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Executive Summary

Not all shocks are equally damaging and not all vulnerability reducing instruments are equally effective. Rural households in Sub Saharan Africa live in risky environments and very often they cannot protect their income or consumption from shocks. This inability to cope with shocks may permanently damage their earnings prospects and jeopardize their children's future following disinvestment in their human capital. These insights are increasingly appreciated and reflected in the design of poverty reduction strategies. But, shocks take on many forms. They can be climatic (drought, heavy rainfall), biological (illness, death), institutional (appropriation of land, theft or destruction of property) and economic (unemployment, staple or cash crop price shocks). Their relative importance in affecting household welfare across different settings remains poorly documented and the relative effectiveness of different interventions to mitigate household vulnerability is largely unknown.

During the late 1990s and early 2000s attention focused on collapsing commodity prices and new market based insurance instruments emerged to help households cope with shocks. The precipitous decline in many cash crop prices (including coffee) was making headlines, prompting renewed calls for direct market interventions to support small holder cash crop growers. Direct price support interventions, such as buffer stock policies, or international commodity agreements, often failed in the past. The commodity price shocks were inadvertently also diverting attention from potentially more damaging shocks for smallholders such as climatic and health shocks. At the same time, markets witnessed a proliferation of financial instruments to manage risks, such as futures, options, swaps, etc. This development did not only open new avenues to help farmers hedge against unforeseen price declines, but also against weather related shocks. The use of market based insurance schemes such as coffee price insurance and weather based insurance is increasingly being piloted in developing countries.

A holistic perspective on household vulnerability in the United Republic of Tanzania and an assessment of the potential for market based insurance instruments are called for. This report has two objectives. It assesses the nature and the extent of vulnerability among rural households in Tanzania with a particular focus on smallholder cash crop growers though exploring all risks, including the decline in commodity prices. It further explores the potential role for market based insurance schemes such as commodity price and weather based insurance to mitigate household vulnerability. Two rounds of specifically designed surveys of 900 households were conducted in 2003 and 2004 in two cash crop growing region in Tanzania. The inclusion of both a richer (Kilimanjaro) and a poorer (Ruvuma) Region and their contrasting experiences substantially enriches the policy guidance emerging from the report. The report applies descriptive, econometric and contingent valuation techniques to achieve its objectives.

The risk chain provides the organizing framework. According to the risk chain, households live in risky environments which affect their endowments as well as the returns to their endowments. In order to avoid income and welfare losses in case of shocks, households smooth their incomes *ex ante* (before the shock occurs) by reducing their exposure to these events (e.g. through irrigation, use of drought resistant seeds, diversification, use of treated bed nets) or they smooth their consumption *ex post*, after the shock has occurred, e.g. through self or mutual insurance, migration, public safety nets, etc. Vulnerability is defined as the likelihood of being poor in the future. The degree of vulnerability depends on the nature of the risk environment, the household's exposure to this risk and its capacity to cope with it *ex post*.

While there are significant differences in asset endowments across different categories of producers within each region, these differences are much smaller than the corresponding ones across regions (especially when considering community factors). Consumption per capita was 20 percent higher in Kilimanjaro than in Ruvuma in 2003, which is no surprise given the higher incomes and asset endowments of that region. Food shares are also slightly higher in Ruvuma, as expected among a poorer population. The starkest difference in consumer goods among the two regions is seen in the value of household dwellings, which is over 6 times greater in Kilimanjaro than in Ruvuma, likely a function of higher land prices and better housing quality. Indeed, land ownership is significantly higher in Ruvuma and land scarcity appears to be a key factor that drives livelihood strategies and farm planning in Kilimanjaro. Farmers in Kilimanjaro are more engaged in off-farm employment. They also use higher levels of cash inputs for agriculture, though overall inputs to agricultural production are very low in both regions.

Poor farmers possess less productive assets (including land) and are more specialized, especially in their sources of cash income. They have less physical capital, live in more remote villages with less public services and have less social capital. They tend to obtain a larger share of their cash income from non-farm enterprise in Ruvuma, and from wages in Kilimanjaro. Not only do they have substantially less cash income, they also have fewer sources of cash income than their richer neighbours.

About two thirds of all rural households reported to have experienced at least one major shock to their livelihoods during the 1999-2003 period and those who incurred a shock were on average hit 2.1 times. Clearly, rural Tanzanian households live in risky environments and shock incidence is even more pronounced in Kilimanjaro than in Ruvuma. The difference in shock incidence between poor and non-poor households is not statistically significant in either region.

Health related shocks (death and illness) emerge as the predominant risk, closely followed by drought shocks, though the latter only in Kilimanjaro. Other shocks are much less frequent. On average, respondents in Kilimanjaro reported that rainfall had been very low in 2.5 of the past 10 years, whereas in Ruvuma the average number of very low rainfall years was only 0.65 out of 10. Malaria is the most frequently reported cause of ill health and death. This is followed by respiratory and intestinal infections. Tuberculosis, an opportunistic infection common among AIDS patients, is also among the top five causes. Nonetheless, these results should not be taken to mean that commodity prices did not negatively affect welfare, but rather that other health and weather related shocks are equally critical in determining people's vulnerability. Prices have memory and commodity price declines may thus not come as a surprise and may not have been reported as a shock.

Descriptive analysis suggests that households largely cope with shocks through self (particularly cash savings) and mutual (family and friends) insurance with very with little help from official sources. Almost three quarters of all rural households who experienced a shock during the five years before the survey, used savings to cope with it, with the vast majority drawing down their cash. Only about a quarter of those using savings, sold livestock. Households also strongly relied on assistance from others, mostly family members, and to a much lesser extent, their fellow villagers/friends and neighbours. The proportion of shock-affected households receiving assistance from either public or private institutions is very low. In both regions about 30 percent of shock-affected households tried to generate additional income when facing a shock. About a quarter of households reduced non-food expenditures and a quarter changed their dietary pattern to cheaper foods. Both ratios were slightly higher in Ruvuma, where households are on average also poorer. Migration and borrowing were much less frequently observed responses to shocks. Overall, the large majority of households manages to cope well with shocks, largely through traditional methods (self and mutual insurance), but a non-negligible proportion also has to revert to more strenuous coping strategies. Formal risk management instruments are virtually unavailable.

The response to cash crop price declines has differed markedly across regions, with smaller producers in Kilimanjaro uprooting coffee trees and producers in Ruvuma planting new trees, suggesting limited viable alternatives to current cash crop production in Ruvuma. In Kilimanjaro producers have been moving out of coffee for more than a decade, and are now actively uprooting their crops, often switching to bananas for Dar-es-Salaam, while Ruvuma farmers continue to invest in both coffee and cashew despite the long-term negative trend of coffee prices and the particularly low prices of both crops in early 2000. Kilimanjaro farm households spend more time in off-farm activities than those in Ruvuma.

Considerable vulnerability exists in rural Tanzania, more so among poorer farm households. The probability that a household's consumption falls below the poverty line in a subsequent period, our definition of vulnerability, was empirically estimated. Households in Kilimanjaro were found to be substantially less vulnerable than households in Ruvuma. Covariate risk (following from aggregate weather and price fluctuations) are significant in both regions, but contribute more to vulnerability in Ruvuma than in Kilimanjaro. The importance of covariate risks underscores the limitations of mutual insurance to help households cope with shocks.

The immediate welfare losses associated with health and rainfall shocks can be substantial. About one third of the rural population in Kilimanjaro suffered either from a drought or health shock in the survey year of 2003 and those households were estimated to suffer on average an 18 percent (gross) loss in their 2003 consumption. Through reliance on savings and aid from others they were able to partly smooth their consumption and reduce the immediate (net) negative welfare effect of these shocks to 8 percent on average. No immediate (negative) welfare losses were found from drought and health shocks in Ruvuma. The former result is related to the low incidence of drought shocks in Ruvuma in 2003, consistent with the generally more secure rainfall patterns. More importantly, these estimated immediate welfare losses are likely only lower bounds of the welfare losses associated with shocks. They do not account for the long-run damage caused by shocks, the opportunity costs from engagement in low risk, low return activities in an attempt to avoid shocks altogether, and the consequences of households' potential disinvestment in children's human capital in response to a shock.

Welfare losses from health shocks are mainly related to illness shocks, likely resulting from increased medical expenditures and not from reduced income from labour. In depth investigation suggests that the estimated absence of an immediate welfare loss in Ruvuma from health shocks is related to the limited use of medical services which is in turn linked to the lower access to health facilities. The potential income loss from reduced labour supply or reduced return to labour following illness or death appears sufficiently small to not change this picture for Ruvuma. The estimated welfare loss from illness is also largely associated with increased medical expenses in Kilimanjaro and not due to reduced labour income. These results do not not necessarily imply that households in Ruvuma suffer less from illness shocks, but rather that they spend less to deal with them. Finally, while the direct reported expenses related to death shocks are on par with those related to illness shocks, death shocks have much smaller immediate welfare effects. This is consistent with the well documented existence of effective group-based funeral insurance schemes.

The evidence suggests that most coffee growers (except the smaller ones) have managed to weather the effects of the coffee price decline, at least to the point of not falling below the welfare levels of the non-cash crop growers. Ceteris paribus, coffee growers in Kilimanjaro and Ruvuma appear no worse off than non-coffee growers, apart from the smallest in Kilimanjaro whose consumption level was 20 percent lower. The largest coffee growers in Ruvuma are actually better off. Most coffee growers largely managed to weather the effects of the coffee price decline at the expense of a depletion of their (cash) savings. The drop in coffee prices since the late 1990s came on the heels of an income windfall from coffee. In addition, many coffee growers in Kilimanjaro, who have access to the market in Dar-es-Salaam, have also been able to switch to bananas as an alternative cash crop. Indeed, even in 2003 coffee growers in Ruvuma (as well as the richer coffee growers in Kilimanjaro) tend to be more inclined to use their own savings in case of health or drought shocks compared with non-cash crop growers. Cashew crop growers on the other hand, especially the smaller ones, appear worse off than non-cash crop growers in Ruvuma.

Own savings are mostly used to cope with covariant shocks such as droughts, but also in case of idiosyncratic shocks such as illness. Aid from others is especially forthcoming in case of death. There are little formal insurance or assistance schemes available to help households smooth their consumption. Own savings are the more important recourse in case of drought shocks, though they are also relied upon to deal with health shocks, especially illness shocks. Aid from others is frequently received in case of death shocks, and to a lesser extent in case of illness, though not in case of a drought shock. Somewhat surprisingly, physical asset ownership and educational attainment appear to be poor predictors of the use of savings, pointing to the importance of cash savings in rural Tanzania. Female headed households tend to rely more on aid and less on their own savings.

Public health interventions, better connectivity, increased access to off-farm employment and better water management techniques emerge as important household vulnerability reducing interventions. Effective health interventions include continued efforts to combat the HIV/AIDS epidemic and prevent malaria infections. The higher death toll from the HIV/AIDS epidemic jeopardizes the capacity of traditional funeral societies to effectively deal with death shocks. The importance of connectivity in raising overall income levels and thus also households' ability to cope with shocks, cannot be sufficiently underscored. Consumption levels were found to be ceteris paribus 15 to 30 percent higher in villages with a tarmac road compared with those without a tarmac road. Access to non-agricultural employment also helps raising overall welfare levels and reduces exposure to drought shocks. Finally, the ability to control water levels for example through irrigation emerges as an important general instrument to help enhance household consumption even though it has lost its effectiveness as an insurance instrument in Kilimanjaro given its reliance on gravitation irrigation. The need for better water management capacity is confirmed in the strong stated demand for weather based insurance.

The demand for cash crop price insurance is substantial. Households do not only face unexpected cyclical and downward trending commodity prices, but they also face a wide price range within the same year and area, even when these prices are low. Households are on average willing to pay between 13 and 30 percent of the option value they will receive as premium for coffee price insurance. This compares favourably with the actual costs of such option contracts in the New York stock exchange, where 3-month put options trade for about 5-10 percent of the strike price, and slightly more for 6-month put options. Setting the premium at the average willingness to pay (WTP), about 25 000 to 30 000 households in Kilimanjaro (or about one quarter of all coffee growing households) would buy coffee price insurance insuring a total of 1 200-1 700 tonnes or 20-30 percent of the total coffee production in Kilimanjaro. Were the premium to equal average WTP in Ruvuma, about one third of all coffee growing households (i.e. about 20 000 households) would buy the insurance, insuring about 7 000 tonnes of coffee or about 45 percent of Ruvuma's total production. Similarly, about one third of the cashew growers would buy cashew price insurance insuring about 4000 tonnes or about 45 percent of Ruvuma's total cashew nut production. Were the coffee and cashew price contracts offered at a premium equal to households' average willingness to pay, the societal benefit (consumer surplus) could be up to Tsh 700 million or about US$700 000. Clearly, the cost of uninsured consumption is large and the societal benefits from insurance substantial.

In addition there is considerable demand for weather based insurance. Given that agricultural income constitutes on average 57 and 71 percent of total income in Kilimanjaro and Ruvuma respectively, a more comprehensive measure of the cost of uninsured residual consumption risk is provided by our estimates of the WTP and consumer surplus related to weather based insurance. Households were more interested in Kilimanjaro and in contracts which provided wider coverage (i.e. covering both more frequent and less severe as well as infrequent but severe droughts). While the average WTP for the 10 percent below normal rainfall contracts was between 12 and 23 percent of the payout in Kilimanjaro, it was only between 10 and 14 percent for contracts which pay out when the rain drops 30 percent below normal. A similar phenomenon was observed in Ruvuma. Were the premium set at the average WTP, about one quarter of all households in Kilimanjaro would insure about 60,000-77,000 acres (about 18-24 percent of total land cultivated) resulting in a consumer surplus or benefit to society of about Tsh 1 billion or US$ 1 million. This is substantial and underscores the welfare loss associated with uninsured risks.

Yet, liquidity constraints substantially reduce the demand for insurance and subsidies may be necessary for weather based insurance to be viable for more vulnerable households. In Kilimanjaro the average WTP constitutes about only 30-55 percent of the actuarially fair value of the contract, depending on the contract. In Ruvuma the average WTP is only 5-18 percent of the actuarially fair premium. About half of all households in Kilimanjaro and about one third of all households in Ruvuma indicated an interest in weather based insurance. Liquidity constraints were mentioned as the main reason for not being interested in such a scheme. The demand for rainfall insurance is further linked with households' actual coping mechanisms. Those that use own savings in case of shocks are more interested and more willing to pay, compared with those that use other safety mechanisms, especially family based ones. This may be related both to differential liquidity constraints and different costs related to these coping strategies. Whether the societal benefits from insurance provision are sufficiently large to justify subsidization deserves further investigation. In doing so, explicit attention must be paid to the long-term welfare loss, the gains from portfolio adjustment as well as the long term gains from increased investment in the human capital of the next generation.

In sum, the report identifies drought, health and commodity price shocks as the key risks faced by rural households in Kilimanjaro and Ruvuma. The welfare loss associated with these shocks are substantial. Households extensively use self and mutual insurance to cope with these shocks, but nonetheless, there remains substantial uninsured risks as indicated by the considerable stated demand for coffee and weather based insurance which could have important societal benefits. The "latent" demand for insurance further suggests that current ways of coping may not be efficient and that there may be important economic opportunities which insurance could open up. Liquidity constraints emerge as important impediments in adopting such market based insurance schemes. Great care will need to go into the design and institutional delivery mechanisms of market based insurance. The establishment of interlinked markets such as input, credit and insurance packages deserves special attention in this regard. Finally, other, more traditional, public interventions such as providing public health services, fostering connectivity and access to off-farm employment, and better water management techniques were also identified as promising household vulnerability reducing interventions.

1 Introduction

While it is increasingly recognized that household vulnerability mitigating interventions must be an integral part of any poverty reduction strategy (World Bank, 2001), the links between risks, shocks and poverty are multifold, their quantitative effects and relative importance poorly documented, and the relative effectiveness of different interventions to mitigate household vulnerability largely unknown. This appreciation of both the importance and inadequate understanding of the links between vulnerability and poverty instigated the Government of Tanzania (GoT) to call for a series of studies to help inform its National Strategy for Growth and Reduction of Poverty (MKUKUTA).

A comprehensive qualitative assessment of households' risk environment, their coping strategies, and the resulting household vulnerability was first undertaken under the 2002/2003 Participatory Poverty Assessment (PPA). It concluded that vulnerability is the result of the interplay between the number and intensity of the impoverishing forces households face and the number and effectiveness of their response options. It identified environmental and macroeconomic conditions, governance, ill health, lifecycle conditions, and cultural beliefs and practices as important impoverishing forces (i.e. forces pushing people down the ladder of well-being). To manage these impoverishing forces the PPA finds that households make use of assets (including human, social, political, natural, physical and financial assets). Thus poverty itself limits people's capacity to improve and safeguard their well-being. In addition, it is seen that people's capacity to manage impoverishing forces diminishes as they struggle to survive successive waves of shocks and stresses. The PPA further emphasizes that there are some disadvantaged social groups in the country that due to their low access to assets are particularly vulnerable. These include children, persons with disabilities, unemployed youths, elderly persons, persons with chronic illnesses, widowed women, drug addicts and alcoholics (United Republic of Tanzania, 2004).

This study supplements this analysis through a quantitative and in-depth assessment with a particular emphasis on cash crop growing households. The late 1990s and early 2000s have been characterized by a precipitous decline in many cash crop prices such as coffee and cashew nuts grabbing headlines and renewing calls for direct market interventions to support small holder cash crop growers. However, direct price support interventions, often backed by buffer stock policies, or through international commodity agreements, often failed in the past (Gilbert, 1996). Following globalization markets also witnessed a proliferation of financial instruments to manage risks, such as futures, options, swaps, etc. This development opened new avenues to help farmers hedge against unforeseen price declines. The use of market based insurance schemes such as coffee price insurance and weather based insurance is increasingly being piloted in developing countries. The ongoing World Bank pilot project to assist the Kilimanjaro Native Cooperative Union in using internationally traded options to obtain coffee price insurance provided an ideal opportunity to gauge the actual demand among cash crop growing smallholders for such market based insurance schemes (and thus the cost from uninsured residual risk), which is usually completely unknown. Nonetheless, as illustrated by the findings from the PPA, cash crop growers are not only exposed to commodity price declines, but as other households, they face many risks and a holistic perspective on household vulnerability is called for.

