Tete	Amendoim pequena	5.63	4.48	10.96	0.009	9.93	12.81	44.52	57.39	0.012	0.017
Tete	Feijao manteiga	31.86	19.11	9.52	0.032	11.99	16.01	229.18	305.89	0.064	0.091
Tete	Feijao nhemba	13.85	15.92	6.61	0.019	5.15	9.53	81.94	151.70	0.023	0.045
Tete	B.Doce	36.46	43.00	1.90	0.014	1.90	2.20	81.50	94.49	0.023	0.028
Tete	Azucar nacional	6.50	5.69	11.57	0.012	12.81	14.31	72.95	81.49	0.020	0.024
Manica	Arroz corrente	8.24	6.85	9.17	0.011	10.18	12.30	69.71	84.18	0.020	0.022
Manica	Milho branca em grao	45.74	144.34	2.89	0.074	3.01	3.29	434.81	474.26	0.124	0.127
Manica	Farinha de milho branca com farela,	349.27	302.48	8.75	0.470	7.80	7.70	2,358.46	2,329.34	0.673	0.622
Manica	Oleo	2.60	1.71	31.07	0.009	32.64	41.46	55.77	70.84	0.016	0.019
Manica	Amendoim pequena	5.63	4.48	10.96	0.009	14.05	20.63	62.95	92.43	0.018	0.025
Manica	Feijao manteiga	31.86	19.11	9.52	0.032	15.08	18.40	288.13	351.69	0.082	0.094
Manica	Feijao nhemba	13.85	15.92	6.61	0.019	5.15	9.53	81.94	151.70	0.023	0.041
Manica	B.Doce	36.46	43.00	1.90	0.014	1.90	2.47	81.50	106.30	0.023	0.028
Manica	Azucar nacional	6.50	5.69	11.57	0.012	12.81	14.31	72.95	81.49	0.021	0.022
Sofala	Arroz corrente	20.62	20.99	7.73	0.039	10.05	11.42	210.90	239.80	0.075	0.087
Sofala	Milho branca em grao	27.70	28.91	2.76	0.019	4.10	3.05	118.58	88.19	0.042	0.032
Sofala	Farinha de milho branca com farela,	152.60	201.59	5.27	0.256	7.82	6.90	1,577.27	1,391.42	0.562	0.504
Sofala	Farinha de mandioca	154.14	107.96	4.88	0.127	3.55	3.33	383.26	359.51	0.136	0.130
Sofala	Amendoim pequena	3.79	5.59	9.31	0.013	9.93	12.81	55.55	71.62	0.020	0.026
Sofala	Feijao manteiga	5.36	10.85	6.27	0.016	11.99	16.01	130.07	173.61	0.046	0.063
Sofala	Feijao nhemba	6.66	9.34	5.24	0.012	5.15	9.53	48.06	88.98	0.017	0.032
Sofala	B.Doce	41.00	52.08	1.25	0.016	1.59	2.07	82.67	107.83	0.029	0.039
Sofala	Mandioca fresca	104.76	104.41	1.23	0.031	1.23	1.54	128.79	160.98	0.046	0.058
Sofala	Mandioca seca	31.25	20.49	1.94	0.005	1.23	1.54	25.28	31.60	0.009	0.011