In particular, the objectives of the study are to 1) quantitatively assess the nature and the extent of vulnerability among rural households in Tanzania with a particular focus on smallholder cash crop growers; and 2) explore the relative effectiveness of different strategies to mitigate household vulnerability with a particular emphasis on the potential role for market based insurance schemes such as commodity price and weather based insurance.

To do so, two rounds of household and village surveys were conducted in 2003 and 2004 in two different cash crop growing regions in Tanzania, Kilimanjaro and Ruvuma, covering about 900 households in each region. The surveys were designed to be representative of rural farm households, and among them of cash crop (coffee in Kilimanjaro, coffee, tobacco and cashew nuts in Ruvuma) as well as non-cash crop producing households. Large-scale public and private coffee estates are not included. The questionnaire was designed to investigate the complete socio-economic characteristics of households with a particular emphasis on their vulnerability to a variety of risks. Special modules were developed to gauge households' demand, i.e. their willingness to pay, for both coffee price and weather based insurance. A community-level questionnaire was administered concurrently to village focus groups.

The study uses the risk chain as conceptual framework (Heitzman *et al*, 2002) and applies descriptive, econometric and contingent valuation techniques to shed light on the immediate effects of shocks on household welfare and the demand and welfare benefit from different interventions. According to the risk chain, households live in risky environments which affect their endowments as well as the returns to their endowments. In order to avoid income and welfare losses in case of shocks, households smooth their incomes *ex ante* (before the shock occurred) by reducing their exposure to these events (e.g. through irrigation, use of drought resistant seeds, diversification, use of treated bed nets) or they smooth their consumption *ex post*, after the shock occurred, e.g. through self or mutual insurance, depletion of assets or divestments, migration, public safety nets, etc. Vulnerability is then defined either as the likelihood of experiencing future loss of welfare, generally weighted by the magnitude of expected welfare loss (Ligon and Schechter, 2003) or, as the likelihood of being poor in the future (Christiaensen, 2000; Chaudhuri, 2002). Vulnerability can thus be seen either as low expected welfare/utility or expected poverty, respectively. The degree of vulnerability depends on the nature of the risk environment, the household's exposure to this risk and its capacity to cope with it *ex post*.

Two further caveats are in place. First, while distinct, the concepts of poverty and vulnerability are also closely related as those who are poor today are also more likely to be poor tomorrow. Second, in the absence of effective *ex post* coping mechanisms, households usually attempt to smooth their income *ex ante* thereby trapping themselves often in low risk, but also low return activities. Uninsured risks may for example hamper the adoption of more risky, but more remunerative technologies and (crop) portfolio strategies. For example, households with limited options for smoothing grow lower return, but safer crops (sweet potatoes, sorghum and millet) than the richer households which usually have more options for consumption smoothing. The cost of such diversification strategy can be high and the farmer can forgo up to 20 percent of their expected income in exchange for greater stability (Dercon, 1996). Similarly, risks may motivate farmers to apply less productive technologies (Rosenzweig and Binswanger, 1993; Kurosaki and Fafchamps, 2002; Dercon and Christiaensen, 2007).

The report proceeds as follows. Chapter 2 describes how households in rural Tanzania combine their assets into different income generating activities and livelihoods. Understanding people's livelihood structure is important, as it determines the risks people are exposed to and their capacity to cope with them *ex post*, and thus their overall vulnerability.

Households in the study regions were classified as cash crop[1] and non-cash crop producers. Given the different production processes and marketing arrangements governing the different cash crops in our study, we further classified the cash crop growers according to the type of cash crops grown, i.e. coffee, cashew or tobacco.[2] The descriptive analysis of people's livelihoods and welfare is followed by a description of their risk environment and coping strategies in Chapter 3. Chapter 4 then shows how assets, risks and coping combine into determining household vulnerability as captured by a series of comprehensive vulnerability measures. These measures are subsequently used to explore the relative role of the different determinants of household vulnerability. The report proceeds by estimating the immediate welfare loss associated with shocks, i.e. the (private and societal) benefits from insurance (Chapter 5). Chapter 6 estimates the stated preferences or willingness to pay for commodity price and weather based insurance, implicit measures of the costs of uninsured consumption risk. Derivation of the resulting demand curves for insurance further allows us to estimate the societal benefit from insurance provision at different premiums.

[1] While some traditional food crops such as maize and bananas are also sold for cash, the term "cash crops" is used here to refer to traditional export crops such as coffee, tobacco, cashew nuts.
[2] The large majority of smallholder farmers was only engaged in one cash crop.

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2 Assets, Livelihoods and Poverty

by Vivian Hoffmann, Panayotis Karfakis and Luc Christiaensen

2.1 Introduction

In this chapter, we characterize the endowments, livelihood strategies, and welfare outcomes of rural households in Kilimanjaro and Ruvuma Regions, with attention to the differences between cash crop growers and those who exclusively cultivate food crops, as well as between the poor and non-poor. Through this descriptive analysis we seek to generate hypotheses about the determinants of poverty and vulnerability across livelihoods, which we will further explore in subsequent chapters. The conceptual framework combines the standard model of the farm household (Singh, Squire, and Strauss, 1986), with livelihoods analysis (Ellis, 2000).

We consider the household as the primary decision-making unit, and evaluate welfare at the household level.[1] Households are endowed with a set of assets, which have been either inherited or accumulated since the household's establishment. Assets are defined broadly to include the physical capital (land, livestock, agricultural tools), social capital (relationships to people and to institutions), and human capital (labour and education) held by the household, as well as the services and institutional environment of the community in which the household is situated.[2] While some of these assets are under the direct control of the household, others are at least partially outside its control, and may be thought of as the environment within which the household exists. Needless to say, a lack of assets undermines not only current but also future efforts to achieve prosperity and resilience against adverse shocks.

Through its production decisions and participation in markets, the household makes use of the assets at its disposal to maximize its welfare. When markets are imperfect (transaction costs are high) or incomplete (not all goods are tradable, credit and insurance markets, for example may not exist), welfare maximization is not separable from the maximization of income. Households' production decisions or livelihood strategies may for instance be conditioned on the need for stable income flows, lack of credit to purchase inputs, and lack of access to markets for its produce.

Thus, assets and markets determine livelihood options; livelihood choices determine expected income and income volatility; and these (variable) income flows determine welfare outcomes. This chapter follows progression. After describing the geographical distribution and demographic characteristics of households, we detail the productive asset base, broadly defined. We then consider the allocation of inputs to, and income streams generated by, various livelihood strategies. This is followed by a discussion of the welfare, poverty, and inequality outcomes.

Throughout the chapter variables are summarized by households' status as cash crop growers at the time of the first survey round, as well as their poverty status at that time. Coffee and

[1] We abstract from intra-household allocation of resources which may further affect the welfare of individual members. Our survey methodology was not designed to address these issues in depth.

[2] This context can be extended to the regional, state, or global level, to include such factors as the macroeconomic and political environment. In the present analysis, however, we limit our attention to the local community (village) and regional levels.

cashew nut producers are respectively defined as farmers who own any coffee or cashew trees, although deliberate non-production decisions or aged trees may result in insignificant or zero produced quantities. Since tobacco is an annual crop, tobacco producers are defined as farmers that report some positive production during the year preceding the first survey round.

2.2 Geographical distribution

The diversity of agro-ecological conditions within both Kilimanjaro and Ruvuma imply that particular crops are concentrated within certain districts of each region. Coffee is the primary cash crop grown in Kilimanjaro. While coffee production is somewhat geographically concentrated within the region, all districts contain a significant number of coffee growing households (see Table 2.1). Within Kilimanjaro, Rombo is the district with the largest proportion of coffee growers (83.4 percent). While Rombo has a relatively high poverty rate at 56.2 percent, the other two major coffee growing districts in Kilimanjaro, Hai and Moshi Rural, have the lowest poverty, at 24.5 and 32.2 percent respectively, compared with the regional rate of 39 percent.

Table 2.1: Kilimanjaro geographic distribution of coffee growers and the poor

		Rombo	Mwanga	Same	Moshi Rural	Hai	Kilimanjaro
Households	Units	40,572	12,737	21,063	77,595	39,555	191,522
Proportion	%	21.2	6.7	11.0	40.5	20.7	100.0
Coffee growers	%	83.4	22.7	22.0	54.5	79.4	60.1
Poor	%	56.2	42.9	60.6	32.2	24.5	39.5

Growers of coffee, as well as cashew, are much more highly concentrated within certain districts of Ruvuma (Table 2.2). All coffee grown in Ruvuma is found in Mbinga, where 73.7 percent of households own trees. While still poorer than Kilimanjaro, this is the district with the lowest rate of poverty in Ruvuma, at 55.6 percent. Tunduru, the cashew growing district, is the poorest, with a poverty rate of 77.1 percent. Over 90 percent of households in this district grow cashew, while cashew growers represent fewer than 7 percent of households in the rest of Ruvuma. Tobacco is both less geographically concentrated and less common overall, with the highest concentration in Namtumbo district at only 20.9 percent of households. Geographical dispersion of cash crop production in Ruvuma is also related with ethnicity (Matengo in the coffee producing district of Mbinga, Yao grow cashew nuts in Tunduru while the Ngoni tribe is occupied with Tobacco production).

Table 2.2: Ruvuma geographic distribution of cash crop growers and the poor

		Songea Rural	Tunduru	Mbinga	Namtumbo	Ruvuma
Households	units	29,814	42,666	77,555	23,886	17,3921
Proportion	%	17.1	24.5	44.6	13.7	100.0
Coffee	%	0.0	0.0	73.7	0.0	32.9
Cashew	%	0.9	92.1	3.7	6.1	25.3
Tobacco	%	6.3	0.0	0.3	20.9	4.1
Poor	%	58.3	77.1	55.6	70.2	63.3

2.3 Demographics and asset base

The differences in demographic characteristics between the two regions are immediately apparent in Tables 2.3 and 2.4. Household heads in Ruvuma, at an average age of 43, are significantly younger than those in Kilimanjaro (the corresponding average is 53 years). This gap may be partially explained by outmigration from Kilimanjaro, where 26 percent of households receive remittances, compared with only 13 percent in Ruvuma. At the same time, the population of Ruvuma overall is younger than that of Kilimanjaro: the average age in Kilimanjaro is 26 years whereas the average age in Ruvuma is 21. Female headship is almost twice as common in Kilimanjaro as in Ruvuma, characterizing 12.5 percent of all households. Female-headed households are less likely to be involved in cash crop production, and households in Kilimanjaro with younger heads less likely to cultivate coffee. The education level of heads is similar across regions and cash crop categories at around six years, but the poor in Ruvuma have on average one year less education than the non-poor. The poor in both regions tend to live in larger households, with a higher proportion of dependents. In Kilimanjaro, the poorer households tend to have younger heads, whereas the opposite holds in Ruvuma.

Table 2.3: Kilimanjaro household demographic and human capital characteristics

		All	Coffee	Non-coffee	Non poor	Poor
Number of households	Units	191,522	117,266	74,256	115,903	75,682
Proportion of total	%	100.0	61.2	38.8	60.5	39.5
Household size**	Units	5.3	5.4	5.2	4.6	6.5***
Female headed***	%	12.5	9.4	17.4***	13.2	11.4
Dependency ratio***	%	50.9	50.6	51.4	48.2	55.1***
Age of head***	years	53.5	55.7	50.1***	54.9	51.3***
Education of head	years	6.0	5.9	6.1	6.1	5.8*

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group (coffee for Kilimanjaro; coffee, cashew, and non-cash for Ruvuma) and the poor are tested against the rest of the sample within the region.

Table 2.4: Ruvuma household demographic and human capital characteristics

		All	Coffee	Cashew	Tobacco	Non-Cash	Non-Poor	Poor
Number of households	Units	173,921	57,195	44,060	7,091	66,849	63,801	110,131
Proportion of total	%	100.0	32.9	25.3	4.0	38.4	36.7	63.3
Household size	Units	5.2	5.3	5.1	5.5	5.2	4.5	5.6***
Female headed	%	7.7	4.8*	4.3**	0.0	13.2***	9.9	6.5
Dependency ratio	%	47.7	48.0	45.0**	46.9	49.4*	42.3	50.8***
Age of head	years	43.4	42.2	43.2	45.7	44.5	41.9	43.9***
Education of head	years	6.0	6.3**	5.6**	5.8	6.0	6.6	5.6***

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

Turning to the physical asset base, the difference between regions is striking (Tables 2.5 and 2.6). The total value of productive assets, which includes the value of land and livestock, agricultural production tools, and non-agricultural enterprise assets, is more than twice as high in Kilimanjaro as in Ruvuma. This difference is mainly due to the higher value of land in Kilimanjaro and the larger livestock holdings, particularly of cattle. The average land holding in Ruvuma actually triples that of Kilimanjaro, but either lower land quality or lower population density mean that the cost of land is much lower in Ruvuma. Land pressure in Kilimanjaro may be one reason behind the apparent higher rates of migration out of rural Kilimanjaro. Note however furthermore that the total productive asset value among coffee growers in Ruvuma is only slightly lower than among coffee and non-coffee growers in Kilimanjaro.

Table 2.5: Kilimanjaro household productive physical assets

		All	Coffee	Non-coffee	Non-poor	Poor
Total productive asset value[1] ***	Tsh000	969.4	961.8	981.3	1210.4	600.4***
Land owned last year ***	acres	2.66	2.66	2.67	2.82	2.42***
Land owned value[2] ***	Tsh000	517.8	566.5	440.5	633.1	341.7***
Agricultural capital **	Tsh000	150.7	122.0	196.0	233.2	24.3***
Non-agricultural capital **	Tsh000	60.2	59.5	61.4	71.5	43.0
Head of cattle, oxen, horses ***	units	1.90	1.56	2.44**	2.24	1.39**
Head of goats, sheep, pigs *	units	3.91	3.19	5.05***	4.34	3.27**
Livestock value ***	Tsh000	241.5	213.8	285.3**	274.3	191.3***
Coffee trees ***	units	263.9	431.1	0.0***	322.7	174.0***
Banana trees ***	units	315.9	440.0	119.8***	388.1	205.4***
Fruit, timber and other trees ***	units	26.6	32.4	17.5	27.5	25.2
Herfindahl index of productive assets	index	0.635	0.592	0.705***	0.631	0.641***

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group (coffee for Kilimanjaro; coffee, cashew, and non-cash for Ruvuma) and the poor are tested against the rest of the sample within the region.

Table 2.6: Ruvuma household productive physical assets

		All	Coffee	Cashew	Tobacco	Non Cash	Non-poor	Poor
Total productive asset value	Tsh000	453.0	823.6***	298.0***	201.9	263.2***	618.9	356.9***
Land owned	acres	6.1	5.7***	9.1***	5.8	4.6..	6.3	6.0
Land owned value[3]	Tsh000	270.2	461.7***	220.3***	149.3*	150.7***	303.9	250.7**
Agricultural capital	Tsh000	87.3	218.0***	23.7**	3.1	25.0*	165.9	41.8
Non-agricultural capital	Tsh000	14.4	7.3	11.1	0.0	24.0**	30.1	5.3***
Head of cattle, oxen, horses	units	0.4	0.9***	0.2**	0.2	0.2***	0.7	0.2***
Head of goats, sheep, pigs	units	3.4	4.6***	2.2***	4.1	3.2	4.3	2.9***
Livestock value	Tsh000	81.1	136.6***	42.9***	49.5	63.4**	118.9	59.1***
Coffee trees	units	408.1	1240.9***	6.3***	0.0***	0.0***	503.1	353.0***
Banana trees	units	41.5	82.2***	9.0***	11.8	31.0	55.9	33.2***
Cashew trees	units	76.3	0.0***	301.1***	0.0*	0.0***	51.0	90.9**
Fruit timber and other trees	units	131.1	223.3***	70.9**	83.6	96.2	176.4	104.8**
Herfindahl index of assets[4]	index	0.695	0.611***	0.815***	0.740	0.682**	0.641	0.726***

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

[1] Calculated from value of land, livestock, agricultural tools, and non-farm enterprise assets (including vehicles).

[2] Land is valued using median price of purchases at the ward level during the year before the survey, and at the district level if there were no such transactions. This yields rather high values for some wards, which inflates the mean. The median values of land held are 237.7 for all households and coffee growers, 235.3 for those not growing coffee, 178.3 for the poor, and 240 for the non-poor.

[3] Land is valued using median price of purchases at the ward level during the year before the survey, and at the district level if there were no such transactions. This yields rather high values for some wards, which inflates the mean. The median values of land held by the respective groups are: 149 for all households, 380 for coffee growers, 136.5 for cashew growers, 100 for those cultivating tobacco, 82.5 for those not cultivating coffee, cashew or tobacco, 160 for the non-poor, and 121.5 for the poor.

[4] Calculated from value of land, livestock, agricultural tools, and non-farm enterprise assets (including vehicles).

Within Kilimanjaro, the difference in total productive asset value between cash crop and non-cash crop growers is negligible, though coffee growers tend to have higher land values and less livestock than average. The poor have on average only half as much productive capital as the non-poor, owing mostly to the lower value of their land. They also possess less animals. In Ruvuma, coffee producers are much better endowed with productive capital than average, while cashew producers as well as non cash crop producers are particularly asset-poor. Traditionally, livestock ownership and use is minor in all Ruvuma (apart from the Mbinga district) due to unfavourable environmental conditions (tsetse flies). Differences in productive assets between the poor and non-poor are also starker in Ruvuma, with significant differences in the holdings of almost every asset. In the framework of Carter and Barret (2006), this suggests that poverty in Ruvuma is to some degree structural, as opposed to purely stochastic or transitory.

In both regions the average number of all trees is around 600, but Ruvuma coffee producers have more intensively planted their fields with coffee trees (over 250 per acre among coffee growers, in contrast with 180 per acre in Kilimanjaro). Likely owing to the partial shade needs of coffee trees, coffee producers tend to own more banana trees than other groups, and in Ruvuma they also have more trees for fruit, timber, and other trees. When looking at the coffee growers only, coffee growers in Ruvuma have on average three times as many coffee trees than their counterparts in Kilimanjaro.

The final row of Tables 2.5 and 2.6 displays the Herfindahl index, a measure of concentration, applied to the values of the major productive assets of land, livestock, agricultural, and non-agricultural capital. For each observation, the share of total productive asset value constituted by each of the particular assets is squared, and the squares added together to derive an index ranging from zero to one. Average Herfindahl index values of 0.6 or greater imply a relatively high degree of concentration of assets, with over 70 percent of all productive value held in one asset.

Over time, farmers may adjust the composition of their assets in response to changes in the relative returns to those assets. With the fall of coffee and cashew prices (described in Chapter 3), we would expect to see disinvestment in these crops and perhaps reallocation of land to more remunerative activities. Indeed, the diminishment of coffee trees in Kilimanjaro can be seen in Table 2.7, both in the decrease of 30 trees in the average number of trees between 2000 and 2003, and in the significant degree of uprooting and much lower rate of planting during the past year. At the same time the number of banana trees has increased since three years, suggesting that some farmers are switching from coffee to into bananas for food or possibly as a cash crop. Increasing banana dependence is equivalent in some degree to increasing self-sufficiency in food, as bananas constitute about 11 percent of the value of food consumption in Kilimanjaro.

Yet, bananas are increasingly also a cash crop sold in the markets of Dar-es-Salaam. Furthermore, the increase in banana production may also affect the power balance in the household as bananas are traditionally grown by women, while coffee production is the domain of the men. While some of the movement out of coffee may be attributable to the low price of coffee since 2000, coffee has been losing some ground in Kilimanjaro since well before the recent price collapse: almost 70 percent of trees are over 30 years old, and just 10 percent were planted during the past ten years. The long-term decline of coffee is also echoed in the older age of heads in coffee-growing households (Table 2.5).

Table 2.7: Kilimanjaro switches into banana?

		All	Coffee	Non-coffee	Non-poor	Poor
Coffee trees at survey time***	units	268.6	441.8	0.0***	322.7	174.0***
Coffee trees 3 years ago**	units	301.0	492.3	2.7***	369.6	189.8***
Coffee trees planted last year	units	7.6	12.4	0.0**	9.3	4.9
Coffee trees uprooted last year***	units	28.1	45.4	1.0***	30.2	24.6
Banana trees at survey time***	units	323.5	442.3	122.2***	388.1	205.4***
Banana trees 3 years ago***	units	289.1	405.5	108.8***	324.9	210.0***
Banana trees planted last year**	units	14.0	18.2	7.4	18.5	6.9
Banana trees uprooted last year***	units	7.6	9.2	5.2	10.3	3.4**

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

Ruvuma, on the other hand, shows expansion of coffee cultivation both over the past decades and since 2000. A third of coffee trees were planted less than 10 years ago, and a further 50 percent between 10 and 30 years ago. Despite low prices in recent years, coffee farmers owned over 40 more trees on average at the time of the survey than two years before (Table 2.8). The same pattern of expansion holds for cashew, with a net increase of 16 trees per cashew farmer during the past two years. Only 19 percent of cashew trees are older than 30 years. One possibility for the seemingly perverse response to low coffee and cashew prices is the lack of alternative cash income sources for farmers in Ruvuma, who are relatively distant from well developed markets compared with those in Kilimanjaro (Tables 2.9 and 2.10).There is some evidence for the tobacco growers shifting out from tobacco production.

Table 2.8: Ruvuma switches into coffee?

		All	Coffee	Cashew	Tobacco	Non-Cash	Non-poor	Poor
Coffee trees at survey time	units	413.8	1258.4***	6.3***	0.0**	0.0***	503.1	353.0***
Coffee trees 2 years ago	units	393.9	1197.3***	6.3***	0.0**	0.4***	492.9	336.6***
Coffee trees planted last year	units	13.1	40.0***	0**	0.0	0.0**	14.4	12.5
Coffee trees uprooted last year	units	1.7	5.1***	0**	0.0	0.0*	2.5	1.2*
Cashew trees at survey time	units	76.7	0.1	308.5***	1.4	0.0	51.0	90.9**
Cashew trees 2 years ago	units	72.7	0.1***	292.9***	3.5	0.0***	50.6	84.9**
Cashew trees planted last year	units	4.2	0.0***	16.7***	0.0	0.0***	2.0	5.6
Cashew trees uprooted last year	units	0.3	0.0*	1.3***	1.2	0.0*	0.2	0.4***
Banana trees at survey time	units	41.7	83.3***	9.0***	10.6	31.1	55.9	33.2
Banana trees 2 years ago	units	36.9	74.3***	8.0***	8.0	27.1	52.0	27.9
Banana trees planted last year	units	3.5	4.6**	0.7**	1.9	4.6	3.9	3.3**
Banana trees uprooted last year	units	0.5	0.7	0.2*	0.0	0.6	0.4	0.6*

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group (coffee for Kilimanjaro; coffee, cashew, and non-cash for Ruvuma) and the poor are tested against the rest of the sample within the region.

The social capital and institutional access of households in Kilimanjaro and Ruvuma appear similar. Differences among the producer categories in both regions are noteworthy: in both regions coffee producers are better connected socially than others, and in Ruvuma tobacco growers are even more so. The poor in both regions appear to be somewhat socially marginalized, with a significantly lower rate of participation in social groups, and in Ruvuma also in savings and credit cooperatives (SACCOs) and positions in community leadership, than the non-poor. Access to formal financial institutions is very low, with only 12.5 and 10 percent of all households in Kilimanjaro and Ruvuma respectively holding a bank account, and 85 and 80 percent reporting that seasonal credit for inputs is difficult to obtain. The poor are particularly excluded in both regions from formal banking and in Kilimanjaro from credit access more broadly.

Table 2.9: Kilimanjaro social capital and institutional access characteristics

		All	Coffee	Non-coffee	Non-poor	Poor
Member belongs to social group	%	37.4	36.7	38.5	38.7	35.5
Member in community leadership position	%	26.7	26.9	26.4	27.7	25.2
Member belongs to SACCO	%	12.4	11.9	13.1	13.5	10.6
Member possesses a bank account	%	12.4	13.5	10.7	16.6	6.0***
Difficult to access seasonal credit	%	85.0	85.2	84.7	82.0	89.5***

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group (coffee for Kilimanjaro; coffee, cashew, and non-cash for Ruvuma) and the poor are tested against the rest of the sample within the region.

Table 2.10: Ruvuma social capital and institutional access characteristics

		All	Coffee	Cashew	Tobacco	Non-Cash	Non-Poor	Poor
Member belongs to social group	%	32.6	37.8***	17.5***	13.5**	17.6***	36.2	30.5*
Member in leadership position	%	27.8	30.2	24.8	45.4*	24.9	32.5	25.1**
Household belongs to SACCO	%	13.6	12.5	5.2***	48.9***	5.4**	19.1	10.5***
Possesses bank account	%	9.9	12.6**	5.1***	22.9*	5.3	14.0	7.5***
Difficult to access seasonal credit	%	79.8	78.9	87.0**	49.4***	87.6	78.0	80.8

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

Infrastructure is clearly more developed in Kilimanjaro than in Ruvuma. This includes connectivity to markets, access to information, and the presence of agricultural services. The nearest town in Kilimanjaro is about half the distance of the nearest town in Ruvuma, and the availability of bus service is twice as common in Kilimanjaro. While electricity and especially cellular phone signals are widely available in rural Kilimanjaro, these amenities are practically non-existent in the surveyed communities in Ruvuma. Agricultural extension, veterinary services, and input shops are also less widespread in Ruvuma.

Within Kilimanjaro, we also see that communities in which coffee growers are concentrated have significantly higher access to a number of services, including more paved roads and greater proximity to larger towns, higher rates of electricity and cell phone access, and more agricultural services and input sales points. The direction of causality here is unclear, but given the historical importance of coffee as a cash crop in Kilimanjaro, it seems likely that infrastructure was developed to serve the economically dynamic coffee-growing areas. Within Ruvuma again coffee growers in Mbinga district appear to have better access to infrastructure or other services, though still lower in comparison with Kilimanjaro.

Table 2.11: Kilimanjaro village characteristics

		All	Coffee	Non-coffee	Non-poor	Poor
Distance to the nearest town[1]***	km	23.2	17.0	33.1***	19.5	28.9***
Tarmac road to village**	%	9.7	9.0	10.7***	12.2	5.7***
Bus services***	%	42.7	42.1	43.7	47.7	35.1***
Market	%	27.5	27.4	27.5	31.8	20.9***
Electricity***	%	64.6	79.2	41.4***	66.7	61.3
Cell phone***	%	82.9	88.7	73.7***	83.6	81.8
Agricultural input shop**	%	19.9	23.4	14.4**	23.2	14.8**
Agricultural extension agent**	%	62.8	60.0	67.3**	60.8	66.0*
Veterinary services***	%	50.6	54.8	44.1***	54.3	45.0**
Health facility[2]	%	52.1	51.3	53.5	50.5	54.6

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

Table 2.12: Ruvuma village characteristics

		All	Coffee	Cashew	Tobacco	Non-Cash	Non-Poor	Poor
Distance to the nearest town	km	42.7	35.0***	42.6**	51. 6	47.5*	43.6	42.1
Tarmac road to village	%	4.1	0***	0***	3.9	10.3***	8.8	1.4***
Bus services	%	22.3	5.9***	13.5**	55.3***	38.2***	24.0	21.3
Market	%	33.3	25.5	30.2**	61.9**	39.3**	33.0	33.5
Electricity	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cell phone	%	2.5	6.8***	0.0**	0.0	0.8**	3.0	2.2
Agricultural input shop	%	4.1	0.0**	0.0**	3.8	10.4***	8.8	1.4***
Agricultural extension agent	%	44.8	51.4***	16.4***	65.4	55.8***	48.2	42.9*
Veterinary services	%	28.2	26.4	14.2***	36.3	38.5***	27.6	28.5
Health facility	%	56.5	56.5	37.3***	80.5***	67.5***	64.0	52.2***

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group (coffee for Kilimanjaro; coffee, cashew, and non-cash for Ruvuma) and the poor are tested against the rest of the sample within the region.

The poor in Kilimanjaro are likewise highly clustered in communities without good access to services. The differences are less pronounced in Ruvuma, though cashew growers are particularly poorly served, and the poor suffer from less access to agricultural extension and inputs, as well as health facilities. While placement effects are no doubt at least partially responsible for the correlation between infrastructure and wealth levels, poor communities' lack of access to information and markets can only hamper their economic development.

In sum, within each region the differences in asset endowments across different categories of producers appear significant but smaller than the corresponding ones across regions (especially when considering community factors). Land scarcity appears to be a key factor that drives livelihood strategies and farm planning in Kilimanjaro. The response to cash crop price declines differs markedly across regions and may indicate a lack of viable alternatives for cash crop production in Ruvuma. In Kilimanjaro producers have been moving out of coffee for more than a decade, and are now actively uprooting their crops, while Ruvuma farmers continue to invest in both coffee and cashew despite the long-term negative trend of coffee prices and the particularly low prices of both crops in recent years.

[1] The sample for means tests between regions is one observation per village, for producer categories household level observations are used.

[2] Dispensary, health centre, or hospital.

2.4 Livelihood strategies

Households choose how to employ their asset endowments to derive income and consumption flows in what we here term a livelihood strategy. In this section, we look at the labour, land, and other variable inputs allocated to various productive activities, and the income flows derived from these.

In addition to starting from a higher asset base as seen in the previous section, Kilimanjaro farm households also allocate more time to production activities, and use higher levels of cash inputs for agriculture. Of all agricultural inputs, only inorganic fertilizer is used to a greater extent by farmers in Ruvuma, and this difference is not statistically significant. In fact, input levels are extremely low in both regions, with a total of Tsh 40 000 and Tsh 8 000 per acre worth of cash inputs used in Kilmanjaro and Ruvuma respectively.

While land holdings are three times as high in Ruvuma as in Kilimanjaro (Tables 2.5 and 2.6), only two-thirds of land is cultivated in Ruvuma, while in Kilimanjaro, where land pressure appears to be much higher, practically all land is under continuous cultivation. In addition to cultivating their scarce land more intensively, Kilimanjaro households also spend more time in non-agricultural activities. Reflecting the more variable (even though on average ample) rainfall pattern in Kilimanjaro irrigation is more common than in Ruvuma, where it is practically nonexistent.

Table 2.13: Kilimanjaro livelihood inputs

		All	Coffee	Non-coffee	Non-poor	Poor
Total family labour days***	units	699.0	728.6	652.2***	666.0	749.4***
Family time in non-agr. activities***	%	19.7	15.9	25.6***	20.8	16.8**
Cultivated land size last year***	acres	2.7	2.7	2. 7	2.8	2.4***
Number of plots***	units	2.0	2.0	1.9*	1.9	2.0
Hired labour days for own farm**	days/ac	5.1	4.0	6.7**	6.4	2.9***
Family labour days on own farm***	days/ac	239.8	239.3	240.5	204.7	293.3***
Total cash inputs***	Tsh000/ac	39.7	39.5	40.1	46.9	28.7***
Hired labour cost***	Tsh000/ac	5.3	4.4	6.8**	7.1	2.6***
Traditional seeds***	Tsh000/ac	2.4	2.2	2.8	2.5	2.3
Improved seeds***	Tsh000/ac	4.0	4.0	3.9	4.1	3.8
Organic fertiliser***	Tsh000/ac	7.3	8.4	5. 7**	7.3	7.4
Inorganic fertiliser	Tsh000/ac	3.9	3.9	4.0	4.3	3.2
Insecticides, herbicides***	Tsh000/ac	2.1	2.6	1.2**	2.4	1.5
Veterinary expenses***	Tsh000/ac	2.0	1.6	2.6**	2.5	1.2***
Livestock related expenses***	Tsh000/ac	5.9	6.2	5.4	8.0	2.7***
Ploughing expenses***	Tsh000/ac	2.1	1.8	2.6**	2.6	1.3***
Transport***	Tsh000/ac	2.8	2.9	2.6	3.5	1.7***
Other production expenses***	Tsh000/ac	1.9	1.5	2.5**	2.4	1.0***
Percent of land irrigated***	%	20.7	17.3	26.2***	22.3	18.3*

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

The poor in both regions spend more time working and allocate more labour per acre to own farm production. Non cash crop producers in both regions allocate more time to non-agricultural activities. Time share to non-agricultural activities, as well as cash input use, on the other hand, are lower among the poor. In Ruvuma, coffee and cashew producers use fewer cash inputs, while tobacco and non cash crop growers use more than average. While the poor own less land than the non-poor (Table 2.6), the difference in the amount of land under cultivation by the poor and non-poor is not statistically significant in Ruvuma, pointing to the abundance of land in the region. Nonetheless, coffee producers appear to face land constraints in the Mbinga district, resulting in migration out of the highlands to the lower parts of the district.

Table 2.14: Ruvuma livelihood inputs

		All	Coffee	Cashew	Tobacco	Non-Cash	Non-Poor	Poor
Total family labour days	days	637.5	667.6**	592.9***	656.6	636.5	615.7	650.2*
Time in non-agricultural activities	%	14.5	11.3**	11.4**	6.5**	19.9**	19.4	11.6***
Cultivated land size last year	acres	6.1	5.7**	9.1***	5.8	4.6***	6.3	6.0
Number of plots	units	2.6	3.0***	2.5	3.0	2.4***	2.7	2.6
Hired labour on own farm	days/ac	1.6	1.1**	1.2*	2.4	2.3**	3	0.8***
Family labour on own farm	days/ac	101.9	100.0	76.4***	87.68	121.8***	82.2	113.4***
Total cash inputs	Tsh000/ac	8.0	5.3***	3.4***	14.9***	12.7***	12	5.8
Hired labour cost	Tsh000/ac	1.8	1.0**	1.3**	2.1	2.8***	3.6	0.8***
Traditional seeds	Tsh000/ac	0.1	0.1*	0.1	0.0	0.2**	0.1	0.1
Improved seeds	Tsh000/ac	0.1	0.2	0.0**	0.0	0.2*	0.3	0.1***
Organic fertilizer	Tsh000/ac	0.1	0.2**	0.0	0.0	0.0	0.1	0.0
Inorganic fertilizer	Tsh000/ac	4.2	1.8***	1.3***	11.3***	7.3***	4.9	3.8**
Insecticides, herbicides	Tsh000/ac	0.3	0.8**	0.1	0.0	0.1	0.7	0.1**
Veterinary expenses	Tsh000/ac	0.2	0.2	0.0**	0.1	0.3**	0.3	0.1
Livestock related expenses	Tsh000/ac	0.2	0.2	0.0***	0.0	0.3**	0.4	0.1***
Ploughing expenses	Tsh000/ac	0.0	0.0	0.1**	0.0	0.0	0.0	0.0
Transport	Tsh000/ac	0.7	0.6	0.2***	0.6	1.0**	1.2	0.4***
Other production expenses	Tsh000/ac	0.4	0.2	0.2	0.8	0.5**	0.5	0.3***
Irrigated land	%	3.9	3.7	1.5	2.7	5.7	4.8	3.4

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group (coffee for Kilimanjaro; coffee, cashew, and non-cash for Ruvuma) and the poor are tested against the rest of the sample within the region.