Inhambane	Arroz corrente	65.56	83.62	8.12	0.103	6.92	8.86	578.33	740.57	0.255	0.232
Inhambane	Milho branca em grao	88.86	78.55	5.19	0.062	4.21	4.55	331.04	357.06	0.146	0.112
Inhambane	Farinha de milho branca com farela,	10.19	14.11	9.07	0.019	10.31	11.72	145.45	165.27	0.064	0.052
Inhambane	Farinha de mandioca	7.78	3.88	3.72	0.002	3.55	3.33	13.78	12.93	0.006	0.004
Inhambane	Oleo	0.94	1.20	35.69	0.006	30.77	46.15	36.89	55.33	0.016	0.017
Inhambane	Amendoim pequena	8.66	9.74	19.24	0.028	16.40	22.52	159.76	219.43	0.070	0.069
Inhambane	Feijao nhemba	15.88	23.75	5.12	0.018	11.61	14.42	275.61	342.47	0.122	0.107
Inhambane	Feijao nhemba	9.40	8.76	11.08	0.015	11.61	14.42	101.68	126.35	0.045	0.040
Inhambane	B.Doce	16.43	15.21	2.77	0.006	2.77	2.90	42.07	44.18	0.019	0.014
Inhambane	Mandioca fresca	199.46	204.97	2.29	0.071	2.29	4.84	469.42	992.92	0.207	0.311
Inhambane	Mandioca seca	11.10	6.16	4.54	0.002	2.29	4.84	14.10	29.83	0.006	0.009
Inhambane	Azucar nacional	4.39	6.22	15.04	0.014	15.92	17.66	99.03	109.86	0.044	0.034
Gaza	Arroz corrente	65.56	83.62	8.12	0.103	6.92	8.86	578.33	740.57	0.255	0.240
Gaza	Milho branca em grao	88.86	78.55	5.19	0.062	4.21	4.55	331.04	357.06	0.146	0.116
Gaza	Farinha de milho branca com farela,	10.19	14.11	9.07	0.019	10.31	11.72	145.45	165.27	0.064	0.054
Gaza	Farinha de mandioca	7.78	3.88	3.72	0.002	3.55	3.33	13.78	12.93	0.006	0.004
Gaza	Oleo	0.94	1.20	35.69	0.006	30.77	46.15	36.89	55.33	0.016	0.018
Gaza	Amendoim pequena	8.66	9.74	19.24	0.028	16.40	22.52	159.76	219.43	0.070	0.071
Gaza	Feijao nhemba	15.88	23.75	5.12	0.018	11.61	14.42	275.61	342.47	0.122	0.111
Gaza	Feijao nhemba	9.40	8.76	11.08	0.015	11.61	14.42	101.68	126.35	0.045	0.041
Gaza	B.Doce	16.43	15.21	2.77	0.006	2.77	2.90	42.07	44.18	0.019	0.014
Gaza	Mandioca fresca	199.46	204.97	2.29	0.071	2.29	4.34	469.42	888.68	0.207	0.288
Gaza	Mandioca seca	11.10	6.16	4.54	0.002	2.29	4.34	14.10	26.70	0.006	0.009
Gaza	Azucar nacional	4.39	6.22	15.04	0.014	15.92	17.66	99.03	109.86	0.044	0.036
Maputo Prov	Arroz corrente	174.07		8.69	0.134	6.92	8.86	1,203.87	1,541.61	0.285	0.288
Maputo Prov	Milho branca em grao	130.73		6.81	0.079	4.21	4.55	550.91	594.21	0.131	0.111
Maputo Prov	Farinha de milho branca com farela,	16.97		11.60	0.017	10.31	11.72	174.98	198.83	0.041	0.037
Maputo Prov	Oleo	9.43		31.60	0.026	30.77	46.15	290.19	435.29	0.069	0.081
Maputo Prov	Amendoim pequena	35.95		21.61	0.069	16.40	22.52	589.57	809.79	0.140	0.151
Maputo Prov	Feijao manteiga	8.38		24.19	0.018	18.48	23.36	154.87	195.74	0.037	0.037
Maputo Prov	Feijao nhemba	8.69		14.42	0.011	11.61	14.42	100.90	125.38	0.024	0.023
Maputo Prov	B.Doce	62.89		5.70	0.032	4.49	5.18	282.13	325.53	0.067	0.061
Maputo Prov	Mandioca fresca	212.27		3.05	0.057	3.05	4.16	647.59	883.07	0.153	0.165
Maputo Prov	Azucar nacional	14.15		17.70	0.022	15.92	17.66	225.29	249.93	0.053	0.047

Source: IAF data from MPF, 2004. SIMA 2002-2005.

Notes: 1) MPF does not report flexible adjusted quantities for Maputo Province, so for Maputo Province, we use multiply original mean quantity by mean price and compute expenditure shares for the complete IAF Maputo Province basket. 2) The IAF price is from the period July 2002 - June 2003; the SIMA (2002) price covers the period October 2001 - September 2002; thus, these two prices differ by both time and space (the IAF prices are derived from retail prices reported by household expenditure survey data and/or village prices collected at the same time; the SIMA retail prices are from 1-3 rural markets per province).