Unsurprisingly, given the higher asset base and input levels, gross incomes in Kilimanjaro (including food produced for own consumption) are a third higher than in Ruvuma. As suggested in section 2.3, coffee retains greater importance to rural livelihoods in Ruvuma, comprising over 20 percent of gross cash income among coffee growers, and only 4 percent in Kilimanjaro. This is also reflected in the much lower production per tree in Kilimanjaro compared with Ruvuma (114 and 220 grams per tree respectively), even though yields are extremely low in both regions. Cashew constitutes a similar income share as coffee in Ruvuma among its growers, whereas tobacco producers are much more specialized in the crop, from which they derive 40 percent of their cash income. For all groups except tobacco growers, the single most important source of income is food crops. Land productivity, defined as net income from crops over land under cultivation, is higher in densely populated Kilimanjaro.

The poor have less income from non-farm enterprise in Ruvuma, and more income from wages in Kilimanjaro; in both regions the poor derive a lower share from livestock and agricultural processing activities. Comparing Herfindahl indices of income and cash income calculated using 34 different income sources[1] we see that farm households in Kilimanjaro rely more heavily on fewer sources of income than households in Ruvuma. In particular, cash

[1]Income sources consist of 20 particular crops, regular wages, irregular wages, non-farm enterprise, pensions, state assistance, gifts, remittances, processed farm products, and livestock sales and products.

income portfolios are highly specialized in Kilimanjaro, with the typical household relying on one source for about 70 percent of total cash income. Coffee growers in both regions have more diverse income streams than other producers, and the poor's sources of income, particularly of cash income, are more concentrated.

Table 2.15: Kilimanjaro household income flows

		All	Coffee	Non-coffee	Non-poor	Poor
Gross income per capita***	Tsh000	162.5	159.0	168.2	212.4	86.4***
Cash income per capita***	Tsh000	111.1	107.9	115.9	149.6	52.1***
Non-farm business	%	11.8	9.9	14.7	11.2	12.6
Transfer income (1)***	%	3.7	3.3	4.3	4.4	2.7**
Remittances***	%	5.4	6.1	4.4**	6.5	3.7***
Coffee***	%	2.6	4.3	0.0***	2.5	2.8
Other crops***	%	43.3	44.8	40.8**	42.4	44.6
Livestock & processing income***	%	18.1	18.1	18.1	19.5	16.0***
Wages***	%	15.1	13.4	17.8**	13.5	17.6***
Labour productivity (2)	Tsh000/day	0.75	0.58	1.02	0.80	0.44***
Land productivity***	Tsh000/ac	94.1	102.2	81.4*	105.3	76.5*
Herfindahl index of gross income (3)***	index	0.44	0.42	0.47***	0.44	0.44
Herfindahl index of cash income (3)***	index	0.57	0.55	0.62***	0.53	0.59***

(1) Includes pensions, state assistance and gifts
(2) Net income from crops, divided by person-days in cultivation.
(3) Net income from crops, divided by acres under cultivation.
(4) Herfindahl indices contain 34 income sources.

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group (coffee for Kilimanjaro; coffee, cashew, and non-cash for Ruvuma) and the poor are tested against the rest of the sample within the region. Income shares (%) relate to shares of cash (not total) income.

Table 2.16: Ruvuma income flows

		All	Coffee	Cashew	Tobacco	Non-Cash	Non-Poor	Poor
Gross income per capita	Tsh000	118.4	130.1*	92.2***	127.4	124.3	201.6	70.2***
Cash income value per capita	Tsh000	80.7	81.3	64.1**	90.3	90.0	143.4	44.3***
Non-farm business	%	12.9	11.3	9.7***	6.2**	16.9***	17.0	10.5***
Transfer income	%	1.2	0.7	0.9	0.9	1.8**	1.3	1.1
Remittances	%	2.6	2.3	1.3**	1.9	3.7***	3.6	2.0*
Coffee	%	7.0	21.2***	0.2***	0.0**	0.0***	8.5	6.1**
Cashew	%	5.6	0.0***	22.2***	0.0**	0.0***	3.4	6.9***
Tobacco	%	1.6	0.0***	0.8	39.9***	0.0***	0.8	2.1
Other crops	%	50.3	47.6	48.8	36.2***	55.1***	45.2	53.3***
Livestock & processing income	%	9.4	12.1***	4.5***	12.8	9.9	11.6	8.1***
Wages	%	9.4	4.8***	11.6*	2.0**	12.6***	8.5	9.9
Labor productivity	Tsh000/day	0.91	0.60	1.54	0.91	0.76	1.06	0.83
Land productivity	Tsh000/ac	43.4	49.4***	31.2***	66.1***	44.3	50.5	39.3***
Herfindahl index of gross income	index	0.36	0.32***	0.38**	0.38	0.38***	0.36	0.36
Herfindahl index of cash income	index	0.53	0.51**	0.56*	0.51	0.54	0.50	0.56***

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region. Income shares (%) relate to shares of cash income.

2.5 Welfare outcomes

To gauge the relative welfare of rural households, not only across regions and between groups, but also over time, we construct a consumption aggregate that is as comparable as possible with that used in the 2000/01 Tanzanian Household Budget Survey (HBS) Final Report (NBS, 2002).[1] Consumption per capita was 20 percent higher in Kilimanjaro than in Ruvuma in 2003, which is no surprise given the higher incomes and asset endowments of that region. Food shares are also slightly higher in Ruvuma, as expected among a poorer population. The starkest difference in consumer goods among the two regions is seen in the dwelling value, which is over five times greater in Kilimanjaro than Ruvuma, likely a function of higher land prices as well as housing quality. Improved roofs are nearly universal in Kilimanjaro, and a majority of households have access to piped drinking water, compared with only a third of Ruvuma households.

Table 2.17: Kilimanjaro consumption

		All	Coffee	Non-coffee	Non-poor	Poor
Total consumption per capita, 2003***	Tsh000	159.9	157.9	163.1	209.5	83.5***
Total consumption per capita, 2004[1)]***	Tsh000	160.6	164.2	155.1	218.0	75.9***
Food share, 2003	%	69.3	69.7	68.6	68.0	71.3***
Food share, 2004	%	71.5	71.9	70.8	70.5	72.7**
Consumer durables***	Tsh000	250.5	235.8	272.6	323.4	138.9***
Dwelling value***	Tsh000	1524.4	1847.5	1014.3***	1672.7	1297.5***
Improved water source***	%	64.64	72.79	52.38***	63.6	61.2
Electricity***	%	15.35	15.15	15.64	21.5	6.0***
Metal, stone, or concrete roof***	%	92.20	97.02	84.95***	94.1	89.4**

1) constant Tsh 2003. ***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

Table 2.18: Ruvuma consumption

		All	Coffee	Cashew	Tobacco	Non - Cash	Non-Poor	Poor
Total consumption per capita, 2003	Tsh000	129.8	148.0***	104.1***	104.5	133.2	212.3	81.0***
Total consumption per capita, 2004[1)]	Tsh000	134.4	152.1***	108.9***	107.8	138.5	220.8	85.2***
Food share, 2003	%	70.3	71.1	70.2	66.2**	70.0	69.6	70.7
Food share, 2004	%	72.5	71.8	74.0	72.5	71.9	68.8	74.4***
Consumer durables (hh)	Tsh000	178.8	250.9	122.8**	149.6	156.2	200.1	107.5***
Dwelling value	Tsh000	298.7	470.2***	166.1***	200.5**	247.2*	349.9	269.0***
Improved water source	%	34.3	21.6***	26.2***	59.2***	47.70***	35.5	30.7
Electricity	%	0.1	0. 0	0.5*	0.0	0.0	0.4	0.0*
Metal/stone/concr. Roof	%	51.7	76.9***	28.8***	47.1	45.7	64.2	44.4***

1) constant Tsh 2003. ***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

Within Kilimanjaro, welfare outcomes do not differ substantially between cash crop growers and others except in terms of housing quality. Dwelling value is almost twice as high among

1 See Appendix 3 for a detailed description of the consumption aggregate.

coffee growers as others, and a higher proportion also have access to an improved water source and a roof made of metal, stone or concrete. Ruvuma on the other hand shows marked differences in the consumption expenditures of coffee and cashew farmers compared with other households. Coffee farmers enjoy higher levels of current consumption in both survey years, as well as double the dwelling values of non-coffee growers, while cashew growers are worse off by both of these measures.

In an attempt to compare our poverty measures with those from HBS, we have matched the means of household consumption expenditures per capita after adjusting for GDP growth and inflation and the ratio of underestimation between the two surveys as explained in detail in Appendix 3. After making this adjustment, any observed increase or decrease in poverty (using the same poverty line as the HBS) between the HBS and the first year of this survey is attributable to changes in the distribution of consumption around the mean as well as the shift in the mean as calculated based on overall gross domestic product (GDP) growth. In both regions, poverty has increased substantially since the period in 2000 and 2001 when the HBS data was collected. At that time, it was found that 32 percent of households in Kilimanjaro and 44 percent in Ruvuma were living below the poverty line. We find a striking 8 percentage points increase in poverty for Kilimanjaro and a 17 percentage points raise in Ruvuma from that level in the first year of the survey, and these proportions remain almost the same the second year of the survey. This striking difference reflects the facts that in our survey large plantations and most importantly households from urban areas were not surveyed. Research has extensively shown that poverty incidence in rural populations is usually much higher in comparison with urban sites. Finally one reason for the increase in poverty by 2 percentage points in Kilimanjaro during the second survey may be drought, reported as a shock by 40 percent of Kilimanjaro households in 2004.[1]

Table 2.19: Kilimanjaro poverty

		All	Coffee	Non-coffee
2003 Poverty line: 148.0 basic needs, 108.0 food				
Headcount ratio (basic needs poverty)***	%	39.9	40.4	39.2
Headcount ratio (food poverty)***	%	19.0	19.4	18.3
Average poverty gap among the poor (per capita)	Tsh000	17.1	17.9	15.9
2004 Poverty line: 139.9 basic needs, 102.2 food				
Headcount ratio (basic needs poverty)***	%	41.3	39.0	45.2***
Headcount ratio (food poverty)***	%	23.3	20.2	28.3***
Average poverty gap among the poor (per capita)	Tsh000	18.6	16.3	22.3

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

The differences in poverty rates among Ruvuma producer groups reflect the differences in mean consumption noted above. Poverty among cashew growers was over 40 percent as high as among coffee producers in 2003, a gap which narrowed somewhat in 2004. Not only was poverty more common among cashew growers, it was also more extreme. In 2003, 56 percent of poor cashew growers had food expenditures below what is necessary to achieve the recommended calorie intake, and the average expenditure level of these poor was 48.300 Shillings (about 50 USD) below the poverty line per capita. The significant decrease in

[1] Forty-eight percent of households in Kilimanjaro reported a drought shock in 2004; 48 percent reported “much below normal” rainfall on their cultivated land. The corresponding proportions in Ruvuma for either a drought shock or “much below normal” plot rainfall was about 4% in 2003 and 0% in 2004.

poverty incidence among tobacco producers can be associated with the signs of switch out of production reported earlier. The basic needs poverty rate in Ruvuma remained stable over the two survey rounds, though food poverty decreased slightly.

Table 2.20: Ruvuma poverty

		All	Coffee	Cashew	Tobacco	Non-Cash
2003 Poverty line: 151.2 basic needs, 110.3 food						
Headcount ratio (basic needs)	%	63.3	52.8***	75.8***	82.8	62.4
Headcount ratio (food poverty)	%	41.6	30.7***	55.9***	52.6	40.7
Average poverty gap among the poor (per capita)	Tsh000	35.2	26.6	48.3	45.2	33.2
2004 Poverty line: 159.7 basic needs, 116.6 food						
Headcount ratio (basic needs)	%	63.0	56.0***	75.5***	66.9	61.5
Headcount ratio (food poverty)	%	41.2	34.0***	52.7***	34.9	40.4
Average poverty gap among the poor (per capita)	Tsh000	36.9	29.0	48.4	29.8	37.4

***, ** and * indicate statistical significance of the difference in means at the 1%, 5% and 10% level respectively. Significance of difference between regional means is noted next to the name of the variable (left-most column). Means of each producer group and the poor are tested against the rest of the sample within the region.

While poverty increased in Kilimanjaro between 2003 and 2004, the proportion of households that were poor during both periods is relatively low, suggesting that much of poverty in that region is transitory rather than chronic. In fact, almost half of the poor in 2003 became non-poor in 2004, and only a third of the poor in 2004 had also been poor during the previous year. The picture in Ruvuma is similar: only 23 percent of the poor in 2003 were poor the following year. The apparent year-to-year unpredictability about a household's future wellbeing points to the importance of insurance mechanisms and safety-net interventions for welfare in rural Tanzania.

Table 2.21: Kilimanjaro poverty transition between rounds (% of household)

		2004	
		Non poor	**Poor**
2003	Non-poor	42.8	16.1
	Poor	17.7	23.4

Table 2.22: Ruvuma poverty transition between rounds (% of household)

		2004	
		Non poor	**Poor**
2003	Non-poor	21.0	15.9
	Poor	15.5	47.6

The Gini coefficient is an index from 0 to 1 measuring the distribution of some asset or flow (typically income or consumption) across the population, with 0 indicating complete equality (each member has an equal level of the asset or flow) and 1 complete inequality (one individual owns all of the asset or receives all of the flow). Tables 2.23 and 2.24 show the Gini coefficient applied to productive assets, income, and consumption for Kilimanjaro and Ruvuma. The Gini coefficients for consumption per capita calculated for both Kilmanjaro and Ruvuma are comparable to that reported for rural mainland Tanzania as a whole in the HBS (0.33). This puts Tanzania among the 40 most equal countries for which Gini data are included in the 2005 Human Development Indicators (UNDP). The low levels of inequality for consumption must be contrasted with the more unequal distribution of assets and income, the latter particularly for Kilimanjaro. The inequality of consumption expenditures increased between survey rounds in Kilimanjaro mainly, and appears responsible for most of the increase in poverty.

Table 2.23: Kilimanjaro inequality

Gini coefficient for:	All	Coffee	Non-coffee
Productive assets per capita, 2003	0.63	0.62	0.63
Net income per capita, 2003	0.58	0.56	0.60
Consumption per capita, 2003	0.32	0.32	0.32
Consumption per capita, 2004	0.37	0.37	0.35

Table 2.24: Ruvuma inequality

Gini coefficient for:	All	Coffee	Cashew	Tobacco	Non-Cash
Productive assets per capita, 2003	0.58	0.49	0.49	0.45	0.51
Net income per capita, 2003	0.51	0.53	0.48	0.34	0.51
Consumption per capita, 2003	0.33	0.32	0.32	0.26	0.35
Consumption per capita, 2004	0.33	0.32	0.31	0.16	0.34

2.6 Conclusion

Within both regions, and even more pronounced in Ruvuma, cash crop production is concentrated in certain districts, suggesting a high degree of spatial co-variation in the effect of cash crop price shocks. District-level poverty rates further suggest that cashew growers are at present suffering, whereas coffee growers within Ruvuma are better off and those in Kilimanjaro are not worse off than the other agricultural households.

Households in Kilimanjaro are much better endowed with assets, though part of this is due to the higher value of land in Kilimanjaro, indicating land pressure in this densely populated region. Kilimanjaro households also devote more time to non-agricultural activities than those in Ruvuma, and correspondingly earn a higher share of income from processing activities and wages. This may reflect both higher land pressure as well as better off-farm employment opportunities. Within Kilimanjaro, we see little difference between the productive asset endowments of cash crop growers versus other households. In Ruvuma, however, coffee growers have higher levels of assets while cashew growers are worse off, a pattern also reflected in the income and consumption levels of these groups.

Kilimanjaro farmers have been disinvesting in coffee production, a process which already started in the 1990s and accelerated in early 2000 following the precipitous decline in coffee prices. It is best illustrated by the small share of cash income currently derived from coffee even among coffee-producing households in Kilimanjaro (4 percent), compared with those in Ruvuma, where 20 percent of cash income among coffee and cashew farmers is made from sales of these crops respectively. Tobacco farmers earn 40 percent of their cash income from the crop. The stark decrease in coffee production over the past few years in Kilimanjaro went hand in hand with an increase in banana production, including production for export to

Dar-es-Salaam, a trend which is likely to affect the power balance within the households as bananas are traditionally cultivated by women and coffee by men. However, the opposite trend has been observed in Ruvuma, where coffee trees are generally younger than in Kilimanjaro and where coffee growers have even been planting more new coffee trees over the past couple of years than they have uprooted.

It is hypothesized that the better integration of Kilimanjaro in the national economy and its well established links with the markets in Dar-es-Salaam, together with its higher population density and the emerging land scarcity, have substantially raised the opportunity cost of coffee production in Kilimanjaro. In Ruvuma on the other hand, land is still relatively abundant (though there are signs of some tightening of the land market in Mbinga – the coffee producing region in Ruvuma) and alternative employment opportunities as well as access to markets are limited due both to limited infrastructure and distance, potentially rendering coffee production the more profitable activity, despite the recent slump in coffee prices. This very divergent reaction to the recent collapse of coffee prices deserves further investigation, especially since coffee producers in both regions do not appear to differ that much in their individual characteristics. Yet, infrastructure and service delivery is much more developed in Kilimanjaro compared with Ruvuma.

Credit for agricultural inputs is scarce in both regions. The limited access to credit is most likely linked to the liberalisation of the cash crop marketing systems during the mid 1990s. Cooperatives could no longer enforce repayment of the credit for inputs given that farmers were now also able to sell to private traders. As a result they have completely retreated from the provision of credit, a gap which has not been filled by the private traders for similar reasons. In the absence of interlinked markets, lack of collateral as well as the regulatory framework (registration procedures) further compound the provision of credit, while the savings and credit cooperatives (SACCO's) have a relatively short history. Lack of credit access is likely to be important in explaining the limited use of modern inputs (estimated at Tsh 40,000 per acre in Kilimanjaro and just Tsh 8,000 in Ruvuma) (Sarris, Savastano and Christiaensen, 2006).

The contrast in wealth levels between Kilimanjaro and Ruvuma is reflected in and likely exacerbated by much lower levels of infrastructure in Ruvuma. Access to paved roads, telecommunications, electricity, agricultural inputs and extension are all poorer in Ruvuma. Moreover, both in Ruvuma and Kilimanjaro, these services also tend to be more concentrated in the coffee-growing districts.

While average (nominal) consumption levels in Kilimanjaro remained constant from 2003 to 2004, poverty increased by 2 percent during this year, possibly due to low rainfall in the region. Poverty in both Kilimanjaro and Ruvuma has a large transitory component, with almost half of the poor in the first period becoming non-poor in the next. These observations suggest the importance of climate shocks to welfare, and indicate an important role for insurance mechanisms and safety net interventions in rural Tanzania.

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3. Risks and Coping Strategies

by Danford Sango, Vivian Hoffmann and Luc Christiaensen

3.1 Introduction

In this chapter we describe the risk environment of rural Tanzanian households and provide a qualitative account of how they cope with these risks.[1] We begin from the premise that rural households are exposed to a number of uncertain and risky events, which have the potential to disrupt their livelihoods. Specifically, we will address the following questions: (i) what risks affect households; (ii) which among these risks are most important; (iii) how frequently are rural households affected by these risk events, and (iv) what ex-post (coping) strategies do households employ in dealing with risks. Chapter 5 of this report then investigates the immediate welfare effects of these shocks through multivariate analysis.

3.2 Risks and shocks in rural Tanzania

We begin by identifying the different dimensions of risks and shocks followed by an empirical review of these dimensions in the Tanzanian context. We further analyze the way the risk environment differs across cash crop growers and food crop growers, and poor versus non-poor households.

3.2.1 Dimensions of risk and shocks

In this chapter, we use the term risk to refer to uncertain events that may result in welfare losses (Heitzmann *et al*., 2002; Holzmann and J∅rgensen, 2000). A shock is a risk event that can cause a significant negative impact. How large the impact of a risk event must be to constitute a shock depends in part upon the expected welfare level of the particular household. For households living at the edge of subsistence even a small drop in consumption may have a significant negative impact on welfare. For those comfortably above the poverty line, on the other hand, a larger absolute loss, and even a larger proportional loss, could have a relatively insignificant impact on welfare.[2]

Risks and uncertain events can be characterized along various dimensions: (i) the source of the risk, (ii) the correlation in occurrence of the risk event among individuals (idiosyncratic versus covariate), across time (autocorrelation) and across risk events (bunching), and (iii) the frequency, timing and intensity of the risk. First, risks relevant to the current study can be classified by source as follows: climatic (drought, heavy rainfall), other agricultural production risks (pest infestation and livestock disease), risks to human health (illness, injury and death), risks to assets (appropriation of land, theft or destruction of property) and economic risks (unemployment, staple or cash crop price shocks).

Second, it is especially important to consider the correlation among risk events. Depending on the extent to which different individuals are simultaneously affected, one can distinguish between idiosyncratic and covariate risks. Idiosyncratic risks usually only affect a single person/household or a few households in a community at any given time. They include events such as theft of household assets, non-epidemic diseases and unemployment. Covariate risks

[1] Risks could be thought of as the “known unknowns”, while uncertainty refers to the “unknown unknowns”.

[2] This statement is based on the assumption, generally accepted in economics, of diminishing marginal welfare gains to consumption.

on the other hand affect many households simultaneously in a community. Such risk events include drought, commodity price decline and crop failure. This distinction is important as households usually have a greater capacity to protect consumption from the effects of idiosyncratic risks through the use of informal social support networks while such networks are usually ineffective in protecting households' consumption from covariate shocks (Morduch, 1995; Dercon, 2004). Depending on whether risks are autocorrelated over time or not, risks can also be categorized as repeated or unrepeated risks. Finally, risks are referred to as bunched if they correlate with other risks and un-bunched if they don't. For example, droughts often go together with food price increases and livestock price declines and therefore the two risk events are said to be bunched.

Some risk events occur more frequently (droughts, health shocks), while others only happen once in a lifetime (e.g. earthquake). The effects of infrequent events may be much more catastrophic, though more frequently occurring risk events could turn out to be equally damaging (e.g. droughts, recurrent or chronic illness). In addition to the frequency and intensity of risks/shocks it is also critical to distinguish between sudden risks/shocks and slow onset shocks. This is especially important when considering price shocks. Future price expectations are usually based on past price experiences, i.e. prices tend to have some memory. As a result, a (gradual) decline in prices from one year to the other does not necessarily come as a surprise. However, this is not to say that medium term declines in prices do not constitute a shock. When there is a delay in the supply response to an investment (e.g. new coffee trees only bear fruits after 3 to 5 years), investments based on price experiences two or three years ago may no longer be profitable today. We thus distinguish slow onset and sudden price shocks which are different in nature, though potentially equally devastating in their effects given the irreversible nature of the investment.

3.2.2 Incidence of shocks

The incidence of (i.e. proportion of households affected by) various shocks provides an overview of the risk environment faced by a population. To gauge the shock incidence for different risk events, we asked respondents whether the living conditions of household members had been negatively affected by any of a list of shocks during the five years preceding the date of the survey. We further asked respondents how many times their household had encountered each of these shocks within those five years.

As a first indication of the riskiness of the environment, Table 3.1 presents the number of times households where hit by any shock over the past five years both in Kilimanjaro and Ruvuma and by cash crop and non-cash crop producers. Cash crop producer households in Kilimanjaro region are defined as those owning any coffee trees, whereas for the Ruvuma region, a household with any coffee or cashew trees, or a household which cultivated tobacco during the past year, is considered a cash crop producer.

Table 3.1: Number of shock occurrences between 1999 and 2003, by region and status as cash crop producer (all figures refer to percentages of households that have experienced the indicated number of shocks)

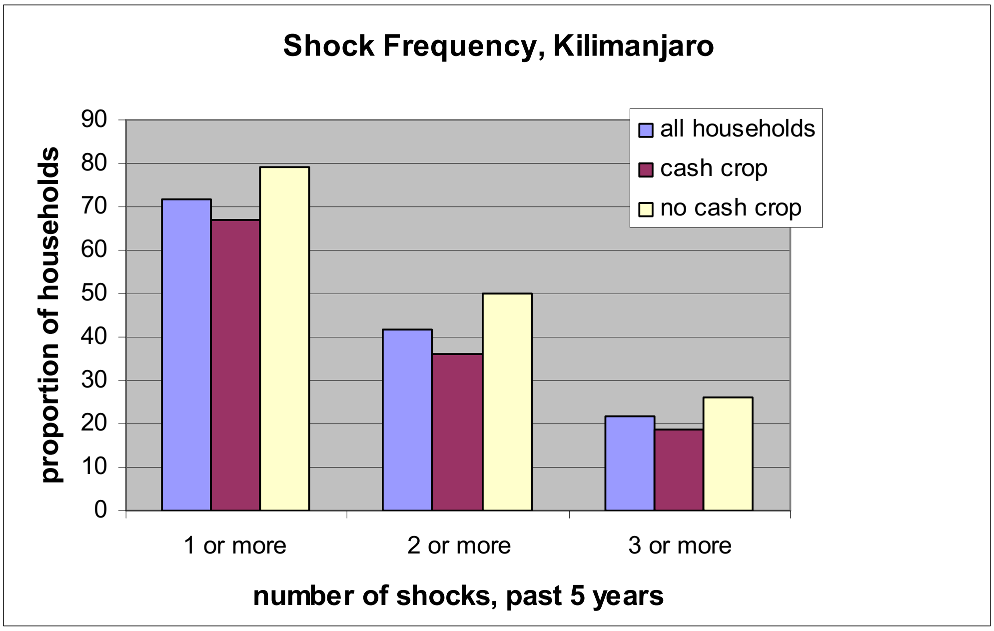
Number of shocks, past 5 years	Kilimanjaro		Ruvuma		Total
	Cash crop	No cash crop	Cash crop	No cash crop	
0.0	32.9	20.9	45.2	39.8	35.3
1.0	30.9	29.0	32.7	34.8	31.8
2.0	17.3	23.9	12.3	14.4	16.7
3.0	8.0	11.9	3.9	5.5	7.2
4.0	2.9	4.7	1.4	1.5	2.6
5.0	4.6	4.8	2.5	1.1	3.4
6.0	1.6	3.1	0.8	1.0	1.6
7.0	0.8	0.8	0.1	0.4	0.5
8.0	0.6	0.4	0.6	1.2	0.7
9.0	0.0	0.0	0.5	0.4	0.2
10.0	0.2	0.5	0.1	0.0	0.2
11.0	0.1	0.0	0.0	0.0	0.0

Source: Own calculations

About two-thirds of all rural households reported to have experienced at least one major shock to their livelihoods during the 1999-2003 period and those who incurred a shock were on average hit 2.1 times. Given that slow onset shocks including the collapse in commodity prices such as coffee and cashew were not fully captured by the administered shock module (see below), this most likely represents an underestimate. Results in table 3.1 above indicate that about a third (31.8 percent) of households affected by shocks in the study areas were affected by a single shock during the past five years. About 17 percent of all households reported to be affected by two shocks in the past five years, while 16 percent reported experiencing three or more shocks, indicating that some households are particularly exposed to risks. Clearly, rural Tanzanian households live in risky environments with shock incidence even more pronounced in Kilimanjaro than in Ruvuma.

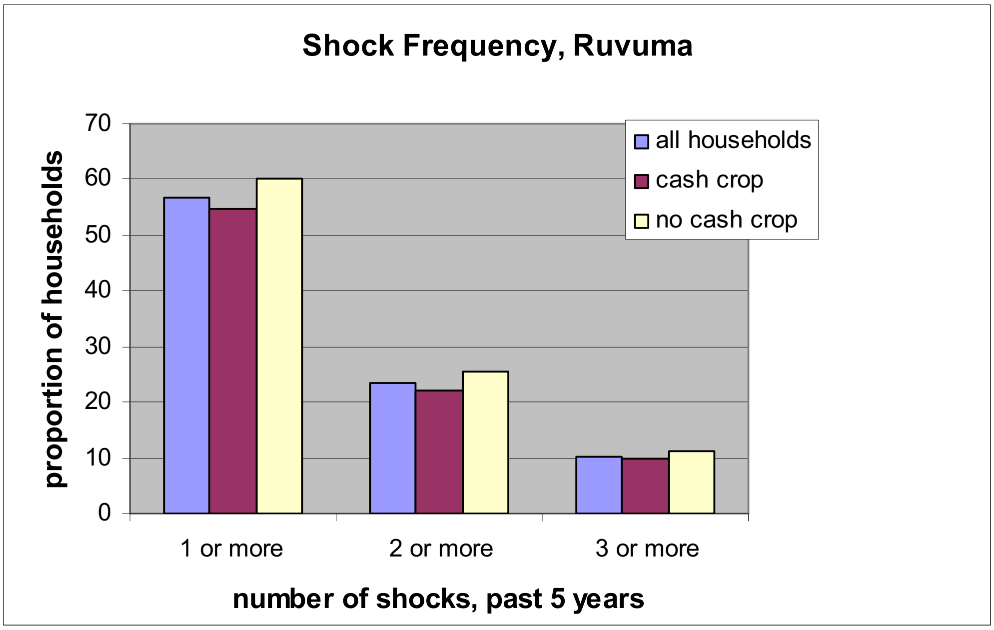
As shown in Figures 3.1 and 3.2, the number of shocks suffered by cash crop growers is slightly lower than the number of shocks reported by non-cash crop growers in both regions, though these numbers must be interpreted with caution as they do not account for the slow onset coffee and cashew price declines which affected all cash crop growers. The difference in shock incidence between poor and non-poor households is not statistically significant in either region.

Figure 3.1: Number of times shocks affected households in Kilimanjaro Region within the past five years, by status as cash crop producer



Source: Own calculations

Figure 3.2: Number of times shocks affected households in Ruvuma Region within the past five years, by status as cash crop producer



Source: Own calculations

Table 3.2 presents the percentage of sample households that experienced a particular type of shock at least once between 1999 and 2003.[1] Health related shocks (death and illness) emerge as the predominant risk households face both in Kilimanjaro and Ruvuma. Drought shocks feature as the second most important risk in Kilimanjaro, though drought incidence does not appear as a major risk factor in Ruvuma. Others shocks are much less frequent.

Table 3.2: Percentage of households affected by each shock type between 1999 and 2003, by region

	Kilimanjaro	Ruvuma	All
Health			
Death	25.9** 1)	17.4	21.8
Illness	23.1**	18.7	21.0
Climatic			
Drought	32.7**	4.4	19.2
Excessive rain/floods	7.2**	3.4	5.4
Agricultural production			
Harvest loss	6.5	5.4	6.0
Livestock loss	6.4**	4.0	5.3
Post harvest maize loss 2)	-	1.7	0.8
Economic			
Cash crop price shock 2) 3)	-	4.6	4.6
Cereal price shock 2) 3)	-	2.5	2.5
Unemployment	0.9*	0.1	0.5
Property			
Theft	5.4	4.9	5.2
Fire/house destroyed	0.7	3.3**	1.9
Land loss	0.5	0.1	0.3

Source: Own calculations.

1) ** Indicates that the proportion of households that experienced the shock type is significantly different between the two regions at the 99% confidence level; * indicates significance at the 95% level; + at 90%.
2) This information was not collected in the Kilimanjaro survey. The total (final column) applies to Ruvuma only.
3) Price shock is defined as an unexpected decline in the price compared to the previous year.

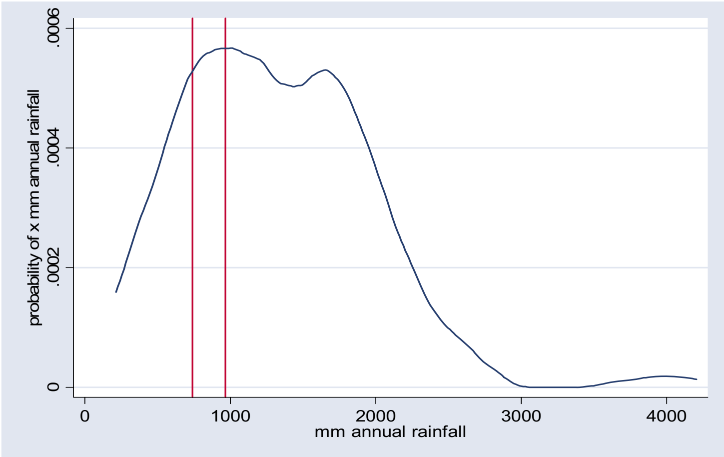
The emerging pervasiveness of health and drought risks in rural livelihoods is consistent with the evidence from other studies. Thirty and seventeen percent of the households in Kagera identified death and illness respectively as a shock with a major negative effect on their welfare over the past decade, while 18 percent identified weather related harvest failure as a major shock (World Bank, 2005). Respondents' rankings of different shocks in two villages in the Kagera region reveal drought and illness respectively as the first and second most important shocks (Kessy, 2004). From the nationally representative HBS we learn that 27 percent of Tanzanians are ill at least once every month. These findings are also consistent with those from neighboring countries. Dercon *et al*., (2005) for example identify drought and illness as the major risk factors in Ethiopia.

While these findings are based on households' subjective assessments and recall of shock events, analysis of the distribution of rainfall patterns in Kilimanjaro and Ruvuma lends supports to the emerging picture. Figures 3.3 and 3.4 show the distribution of total annual

[1] The reported results do not change qualitatively if we use the average number of times a household experienced a particular shock over the past 5 years instead (attributing zero if they did not experience the shock).

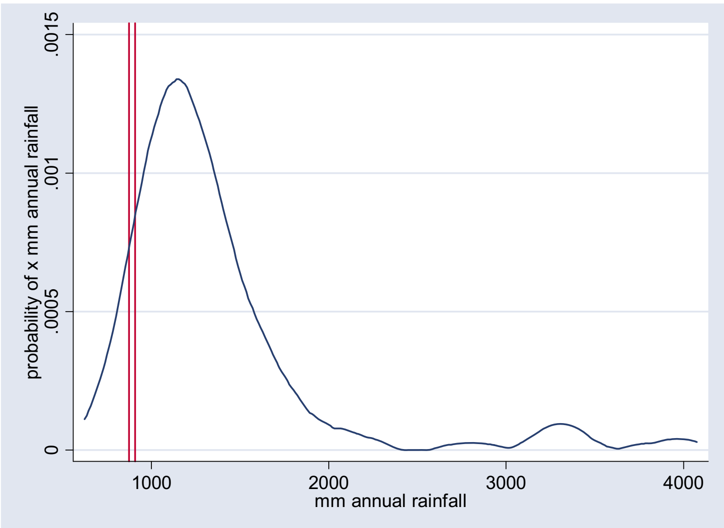
rainfall from 1970 to the present for 10 meteorological stations in Kilimanjaro and five stations in Ruvuma.[1]

Figure 3.3: Kernel density of annual mm rainfall in Kilimanjaro Region



Source: Own calculations using data from the Tanzania Meteorological Agency

Figure 3.4: Kernel density of annual mm rainfall in Ruvuma Region



Source: Own calculations using data from the Tanzania Meteorological Agency

It is clear from these graphs that that while the average rainfall level for the two regions is similar (1,289.7 mm for Kilimanjaro and 1,211.5 for Ruvuma) the distribution of rainfall in Ruvuma is much less dispersed than that for Kilimanjaro. To better understand people's own definition of a rainfall shock, respondents were asked in how many of the past ten years was rainfall "much below normal", and further whether they would consider rainfall at one-tenth, one-quarter, one-third, and one-half below normal "much below normal". Using their responses, we derive two definitions of a rainfall shock.

On average, respondents in Kilimanjaro reported that rainfall had been very low in 2.5 of the past 10 years, whereas in Ruvuma the average number of very low rainfall years was only

[1] Years with any missing months were dropped from this analysis, leaving a total of 248 annual observations for Kilimanjaro and 124 in Ruvuma.