Appendix Table 3. Potential Price Inflators for TIA 2002-05 Panel Income

Province	Value of TIA02 producer basket in 2002 and 2005 (using mean household sale prices by province)		TIA PPI (rural fixed - mean price)	Value of TIA02 producer basket in 2002 and 2005 (using median household sale prices by province)		TIA PPI (rural fixed - median price)	IAF flexible original (SIMA rural)	IAF flexible adjusted (SIMA rural)	INE Urban food CPI (Oct 01 to Sept 05)[1]	IAF expenditure share covered by commodities with SIMA prices[2]
			A			B	C	D	E	F
Niassa	4,689	5,986	**1.28**	4,821	5,613	**1.16**	**1.21**	**1.24**		0.60
C.Delgado	2,319	3,897	**1.68**	2,304	3,844	**1.67**	**1.28**	**1.31**		0.60
Nampula	2,393	3,375	**1.41**	2,419	3,359	**1.39**	**1.22**	**1.36**	**1.24**	0.50
Zambezia	2,630	2,769	**1.05**	2,652	2,747	**1.04**	**1.07**	**1.10**		0.53
Tete	4,800	6,931	**1.44**	4,617	6,532	**1.41**	**0.97**	**0.94**		0.65
Manica	3,015	4,760	**1.58**	2,990	4,760	**1.59**	**1.07**	**1.07**		0.65
Sofala	2,959	3,974	**1.34**	3,008	3,845	**1.28**	**0.98**	**0.98**	**1.24**	0.53
Inhambane	3,805	8,164	**2.15**	3,870	7,558	**1.95**	**1.42**	**1.41**		0.35
Gaza	2,390	4,064	**1.70**	2,394	4,067	**1.70**	**1.37**	**1.36**		0.35
Maputo Prov	4,009	6,084	**1.52**	3,967	6,048	**1.52**	**1.27**	**1.27**	**1.36**	0.46**

Source: INE website; TIA 2002, TIA 2005, MNF 2004

Notes: 1) INE urban food CPI is for the cities of Nampula, Beira, and Maputo. 2)** MPF does not report flexible adjusted quantities for Maputo Province, so to approximate the expenditure shares for MP, we multiply original mean quantity by mean price, then compute expenditure shares for the complete IAF Maputo Province basket.

Appendix Table 4. Rural Household Farm Input Use and Access to Public Goods, by Province, TIA 2002 and 2005

Province	HH used animal traction (%)		HH used chemical fertilizer (%)		HH has non-manual irrigation system (%)[a]		HH hired temporary labor (%)		HH received price information (%)		HH received extension agent (%)	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
Niassa	0.0	0.0	6.9	19.9	0.5	0.0	21.3	9.7	30.1	32.9	9.8	15.7
C.Delgado	0.0	0.0	3.1	0.2	0.2	0.0	23.9	21.6	35.0	53.8	18.3	18.3
Nampula	0.0	0.1	3.6	2.2	0.4	1.0	5.2	20.4	65.2	59.2	15.8	18.6
Zambezia	0.0	0.1	0.9	0.3	0.0	0.2	12.7	13.2	22.1	25.9	9.9	11.2
Tete	33.8	17.9	14.9	13.9	0.3	1.2	29.8	19.3	23.9	43.6	18.8	15.8
Manica	11.8	9.4	3.0	2.2	0.9	0.0	24.1	19.0	60.3	24.7	15.9	11.0
Sofala	1.9	2.3	0.9	0.4	0.0	0.0	15.4	28.4	28.3	54.0	22.2	25.7
Inhambane	48.6	43.0	1.6	1.6	0.8	0.1	18.4	20.9	12.5	34.3	4.7	8.4
Gaza	45.6	36.4	4.6	3.5	14.1	8.5	12.8	16.2	10.0	29.7	11.0	23.2
Maputo Prov	11.0	14.6	3.9	2.3	3.1	1.9	19.0	21.5	17.9	17.3	10.7	11.6
National	11.3	8.8	3.8	3.5	1.4	1.0	15.8	18.3	34.6	40.3	13.6	15.7

Province	HH belongs to farm association (%)		Total density (km roads per 1000 km^2)[b]	HH bought seed of improved food crop variety (%)	HH cultivated in rows, 2005 (%)	HH practiced crop rotation, 2005 (%)	HH obtained credit from NGO, govt or firm, 2005 (%)
	2002	2005	2002	2005	2005	2005	2005
Niassa	3.2	12.9	35.6	6.9	48.2	10.4	9.6
C.Delgado	3.8	4.5	34.4	1.4	31.2	36.7	3.3
Nampula	5.7	9.0	66.3	5.3	35.2	50.1	5.3
Zambezia	2.8	4.7	43.3	4.9	33.4	43.4	0.4
Tete	3.2	7.3	39.9	12.8	82.2	34.0	6.9
Manica	4.3	4.4	37.3	12.2	34.5	21.6	1.7
Sofala	2.4	4.1	39.2	5.4	54.5	19.9	5.3
Inhambane	1.9	3.6	77.6	10.1	55.2	38.0	1.8
Gaza	3.5	11.2	59.4	5.0	33.1	33.1	1.9
Maputo Prov	12.4	17.6	65.6	11.9	33.6	29.7	3.3
National	3.9	6.9	50.3	6.5	41.6	37.2	3.5