0.65. We therefore define a rainfall shock in Kilimanjaro as an annual total below the 25th percentile of observations in Kilimanjaro during the past 10 years. The threshold for Ruvuma is the 6.5th percentile over the same period within that region.

From the second set of questions, we can define a rainfall shock as the minimum level which a majority of people define to be a shock. In both regions a majority of respondents (63.7 percent in Kilimanjaro and 59.7 percent in Ruvuma) considered a quarter below normal to be "a lot below normal". Assuming that respondents view the long-term median rainfall level as "normal", we multiply this amount by 0.75 to define the second shock threshold. For Kilimanjaro, the probability of a rainfall shock using this definition is 14.8 percent; for Ruvuma it is 8.8 percent.

The two vertical lines in each of Figures 3.3 and 3.4 represent these two definitions of a rainfall shock. In each case, the definition taken from the proportion of low rainfall years of the past 10 yields a lower threshold, though the difference is much more pronounced for Kilimanjaro. More importantly, droughts are clearly much less frequent in Ruvuma than in Kilimanjaro, consistent with the reported drought shock incidence in each region.

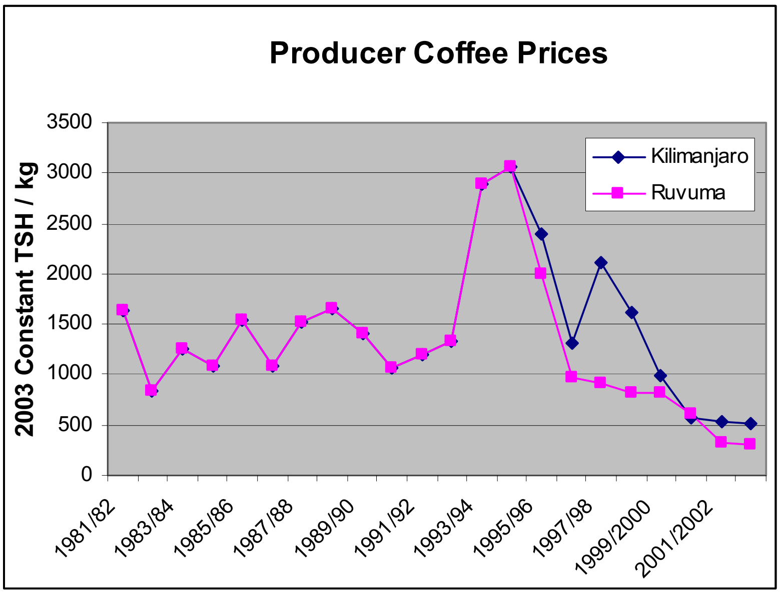
Respondents were asked about the relative amount of rain received on each of their cultivated parcels of land over the past year, on a scale of 1 to 5, with 3 being normal/average, 1 much above normal and 5 much below normal. Weighting these by parcel size and defining a rainfall shock as an average of 4.5 or higher, the shock incidence in Kilimanjaro in the first year of the survey was 20.7 percent, whereas for Ruvuma it was much lower, at 3.6 percent. These figures are comparable to the incidence of drought as reported in the shock section of the questionnaire, with 32.7 percent and 4.4 percent of households reporting a drought at least once over the past 5 years in Kilimanjaro and Ruvuma respectively. The low reported incidence of cash crop price shocks (2 to 4 percent) is of particular interest, especially given the steady decline in world coffee price since 1999.[1]

However, it is important to note that price shocks were defined to respondents as an unexpected decline in price compared to the previous year.[2] Price shocks to commodities that have been slow in their onset are not fully captured by this definition. As shown in Figures 3.5 and 3.6, both coffee and cashew prices have fallen significantly over the five years prior to the time of the survey. These sharp drops in price followed historically high prices for both crops. Coffee from Kilimanjaro experienced another (smaller) price peak in 1998-1999, but this was not mirrored in the prices for Ruvuma coffee beans, suggesting that Ruvuma coffee growers have had a longer time in which to adjust their livelihood strategies to the low prices.

[1] Since 2004, coffee prices appear to be rising again.

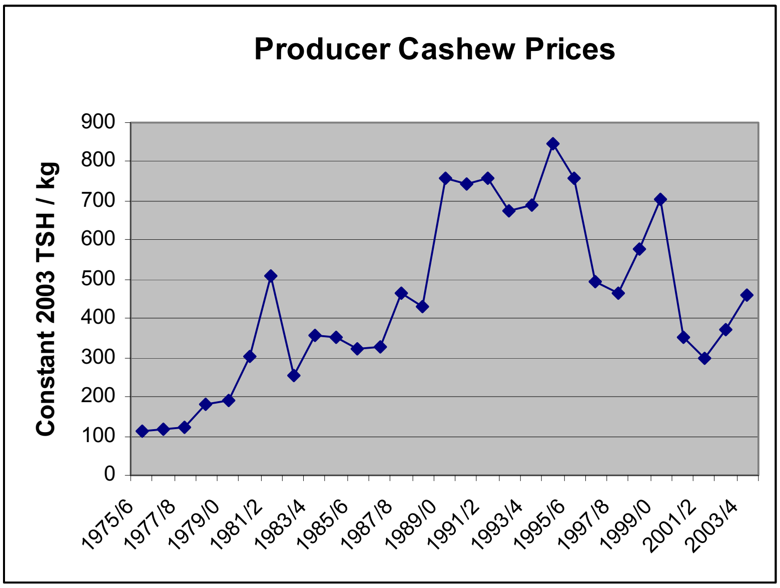
[2] Such shocks could be effectively managed through participation in existing commodity futures markets. See Chapter 6.

Figure 3.5: Real producer prices for mild coffees, Kilimanjaro and Ruvuma Regions, 1981-2003.



Source: Tanzania Coffee Board data.

Figure 3.6: Real producer prices for cashew nut, Tanzania, 1975-2004



Source: Tanzania Cashew Board data.

When asked about the occurrence of coffee price shocks at the village level, without explicitly stating that this only concerned an unexpected deviation from last year's price, leaders of the surveyed villages representing 35.6 percent of Ruvuma households and 82.8

percent of those in Kilimanjaro[1] reported that their community had suffered a coffee price shock. A cashew price shock was reported by communities in Ruvuma representing 24.5 percent of the region's population. Coffee and cashew tend to be highly geographically concentrated within both regions, and within those villages in Ruvuma reporting a price shock, an average of 84.8 percent and 94.9 percent of households were believed to have been affected by the coffee and cashew shock respectively. In Kilimanjaro, 95.3 percent of households in the communities affected by a coffee price shock were thought to have suffered. The tobacco price shock was not as covariate, with only about half (46.5 percent) of households within affected villages, which represented 25.1 percent of Ruvuma's population, believed by village leaders to have experienced the shock directly.

Table 3.2 further shows that short-term food price shocks are relatively unimportant, affecting less than 3 percent of the households. Mahul (2005) and evidence from Kagera (World Bank, 2005) also indicate that food price fluctuations are not a major issue in Tanzania.

Given the importance of health related shocks, we further explored which illnesses or injuries most seriously affect households (Table 3.3).[2] In line with findings in the 2000/01 HBS, malaria is the most frequently reported cause of ill health and death in Kilimanjaro. This is followed by respiratory and intestinal infections. Tuberculosis, an opportunistic infection common among AIDS patients, is also among the top five. This is consistent with the URT (2002), which reports that communicable diseases make up about half of the total burden of disease in Tanzania. It further suggests that HIV/AIDS is taking a heavy toll in rural areas. Addressing communicable diseases of largely preventable nature emerges as an important vulnerability reducing agenda in Tanzania (see also Hoogeveen, 2005).

Table 3.3: Reported causes of death or serious illness in Kilimanjaro Region

Illness or injury	% of cases
Malaria/fever	12.6
Respiratory	10.6
Intestinal infections	9.6
TB	7.3
Accident	6.6
AIDS	4.9
Pregnancy related	3.1
Mental illness	2.4
Diarrhoea	1.3
Skin infections	0.8
Cholera	0.5
Measles	0.4
Other	40.1

Source: Own calculations

[1] For 3 of the 45 communities in Kilimanjaro Region, the community questionnaire was not completed. The percentage reported here reflects only those villages for which the questionnaire was completed.

[2] To understand which illnesses or injuries most seriously affected households, we asked respondents who had experienced the death or serious illness of a household member(s) over the past 5 years to report the cause of death or type of illness. Note that these responses do not reflect all deaths or illnesses, but rather only those which were reported as shocks.

Table 3.4: Percentage of households affected by each shock type between 1999 and 2003, by region and status as cash crop grower

	Kilimanjaro		Ruvuma		Total
	Cash crop	Non-cash crop	Cash crop	Non-cash crop	
Health					
Death	23.1	29.9*** 1)	16.3	19.0	21.8
Illness	23.3	22.8	18.5	19.1	21.0
Climatic					
Drought	27.8	39.9**	2.8	7.1*	19.2
Rains	4.3	11.5**	4.2	2.2	5.4
Agricultural production					
Harvest loss	5.2	8.6*	6.1	4.4	6.0
Livestock loss	5.1	8.5*	3.1	5.4*	5.3
Post harvest maize loss 2)	-	-	0.9	2.9***	1.7
Economic					
Cash crop price shock 2) 3)	-	-	5.8**	2.7	4.6
Cereal price shock 2) 3)	-	-	0.8	5.1**	2.5
Unemployment	0.3	1.7*	0.2	0.0	0.5
Property					
Theft	4.4	6.9***	3.7	6.9*	5.2
Fire/house destroyed	0.2	1.4**	3.0	3.7	1.9
Land loss	0.2	0.9***	0.2	0.0	0.3

Source: Own calculations

1) ** Indicates that the proportion of households that experienced the shock type is significantly different between cash crop producing households and others within the region at the 99% confidence level; * indicates significance at the 95% level; *** at 90%.

2) These shocks were not included in the Kilimanjaro module; final column applies to Ruvuma only.

3) Price shock is defined as an unexpected decline in the price compared to the previous year. This information was not collected in the Kilimanjaro survey.

Abstracting from the incidence of slow onset price shocks to which cash crop growers are much more exposed than non-cash crop growers, we recall from Table 3.1 that non-cash crop growers appear more prone to shocks than cash crop growers. This holds across the different shocks, and is statistically significant for many of these, as indicated in Table 3.4.

In contrast, poor households appear to experience shocks with no more or less frequency than others. The incidence of drought, harvest and livestock losses is slightly lower for poor households in Kilimanjaro, though richer households experienced more deaths, potentially AIDS related.

Table 3.5: Percentage of poor and non-poor households affected by each shock type between 1999 and 2003 by region

	Kilimanjaro		Ruvuma		Total
	Poor	Non-Poor	Poor	Non-Poor	
Health					
Death	20.9	29.1*	15.7	17.2	21.8
Illness	24.1	22.4	18.3	18.1	21.0
Climatic					
Drought	37.1	29.8*	4.4	4.5	19.2
Rains	8.8	6.1	3.2	1.8	5.4
Agricultural production					
Harvest loss	8.2	5.5***	5.6	4.7	6.0
Livestock loss	9.1	4.7*	3.4	4.9	5.3
Post harvest maize loss[2)]	-	-	1.9	1.4	1.
Economic					
Cash crop price shock[2) 3)]	-	-	4.9	3.5	4.4[3)]
Cereal price shock[2) 3)]	-	-	2.5	2.3	2.1[3)]
Unemployment	0.9	0.9	0.2	0.0	0.5
Property					
Theft	5.4	5.5	5.3	4.2	5.2
Fire/house destroyed	0.7	0.7	2.7	3.3	1.9
Land loss	0.3	0.6	0.0	0.3	0.3

Source: Own calculations

1) ** Indicates that the proportion of households that experienced the shock type is significantly different between poor households and others within the region at the 99% confidence level; * indicates significance at the 95% level, *** at 90%.
2) These shocks were not included in the Kilimanjaro module; final column applies to Ruvuma only
3) Price shock is defined as an unexpected decline in the price compared to the previous year. This information was not collected in the Kilimanjaro survey.

3.2.3 Correlation of risks

As discussed in section 2.1, whether a risk is idiosyncratic or covariate has bearing on the ability of households to effectively manage the risk through formal or informal insurance mechanisms. Covariate risks are generally assumed to require a greater degree of external intervention than idiosyncratic shocks. On the other hand, idiosyncratic shocks may have also serious consequences for welfare, particularly for socially marginalized households who may be excluded from the social networks mediating informal insurance. Given that covariate and idiosyncratic risks require different interventions, knowing the extent to which particular shocks tend to be idiosyncratic or covariate in nature is important to the design of safety net programmes.

Respondents were asked to estimate the number of other households in the village (apart from their own) affected by shocks. Responses to this question by shock are presented in Table 3.6 below.

Table 3.6: Percentage of each shock type considered covariate according to respondents' perceptions of who else was affected

Type of shock	Respondents' perception of who else was affected by the shock in the community (percent of respondents that gave indicated answer)	
	Many/almost everybody (Covariate)	Only this/few households (Idiosyncratic)
Drought	94.8	5.2
Cash crop price shock	88.6	11.4
Rains	83.3	16.7
Harvest loss	79.2	20.8
Cereal price shock	73.5	26.5
Land loss	36.4	63.6
Livestock loss	21.4	78.6
Theft	5.5	94.5
Death	5.2	94.8
Post harvest maize loss	3.8	96.2
Fire/house destroyed	3.8	96.2
Illness	3.0	97.0
Unemployment	0.0	100.0
Total	34.8	65.2

Source: Own calculations

Findings in Table 3.6 clearly indicate that climatic and price shocks, as well as major harvest loss are covariate shocks typically affecting many households at a time. However, depending on its cause, harvest loss may also be idiosyncratic. Other major shocks, namely loss of livestock, death of a household member, and major illness are primarily idiosyncratic. Idiosyncratic shocks constitute a majority of all reported shocks. These findings suggest that geographic targeting would be appropriate in tackling weather (rainfall), crop performance and price shocks. Health shocks on the other hand require more specific targeting at the household level.

3.3 Household coping strategies

Households employ *ex-ante* (prevention and mitigation) and *ex-post* (coping) strategies to smooth their consumption following a shock event (Heitzmann *et al*.,2002; Holzmann and J∅rgensen, 2000; Alwang *et al*., 2001; URT, 2004). Here we focus on coping strategies. Documenting the type of strategies used to cope with shocks is useful as it also reflects the severity of a shock's impact on household welfare. For example, drawing down savings, receiving assistance, or generating additional income are shock mitigation strategies to preserve the consumption level of the household which do not come at the immediate expense of future consumption. The sale of productive assets can put households on a long term lower earning path. Again, we explore whether cash and non-cash crop producers cope differently with shocks and whether coping strategies differ among poor and non-poor households.

3.3.1 Coping strategies adopted by households to cope with shocks

Table 3.7 exhibits the different coping strategies used by rural households in Kilimanjaro and Ruvuma. Somewhat surprisingly, almost three quarters of all rural households who experienced a shock over the past five years used savings or sold assets to cope with at least one shock, with assistance from others emerging as the second most important coping strategy. About half of shock-affected households in Ruvuma received assistance from family members, friends or state and non-state institutions and about 60 percent of households in Kilimanjaro. In both regions about 30 percent of shock-affected households tried to generate additional income. Consistent with our earlier observations that poverty incidence in Ruvuma is higher than in Kilimanjaro, households in Ruvuma tend to revert more to a reduction in non-food expenditures. The proportion of households affected by a shock that resorted to reducing food expenditures is quite high, and statistically indistinguishable in both regions: food security is substantially affected by risk in both Kilimanjaro and Ruvuma. Both migration and borrowing were much less frequently observed responses to shocks.

Table 3.7: Percentage of shock affected households in Kilimanjaro and Ruvuma using strategy to cope with at least one shock between 1999 and 2003

	Kilimanjaro	Ruvuma	Both Regions
Used cash savings	72.6	74.5	73.4
Received aid	59.7 1)	51.7	56.3
Generated additional income	30.6	31.2	30.8
Reduced non-food consumption	25.0	29.3 1)	26.8
Changed dietary patterns	24.2	28.2	25.9
Migrated / split up household	6.0	7.9	6.8
Borrowed	5.8	4.6	5.3

Source: Own calculations

1) Indicates that the proportion of households using the strategy is significantly different between regions at the 90% confidence level.

Results in Table 3.7 indicate that disposition of savings/assets is the most frequently used strategy to cope with shocks. Use of liquid savings does not disrupt households' productive resource base, though the precautionary savings required for such a strategy to be used may tie up scarce assets in unproductive or low-productivity assets. Nonetheless, overall it could suggest that households are quite able to weather the shocks, i.e. they are not so vulnerable. Liquidation of productive assets on the other hand has implications for the households' future productive capacity. Households presumably only resort to these strategies in case of deep stress and large-scale liquidation of productive assets would suggest that households are much more vulnerable. For this reason, further disaggregation can shed light on the vulnerability status of rural households in rural Tanzania. Table 3.8 shows the proportion of households which used or sold the particular asset to cope with at least one shock.

Table 3.8: Of those households which used savings or sold assets, percentage that used particular asset at least once, by region[1]

	Kilimanjaro	Ruvuma	Both Regions
Cash savings	73.5	68.0	71.1
Foodstocks	15.9	22.7**1)	18.8
Livestock (other than cattle)	16.2	19.3	17.5
Cattle (other than oxen)	10.3**	2.0	6.8
Jewelry or household items	6.6	5.7	6.2
House or land	4.1	3.8	4.0
Oxen	2.5***	0.9	1.8

Source: Own calculations
1) ** Indicates that the difference in proportion of households that used the asset between regions is significant at the 99% confidence level; * indicates significance at the 95% level, and *** at 90%.

Almost three-quarters of all households who use savings or assets in case of shocks draw down their cash savings. This shows that households keep savings in cash and would suggest

[1] Columns do not add to 100 because households may have liquidated assets in more than one category.

that they are overall well able to cope with most shocks. Only about one-quarter of the studied households using assets to cope with shocks sold livestock. More broadly, the role and effectiveness of livestock in coping with shocks is still poorly understood in Sub Saharan Africa (Fafchamps, *et al*., 1997; Christiaensen and Subbarao, 2005; Kazianga and Udry, 2006). In understanding the effectiveness of livestock in smoothing consumption it is also important to distinguish between more liquid and less productive small ruminants (goats/sheep) and the less liquid and more productive cattle. Less than 7 percent of households selling assets, constituting only 4 percent of all households, sold cattle or oxen. Less than 5 percent of the households using assets (2 percent of all households) were forced to sell their land or house to cope with the shocks. Together the evidence suggests that households are overall quite capable to deal with shocks and that they were thus not so vulnerable.

Further analysis of the sources of assistance (Table 3.9) shows that the overwhelming majority of households which received assistance were aided by family members, and to a much lesser extent, their fellow villagers/friends and neighbours. The proportion of shock-affected households receiving assistance from either public or private institutions is very low. This observation underscores the continuing predominance of traditional methods in handling risks in rural Tanzania. Formal risks management instruments are virtually unavailable to rural households.

Table 3.9: Of those households which received aid, percentage that received aid from a particular source at least once

	Kilimanjaro	Ruvuma	Both Regions
Family	92.9	91.0	92.3
Neighbours / villagers	13.7**1)	5.0	11.0
Friends	5.8	1.6	4.5
Government	5.4**	1.9	4.3
Religious	3.9	1.5	3.1
(Inter) national NGO	0.6	1.0	0.7
Local NGO	0.5	0.0	0.4

Source: Own calculations

1) ** Indicates that the proportion of households using the coping strategy is significantly different between regions at the 99% confidence level.

Third on the list of coping strategies used by households is the generation of additional income. Around 30 percent of shock-affected households employed this strategy to contend with the effects of shocks. The observation that households have opportunities to generate additional income is good.

Table 3.10: Of those households which generated additional income to cope with a shock, percentage that used particular strategy at least once

	Kilimanjaro	Ruvuma	Both Regions
Increase agricultural labour	63.5	59.2	61.7
Non-farm enterprise	29.2	37.5*1)	32.7
Food for work	2.0	4.5	3.1

Source: Own calculations

1) ** Indicates that the proportion of households that experienced the shock type is significantly different between cash crop producing households and others within the region at the 95% level.

Findings presented in Table 3.10 indicate that rural households rely primarily on agricultural labour, either through intensification of work on their own farm, or through employment on others' land. Non-farm enterprise such as making of handcrafts and fishing is also an important income-generating strategy, used by about a third of households, with a slightly higher proportion in Ruvuma than Kilimanjaro. This is a much higher proportion of engagement in non-agricultural activities compared with Chapter 2, indicating that returns may be relatively lower for non-agricultural enterprise, but that these activities nevertheless constitute an important emergency source of income. It should also be kept in mind that while opportunities to generate additional income are certainly welcome, these do not come for free. Longer hours at work imply that income-earners have less time to attend other household duties such as caring for children. Alternatively, the increase in agricultural labour could be the result of increased child labour. Engaging in off-farm employment to generate cash for immediate needs reduces the availability of household labour for own farm production, which may have a higher return but involve a time lag before crops can be harvested.

Other methods of handling shocks identified in this study include the reduction of non-food expenditure, consumption of less expensive foods, and sending household members away to work or migration of the entire household. It is clear that the cost of implementing these strategies, particularly the latter three, is high. Consumption of less expensive foods, which often include lower-protein foods, can lead to malnutrition and associated illnesses. This strategy was employed at least once over the past five years by 26 percent of households that experienced a shock, or 17 percent of all households, a disturbingly high number. The proportion of households reducing food expenditures was slightly higher in Ruvuma, the poorer of the two regions.

3.3.2 Coping strategies by cash crop and non-cash crop growers

To explore the difference in coping strategies (and by extension shed light on differences in their vulnerability status) of cash crop producers versus others, we consider next the coping strategies employed by each group.

Table 3.11: Percentage of shock affected households using strategy to cope with at least one shock between 1999 and 2003, by region and status as cash crop grower

	Kilimanjaro		Ruvuma		Total
	Coffee growers	Non-coffee	Cash-crop growers	Non-cash crop	
Used cash savings / sold assets	76.3*	68.0	76.4	71.8	73.4
Received aid	59.5	60.0	69.2***	60.0	56.4
Generated additional income	28.7	33.0	27.8	36.2	30.8
Reduced non-food consumption	30.0**	18.7	32.0*	24.9	26.8
Changed dietary patterns	27.5*	20.0	30.3	24.7	25.9
Migrated / split up household	5.1	7.2	7.8	8.0	6.8
Borrowed	4.4	7.5***	2.3	7.8**	5.3

Source: Own calculations

** Indicates that the proportion of households that experienced the shock type is significantly different between cash crop producing households and others within the region at the 99% confidence level; * Indicates significance at 95% confidence, and *** at 90%.

Results in Table 3.11 indicate that cash crop producers and non cash crop producers largely use the various coping strategies with similar frequency. Interestingly however, cash crop producers tend to use more of the low-cost coping strategies (significantly higher use of savings in Kilimanjaro, and receipt of aid in Ruvuma), but they also tend to use more of the costly coping strategies such as reduction in non-food expenditures and substitution into less expensive foods. This suggests a diversity in responses, reflecting the diversity of wealth levels among coffee growers as discussed in Chapter 2, with the larger coffee farmers able to weather the coffee and cashew price declines quite well, and the smaller farmers having to revert to more painful coping strategies.

We next turn to the coping responses of the poor versus non-poor households. Households are classified as poor if their total consumption expenditures in the year preceding the survey fell below the basic needs poverty line as defined in Chapter 2.

Table 3.12: Percentage of poor and non-poor shock affected households using strategy to cope with at least one shock between 1999 and 2003, by region

	Kilimanjaro		Ruvuma		Total
	Poor	Non-poor	Poor	Non-poor	
Used cash savings / sold assets	66.0	77.2*	73.3	76.5***	73.4
Received aid	51.1	65.8*	50.4	54.2	56.4
Generated additional income	33.3	28.7	32.6	28.9	30.8
Reduced non-food consumption	31.6	20.3**	29.4	29.1	26.8
Changed dietary patterns	29.9	19.6**	29.1	26.5	25.9
Migrated / split-up household	5.1	6.7***	7.8	8.2	6.8
Borrowed	7.9	4.3**	4.2	5.3	5.3

Source: Own calculations

** Indicates that the proportion of households that experienced the shock type is significantly different between poor households and others within the region at the 99% level; * Indicates significance at 95% confidence; *** at 90%.

As expected, poor households, who typically have fewer savings and assets to draw on, are less likely to use these to cope with a shock. In Kilimanjaro poorer households are also less likely than others to receive assistance from others. Evidence of exclusion of the poor from informal social insurance networks has been documented by Santos and Barrett (2005). Not surprisingly, in both regions poorer households are more likely to modify dietary attitudes towards less expensive food baskets. Poor households in Ruvuma appear to be rather similar with richer ones with respect to reducing non-food consumption as a shock coping mechanism. This may reflect that these households have few non-essential expenses to start with.

3.3.3 Coping strategies by type of shock

As discussed above, households' options for coping with shocks is expected to differ according to the nature of the shock. Specifically, if a shock affected others on whom the household would normally rely for assistance, the probability of receiving such support is diminished. Table 3.13 shows evidence of this effect. Over 65 percent of the times households suffered an idiosyncratic[1] shock, they received assistance from others; this drops to just 34 percent if the shock was described by the household as affecting many or most other households within the community.

[1] Defined as in Table 3.6.

Table 3.13: Percentage of shocks idiosyncratic and covariate for which a particular strategy was used

	Idiosyncratic	Covariate	All Shocks
Used cash savings / sold assets	68.3	68.4	68.3
Received aid	65.4**1)	33.1	54.3
Generated additional income	22.8	33.9**	26.6
Reduced non-food consumption	24.3	26.1	24.9
Changed dietary patterns	22.6	26.8**	24.0
Migrated / split up household	5.3	5.5	5.4
Borrowed	7.5***	4.8	6.5

Source: Own calculations

1) ** Indicates that proportion of times the strategy was used is significantly different between idiosyncratic and covariate shocks at the confidence 99% level; * indicates significance at the 95% level; *** at 90%.

We also see in Table 3.13 that households are more likely to respond to a covariate shock by attempting to generate more income. Unfortunately, this may reduce the effectiveness of the strategy. If the labour supply increases sharply in response to a covariate shock, wages may decrease or unemployment arise unless the demand for labour is concurrently increased. Likewise, if many non-farm enterprises start up or expand in response to a covariate shock, markets for the goods they sell may be quickly saturated. Government food for work or other public works programme that expand the demand for labour in times of widespread crisis can provide one response to this problem. The degree to which households suffer more greatly from covariate shocks is seen in the higher proportion of households decreasing their food expenditures in response to these shocks.

3.4 Conclusion and recommendations

The overall objective of this chapter was to assess rural households' risk environment in Tanzania using Kilimanjaro and Ruvuma as case study regions. Specifically, the paper was meant to (i) identify and characterize shocks to which households are exposed, (ii) identify and characterize coping strategies used by farm households and (iii) deduce some relevant hypotheses regarding policy which may be of use in helping to secure the livelihoods of farm households in rural Tanzania. We have seen that in addition to slow onset commodity price declines, health risks and climatic shocks are the most pervasive risks affecting farm households in rural Tanzania. The prevalence of health shocks stems largely form the high incidence of preventable communicable diseases such as malaria.

Aside from the price volatility that plagues coffee and cashew growers alike, households who do not grow coffee appear slightly more exposed to risk than those who do. The poor and non-poor suffer from shocks with approximately the same frequency.

In order to survive during periods of crisis, households in rural Tanzania rely heavily on the use of, primarily liquid, assets. Many also rely on support from kin and, to a lesser extent, non-kin social networks. Households have few coping options available aside from self- and informal social insurance due to the inexistence of formal insurance or safety net programmes through the government, non-governmental organizations or the private sector. The existing informal mechanisms exclude many of the poor, who have fewer savings to draw on, and, in Kilimanjaro, are also less likely to receive assistance from others.

These observations indicate that efforts to contain the spread of communicable diseases in rural Tanzania, and to develop mechanisms through which households can better manage health and weather risks could have a significant impact on welfare. Our findings further suggests that of all the risks faced by farm households in Tanzania, weather, price, and crop performance shocks are the most difficult to manage through informal mechanisms due to their covariate nature. Finally, it is clear that formal safety nets and insurance mechanisms have as yet unrealized potential to help rural households manage risk more effectively. We explore the immediate welfare losses associated with drought, health and commodity price shocks in more depth in Chapter 5 using a multivariate framework.

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4. Household Vulnerability

by Alexander Sarris and Panayotis Karfakis

4.1 Introduction

Having described households' endowment base, the risks they face, their livelihood systems and coping strategies as well as their welfare and poverty levels in Chapters 2 and 3, Chapter 4 explores the status of vulnerability of households in Tanzania, the combined result of these different factors. To do so, we calculate a measure of household vulnerability and estimate for each household its probability of falling below a poverty level in the next period. The vulnerability measure can be used to construct a vulnerability profile of the population and identify appropriate policy interventions and targeting rules.

The subject of risk and especially the contribution of risk to poverty dynamics are of growing importance in the literature on poverty. Risks contribute to poverty in a number of ways. Firstly, risks may blunt the adoption of technologies and strategies of specialization necessary for agricultural efficiency (Carter, 1997). For example, households with limited options for consumption smoothing grow lower return, but safer crops (sweet potatoes, sorghum and millet) than the richer households which usually have more options for consumption smoothing. Risks may motivate farmers to apply less productive technologies in exchange for greater stability (Morduch, 2002, Larson and Plessman, 2002). The cost of such an income-smoothing strategy can be high and a farmer may forgo up to 20 percent of his or her expected income to obtain a smoother income stream (Dercon, 1996). Secondly, risks may function as a mechanism for economic differentiation within a population, deepening the poverty and food insecurity of some individuals even as aggregate food availability improves (Carter, 1997). Thus, in the absence of risk management instruments, risk events may plunge particularly vulnerable households into poverty (Holzmann and J∅rgensen, 2000). The policy message emanating out of these insights are that risks are detrimental to the welfare of (poor) households and that ensuring security of consumption is an essential ingredient of any poverty alleviation strategy (World Bank, 2001).

A household facing a risky situation is subject to future loss of welfare. The likelihood of experiencing future loss of welfare, generally weighted by the magnitude of expected welfare loss, is called vulnerability. The degree of vulnerability depends on the characteristic of the risk and the household ability to respond to risk through the risk management strategies discussed above. Household vulnerability has thus been decomposed by Heitzman *et al.* (2002) into a "risk chain" comprising (a) uncertain events (b) the options for managing risks or risk responses and (c) the outcome in terms of welfare loss. Households face risks namely exposure to uncertain events. To contend with risks households make use of a number of risk management options. Risks combined with responses lead to outcome. Thus a household is said to be vulnerable to the outcome of an uncertain event, if it does not have sufficient resources to adequately contend with the outcome of the event. In other words, the extent to which a household is vulnerable to an uncertain event, namely the extent to which the household can become and/or remain poor, depends on the size of the shock and how effective the household is in managing the uncertain event both *ex-ante*, as well as *ex-post*.

While the development community has largely settled on the appropriate indices to measure poverty [namely the Foster Greer and Thorbecke (1984) (FGT) indices], no consensus has yet emerged about the appropriate way to measure vulnerability. Essentially two approaches have emerged in the literature, which consider vulnerability. The first associates vulnerability with high expected poverty (Christiaensen and Boisvert, 2000; Chaudhuri, *et al*. 2002), while the second with low expected utility (Ligon and Schechter, 2003). The latter requires information about individual risk preferences. Given that individuals are often uncertain about their preferences, especially those related to stochastic events,[it is hard to imagine that human knowledge can be so perfect that tomorrow's hunger or pain can be felt today (Kanbur, 1987)] we opt to follow the expected poverty approach below.[1]

A comprehensive qualitative assessment of households' risk environment, their coping strategies, and the resulting household vulnerability in Tanzania, was first undertaken under the 2002/2003 PPA (URT, 2004). It concluded that vulnerability is the result of the number and intensity of the impoverishing forces households face versus the number and effectiveness of their response options. It identified environmental and macroeconomic conditions, governance, ill health, lifecycle conditions and cultural beliefs and practices as important impoverishing forces (i.e. forces pushing people down the ladder of well-being). To manage these impoverishing forces the PPA finds that households make use of assets (including human, social, political, natural, physical and financial assets). Thus poverty itself limits people's capacity to improve and safeguard their well-being. In addition, it is seen that people's capacity to manage impoverishing forces diminishes as they struggle to survive successive waves of shocks and stresses. The PPA further emphasized that there are some disadvantaged social groups in the country that due to their low access to assets are particularly vulnerable. These include children, persons with disabilities, unemployed youths, elderly persons, persons with chronic illnesses, widowed women, drug addicts and alcoholics.

This study supplements this analysis through a quantitative assessment with a particular emphasis on cash crop growing households. The late 1990s and early 2000s have been characterized by a precipitous decline in many cash crop prices such as coffee and cashew nuts grabbing headlines and renewing calls for direct market interventions to support small holder cash crop growers. Nonetheless, as illustrated by the findings from the PPA, cash crop growers are not only exposed to commodity price declines, but as other households, they face many risks and a holistic perspective on household vulnerability is thus called for.

In the second section we briefly review the concept of vulnerability and we discuss our methodology. The proposed methodology complements and improves on the applications by Chaudhuri. *et al*. (2002) and Christiaensen and Subbarao (2005), through the inclusion of covariate risks, by utilizing historical information on prices yields and production. The data is described in Section 4.3 and Section 4.4 provides empirical estimates of households' vulnerability and discusses the various aspects of the estimates and results. Section 4.5 summarizes the conclusions.

[1] Christiaensen and Subbarao (2005) provide a more elaborate discussion of the normative assumptions underpinning the different approaches to vulnerability measurement.

4.2 Methodology

There are two basic ideas that appear consistently in the vulnerability literature. First the groups of poor and the vulnerable are not the same. Secondly, although poverty is a static concept (a situation into which somebody already finds himself), vulnerability is a dynamic concept (referring to a situation in which somebody can potentially fall into). As such the most popular vulnerability measures estimate the probability that a welfare variable (usually consumption), will fall below an ex-ante defined poverty line.

In general there are two approaches that have been tried to assess and estimate vulnerability. The first considers vulnerability as the probability of consumption falling below a poverty threshold (Christiaensen and Subbarao, 2004, Chaudhuri, *et al*. 2002), while the second considers vulnerability as low expected utility (Ligon and Schechter, 2003). Hoogeveen *et al* (2004) provide guidelines for constructing vulnerability measures, and a review of the shortcomings of the measures developed until now. Hoddinott and Quisumbing (2003) provide a more formalized survey of vulnerability together with the econometric methodology behind the currently developed measures. Finally Kurosaki (2006) reviews the quickly expanding literature on different vulnerability measures, favouring their use as advancing poverty measurement from a static to a dynamic framework. He argues for the usefulness of all (for different policy purposes), and thus for the inability to choose an overall acceptable definition. In the sequel we follow the first approach.

Both of the approaches to vulnerability indicated above consider as the object of study household consumption, which is determined by individual characteristics, and is subject to covariate or idiosyncratic risk factors. The idea is to construct an appropriate probability distribution of consumption. In a second step taking into account the probability distribution of consumption, vulnerability indicators that relate to the family of the FGT, are estimated for groups of households.