Source: TIA02, TIA05. Notes: a) Non-manual irrigation = HH owns pump equipment or gravity irrigation system; b) Total roads is a district-level measure of both primary (year-round) and secondary roads

Appendix Table 5. Rural Household Access to Various Income Activities from 2002 to 2005, TIA Panel Households

Years of HH engagement in activity	Crop production	Retained food crops	Sold food crops	Sold high-value crops	Livestock sales	Unskilled farm labor	Farm income
			---------- % households ----------				
Neither year	0.5	0.5	32.1	50.0	54.7	77.7	0.3
Only 2002 (disadopters)	2.5	3.0	18.4	18.3	19.2	4.6	1.7
Only 2005 (adopters)	0.8	1.0	16.7	13.3	14.3	15.3	0.6
Both years	96.3	95.5	32.8	18.4	11.8	2.4	97.3

Years of HH engagement in activity	Unskilled nonfarm labor	Skilled nonfarm labor	SME Resource extraction	SME other - low	SME other - high	Remittance / pensions	Non-farm income
			---------- % households ----------				
Neither year	90.3	88.3	74.0	62.4	70.2	64.7	16.2
Only 2002 (disadopters)	3.6	3.0	8.0	12.1	9.7	11.8	14.2
Only 2005 (adopters)	5.3	5.8	11.4	17.5	13.7	15.2	26.4
Both years	0.8	2.8	6.5	8.0	6.4	8.3	43.2

Source: TIA02, TIA05

Appendix Table 6. Household Participation in Income Activities by Income Quintile, 2002 and 2005.

Quintiles of total net HH income/AE, 2002 & 2005	Crop production		Retained food crops		Food crop sales		High-value crops		Livestock sales		Unskilled farm labor		Farm income	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
	% of households participating in the given activity													
1-low	97.8	93.6	97.1	93.0	36.6	32.8	25.2	18.6	20.9	18.2	6.3	17.6	98.1	95.3
2	99.2	98.6	98.8	98.4	48.5	48.8	35.0	27.9	29.3	24.5	6.1	22.3	99.7	98.9
3-mid	99.4	98.2	99.3	97.8	56.9	52.0	35.0	33.1	31.8	30.0	6.9	20.2	99.4	98.9
4	99.0	96.0	98.8	95.6	58.4	55.7	41.4	38.3	33.7	30.2	8.8	18.1	99.1	96.4
5-high	98.4	96.0	98.0	95.2	57.0	54.1	45.9	40.3	37.4	27.2	6.1	12.1	98.8	96.4
total	98.8	96.5	98.4	96.0	51.5	48.7	36.5	31.6	30.6	26.0	6.9	18.1	99.0	97.2

Quintiles of total net HH income/AE, 2002 & 2005	Unskilled nonfarm wage		Skilled nonfarm wage		SME natural resource ext		SME other - low		SME other - high		Remittance/ pension		Non-farm income	
	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005	2002	2005
	% of households participating in the given activity													
1-low	1.6	2.5	0.5	1.6	12.7	11.5	12.8	16.3	10.1	8.6	13.4	15.8	41.5	48.8
2	2.5	5.0	1.2	3.1	14.8	18.2	19.2	25.6	11.5	13.4	20.0	21.5	54.5	64.1
3-mid	5.0	7.5	2.7	6.8	13.2	21.2	20.1	29.2	12.3	18.8	16.7	21.5	51.2	72.8
4	6.1	7.6	7.2	12.0	16.9	19.2	24.2	28.5	15.9	24.3	22.3	26.1	63.3	77.6
5-high	6.0	7.8	18.6	24.5	16.9	19.3	25.4	28.9	30.6	37.7	26.1	30.9	74.4	87.7
total	4.2	6.1	6.0	9.6	14.9	17.9	20.4	25.7	16.1	20.6	19.7	23.1	57.0	70.2

Source: TIA02, TIA05

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