Vulnerability can be defined as the probability that consumption at period t+1 denoted as ct+1, will fall below an *ex ante* defined poverty line (z):

$$V_{ht} = \Pr(c_{h,\,t+1} \leq z) \tag{4.1}$$

Extensions of the methodology are provided by Prithcett *et al* (2000), who expand the time horizon based on the fact that the higher length of the time horizon is associated with more risk and thus with higher vulnerability.

Given an efficient estimate of the probability distribution of consumption a vulnerability index for a household h at time t can be computed by applying the following FGT type of formula.

$$V_{h,t,v} = F(z)\int_{\underline{c}_t}^{z}(z-c_t)^{v}\,\frac{f(c_{h,t})}{F(z)}\,dc_t \tag{4.2}$$

where f is the density and F the cumulative distribution of consumption. As such, vulnerability measures the probability of falling below the benchmark poverty line (if ν =0), or this probability weighted by the depth of the shortfall (if ν ≠0).

However popular the FGT measures, there is a debate concerning their properties as well as their interpretation (see for instance the discussion in Ligon and Schechter 2003). Furthermore in a recent paper Cafiero and Vakis (2006) suggest that a major issue with these measures is that no matter how much retrospective information is available (for instance with long panel data), vulnerability measures are not forward looking since they are based always on past realized welfare outcomes, shocks and characteristics. Similarly Alwang, Siegel and Jørgenson (2001) suggest that: "Vulnerability is the continuous forward looking state of expected outcomes. *Ex post* welfare losses are neither necessary nor sufficient for the existence of vulnerability. Past welfare losses, in and of themselves, are not sufficient to identify a household as vulnerable." All of these critiques have to do with the inherent upredictability of some events that have not occurred in the past, and for which one cannot form probability distributions. As such, even though any vulnerability measure is richer in information in comparison with a simple poverty line, it cannot be forward looking. On these grounds Cafiero and Vakis (2006) suggest the use of traditional poverty lines, but upwards adjusted by an amount that captures the cost of insurance for the uninsured risks (even if insurance markets are not present). However, even this risk premium cannot be estimated on the basis of events that have never occurred in the past and hence have unknown probability.

Irrespective of their disadvantages the FGT class of indices are popular due mainly to their simplicity and comprehensiveness. Also an advantage of these indices is that they do not depend on individual utility functions.

Our methodology builds on the approach of Christiaensen and Subbarao (2005) and Chaudhuri et. al. (2002). We shall specify a stochastic consumption function, and we shall try to identify the idiosyncratic and the covariate components of risk.

Consider the specification of household consumption. We assume that consumption in some period t for household h, is a stochastic variable that depends on a set of variables X specific to the household, as well as a set of idiosyncratic and covariate shocks S.

$$\ln c_{ht} = X_{ht}\beta + S_{ht}\gamma + e_{ht} \tag{4.3}$$

where c_{ht} is per capita or per equivalent adult consumption expenditure of the household in period t, X_{ht} is a set of household characteristics that can be considered exogenous to the household at time t (including for instance past levels of various assets, other household variables etc.), S_{ht} is a vector of identifiable idiosyncratic shocks, as well as variables affected by covariate shocks experienced by the household between times t-1 and t, β and γ are vectors of parameters to estimate, and e is a zero mean error term that captures idiosyncratic shock factors that affect consumption apart from the ones explicitly included in S.

The variance of e is assumed to also depend on X_h as follows.

$$\sigma^2_{e,h} = X_h\theta \tag{4.4}$$

Both Christiaensen and Subbarao (2005) and Chaudhuri *et al.* (2002) have utilized a three step feasible generalized least squares (FGLS) procedure to estimate β and θ. This involves first estimating (4.3) by OLS. Then (4.4) is estimated by OLS by using the squared residuals from the estimation of (4.3) as left hand variables. The predictions $X_h\hat{\theta}$ from this regression are used to re-estimate (4.4) by OLS after dividing each observation as well as the right hand variables in (4.4) by $X_h\hat{\theta}$. The new estimates of θ are asymptotically efficient, and are used to weigh (4.3) and re-estimate it by weighted least squares, to obtain asymptotically efficient estimates of β and γ. Once this is done, the expected value of consumption and its variance given X_h are equal to

$$E[\ln c_h / X_h] = X_h\hat{\beta} + E(S_{ht})\gamma \quad (4.5)$$

$$Var[\ln c_h / X_h] \equiv \hat{\sigma}^2_{e,h} + \gamma' Var(S_{ht})\gamma = X_h\hat{\theta} + \gamma' Var(S_{ht})\gamma \quad (4.6)$$

where the expectations are conditional ones, namely given information at the beginning of time t, and V(S) is the conditional covariance matrix of the shocks S, These expressions were utilized by Christiaensen and Subbarao (2005) and Chaudhuri *et al*. (2002) to estimate the probability that consumption will fall below some poverty threshold, which was defined as the vulnerability of the household.

Notice that the above procedure accounts for both idiosyncratic shocks affecting households, as well as covariate ones, as long as the conditional variance of S can be estimated. It is not easy to estimate the variance of S, and it is there that we shall try to extend the current practice.

Suppose that S can be decomposed into two vectors Y, and Z, where Y includes k variables that are themselves, or are directly affected by, independent covariate shocks, while Z includes identifiable idiosyncratic shocks. Idiosyncratic shocks that cannot be separately identified, and hence are not included in Z are subsumed in the error term e. We omit the time subscript for ease of notation.

$$S_h = [Y_h, Z_h] \quad (4.7)$$

We can also partition the coefficient vector γ conformably to the above decomposition.

$$\gamma = [\gamma_Y, \gamma_Z] \quad (4.8)$$

For instance Y could include some rainfall related variable, or production/income of a crop whose yield is subject to environmental variations, but also whose price varies in ways exogenous to the household. Under the above assumptions the conditional mean and variance of consumption can be written as follows.

$$E[\ln c_h / Z_h] = X_h\hat{\beta} + E[Y_h / X_h]\hat{\gamma}_Y + E[Z_h / X_h\}\hat{\gamma}_Z \quad (4.9)$$

$$Var[\ln c_h / Z_h] = \sum_{i=1}^{k}\hat{\gamma}^2_{i,Y} Var[Y_{h,i} / X_h) + X_h\hat{\theta} + \sum_{j=1}^{m}\hat{\gamma}_{j,Z} Var[Z_h / X_h] \quad (4.10)$$

where k denotes the number of variables affected by independent covariate shocks included in Y and m is the number of independent idiosyncratic shocks included in Z. The first component of the right hand side of (4.10) represents the contribution of covariate shocks to the variance of consumption, while the last two represent the contribution of idiosyncratic shocks. Chistiaensen and Subbarao (2005) included covariate as well as idiosyncratic shocks in their analysis, and used external information on these shocks to implement (4.10). The problem is to estimate the relevant parameters β, θ, and γ, as well as estimating the variances of each independent covariate and idiosyncratic shock variable included in the Y and Z vectors.

Given (4.9) and (4.10), the vulnerability of the household will be defined as follows

$$V_h = \Pr ob(\ln c_h < \ln z / X_h) \tag{4.11}$$

The most important covariate shocks affecting farm households in Tanzania (and probably everywhere else), are weather induced reductions in crop yields, and variations in market prices of products. As every farm household produces a variety of crops it is difficult to account for all individual crop specific risks for each farmer. What we propose, instead, is to include total crop income as an explanatory variable in the consumption equation, as the main variable subject to covariate shocks. Crop income is the most important component of income in rural areas in Tanzania, and the most important sources of covariate risks, constituting more than 50 percent on average total (cash and non-cash) income among rural households in the two regions studied. We then propose to determine for each household the covariate and idiosyncratic components of the variance of this crop income, based on the survey data, as well as household specific crop production patterns, and exogenous time series information on prices and yield variations. Finally we will combine the total variance of crop income with the idiosyncratic component of consumption risk, in order to ascertain the total vulnerability faced by each household. If we let Y in the equations above denote the total crop income of the farm household (a scalar), then the whole discussion above carries through as a special case.

In summary the procedure that we shall follow is the following.

First we estimate from a cross-section the consumption per adult equivalent of each household by a relation of the following form.

$$\ln c_{ht} = X_{ht}\beta + \gamma_Y \ln Y_{ht} + Z_{ht}\gamma_Z + e_{ht} \tag{4.12}$$

where Y is the household (gross)[1] crop income per acre (the land cultivated is included in the X variables), X is a shorthand for all other explanatory household variables, and Z denotes the identifiable idiosyncratic shocks affecting the household in period t.

Given that the error of this equation is likely to be correlated with the variable Y, this equation will be estimated by instrumental variables, by estimating in a first step the variable Y. Hence the equation actually estimated is a modified version of (4.12)

$$\ln c_{ht} = X_{ht}\beta + \gamma_Y \ln \hat{Y}_{ht} + Z_{ht}\gamma_Z + e_{ht} \tag{4.13}$$

where the hat above Y denotes the fitted values from the first stage regression. This first stage regression includes all the X and Z variables plus the instruments. Ideally all covariate shocks affecting crop income but not consumption, such as weather shocks could be included in the instruments of the first stage of the estimation of Y.

[1] We also utilized net crop income, which is gross crop income after subtracting the values of purchased intermediate inputs, but this led to some losses of degrees of freedom, while not affecting in any substantive way the results.

Once (4.13) is estimated the residuals are squared and the following equation is estimated by OLS.

$$\hat{e}_h^2 = X_h\theta_{OLS} + \eta_h \tag{4.14}$$

After (4.14) is estimated by OLS, it is re-estimated in the following "corrected" form.

$$\frac{\hat{e}_h^2}{X_h\hat{\theta}_{OLS}} = \left(\frac{X_h}{X_h\hat{\theta}_{OLS}}\right)\theta + \frac{\eta_h}{X_h\hat{\theta}_{OLS}} \tag{4.15}$$

This produces efficient estimates of θ denoted by $\hat{\theta}_{FGLS}$. Since $X_h\hat{\theta}_{FGLS}$ is a consistent estimate of $\sigma_{e,h}^2$, we use the estimates of this, namely

$$\hat{\sigma}_{e,h} = \sqrt{X_h\hat{\theta}_{FGLS}} \tag{4.16}$$

to re-estimate (4.13) as follows:

$$\frac{\ln c_{ht}}{\hat{\sigma}_{e,h}} = (\frac{X_{ht}}{\hat{\sigma}_{e,h}})\beta + (\frac{\ln \hat{Y}_{ht}}{\hat{\sigma}_{e,h}})\gamma_Y + (\frac{Z_{ht}}{\hat{\sigma}_{e,h}})\gamma_Z + \frac{e_{ht}}{\hat{\sigma}_{e,h}} \tag{4.17}$$

Given the estimates of β, γ and θ obtained from (4.17) and (4.15) respectively, we can estimate the expected value and variance of log of consumption using (4.9) and (4.10). Note that equation (4.13) implicitly includes, via the parameter γ_Y, the consumption smoothing behaviour of the household. Hence the subsequent estimate of vulnerability refers to vulnerability that remains after the various consumption smoothing mechanisms to income shocks have been employed.

Given (4.17), if it is assumed that consumption is lognormally distributed, equation (4.11) can be estimated directly. Note also from (4.10) that the first component of the right hand side can be considered as the contribution of covariate shocks to overall variance of consumption, while the second component is the idiosyncratic risk.

As crop income is a major component of total income, and hence consumption variability, the determination of its variance is quite important for the estimation of consumption variations, and hence vulnerability. To estimate the expected value and the variance of the log of crop income, we first compute the expected value and variance of crop income using the technique applied by Sarris (2002) and Rapsomanikis and Sarris (2007). Let agricultural (gross) crop income of a household h be denoted by Y_h. Then this can be written as follows.

$$Y_h = \sum_{i=1}^{n} P_{h,i}Q_{h,i} \tag{4.18}$$

where the quantities Q of each product and the prices P are specific to each household, and n is the number of crop products produced by the household.

For the sequel, we assume that *ex-ante*, both price and production of each product are stochastic, and that the distribution of the price of each product is independent of the distribution of the quantity produced by the household[1]. Let the average shares of each crop product *i* in total crop income be s_i , the normalized quantity of product *i* produced by q_i (the normalization is by dividing the amount Q produced in any period by the average value of production), and the normalized price of product *i* by p_i (which is defined as the price P of the product in a period divided by the average value of price). We shall omit household specific indices for ease of notation. Then the normalized deviation of total crop income from its mean, for each household, under the assumption that the quantities produced by the household in period t are independent of the prices faced by the household in the same period can be written as follows (where the expectations as well as the bars above stochastic variables denote conditional expected values for one period ahead):

$$\hat{Y} \equiv \frac{Y - E(Y)}{E(Y)} = \frac{\sum_i P_i Q_i - E(\sum_i P_i Q_i)}{E(\sum_i P_i Q_i)} = \frac{\sum_i P_i Q_i - \sum_i \overline{P_i}\,\overline{Q_i}}{\sum_i \overline{P_i}\,\overline{Q_i}} =$$

$$= \sum_i s_i (\Delta p_i \Delta q_i + \Delta p_i + \Delta q_i) \tag{4.19}$$

Given (4.19), the squared coefficient of variation of income can be written as follows.

$$CV^2(Y) = \sum_i \sum_j s_i s_j E\left[(\Delta p_i \Delta q_i + \Delta p_i + \Delta q_i)(\Delta p_j \Delta q_j + \Delta p_j + \Delta q_j)\right] \tag{4.20}$$

If we assume symmetry of the distributions of the various price and quantity terms, the only terms that will contribute to the expression in (4.20) are those that include even number of terms in the products of the price and quantity terms. Hence (4.20) can be rewritten as follows.

$$CV^2(Y) = \sum_i \sum_j s_i s_j E\left[\Delta p_i \Delta p_j \Delta q_i \Delta q_j + \Delta p_i \Delta p_j + \Delta p_i \Delta q_j + \Delta p_j \Delta q_i + \Delta q_i \Delta q_j\right] \tag{4.21}$$

Clearly the CV of income is just the square root of (4.21) and the standard deviation of crop income is the product of the CV and the average value of crop income.

Denote by σi the coefficient of variation of production of the i'th crop produced by the household, by κ_{ij} the correlation coefficient between the production of the i'th crop and the j'th other crop produced by the household, by v_i the coefficient of variation of the domestic price facing the household of the i'th product, and by ψij the correlation coefficient between the prices of the i'th and j'th products. The various terms of the extended coefficient of variation formula (4.21), under the independence assumptions made, can be evaluated as follows:

$$E(\Delta p_i \Delta p_j \Delta q_i \Delta q_j) = \psi_{ij} v_i v_j \kappa_{ij} \sigma_i \sigma_j \tag{4.22}$$

$$E(\Delta p_i \Delta p_j) = \psi_{ij} v_i v_j \tag{4.23}$$

[1] This assumption, of course, is only an approximation, but it holds for most products where production decisions must be made several months in advance of actual production and sale. It is made for simplicity as otherwise the formulas would become too unwieldy.

$$E(\Delta p_i \Delta q_j) = 0 \tag{4.24}$$

$$E(\Delta q_i \Delta q_j) = \kappa_{ij} \sigma_i \sigma_j \tag{4.25}$$

The above formulas allow the complete specification of each household's variance of crop income, conditional on the characteristics of each household. This, however, is not the complete end of the story, as equation (4.17) involves the log of crop income rather than the simple value of income. The above method yields the mean and the variance of crop income, which for simplicity we denote as μ_Y and σ_Y^2. If it can be assumed that the distribution of total crop income is log normal, then by using the standard statistical formulas of the lognormal distribution (e.g. Lindgren, 1998) we can express the expected value and the variance of the log of Y as follows.

$$E(\ln Y) = \ln \mu_Y - \frac{1}{2}\ln(1 + \frac{\sigma_Y^2}{\mu_Y^2}) \tag{4.26}$$

$$Var(\ln Y) = \ln(1 + \frac{\sigma_Y^2}{\mu_Y^2}) \tag{4.27}$$

The above formulas complete the full specification of the model and the methodology for computing the vulnerability.

4.3 Data

As was indicated in Chapter 2 households in Ruvuma tend to be poorer than those in Kilimanjaro, as reflected in the lower value of their total income and wealth, their lower average annual per capita expenditures and their higher poverty incidence.

In addition to the household survey data, and for the estimation of crop income variability, we also collected time series data on market prices, as well as time series on regional production and rainfall. The monthly price series data cover 15 agricultural commodities and the period from January 1983 to October 2002, yielding in total 238 observations for each commodity. These price series were subject to a large number of missing values. In order to fill the missing values a method of repeated autoregressions of order 2 was used.

The price series data cover the major cities of the Kilimanjaro region (namely Arusha, Gonja and Moshi) and similarly for Ruvuma (Songea, Mbinga and Tunduru). In order to derive a representative price index for the region for each commodity we used the row median price of the cities in each region for which we had data. Each regional price series was deflated using the monthly consumer price index from the international financial statistics of the IMF CD-ROM database (May 2004 edition), with 2000 average prices as the base (The CPI was normalized to equal 1 in average for year 2000). Price series for coffee were downloaded from the International Coffee Organization website (www.ico.org), and refer to prices paid to growers in Tanzania for the Arabica variety.

For production variability we utilized regional yield time series covering the period 1992-2001. Clearly not all yield variations are due to covariate shocks. However, aggregate yields are averages over many individual yields which are subject to both covariate shocks as well as idiosyncratic shocks. If the idiosyncratic shocks are random across households, then the aggregate yield variability should reflect random covariate shocks such as weather, as well as non-random responses to aggregate economic conditions (e.g. prices of fertilizers, etc.). While we did extensive analysis of this at the cross section level there is no reliable time series data on the basis of which to isolate the effects of such variables on aggregate yields. Hence the reported variances are likely overestimates of the true covariate shocks.

Table 4.1a and 4.1b provide summary statistics of the time series and yield data. It can be seen that the volatility of prices as well as production, in both regions is very large, with standard deviations of prices and production often larger than 40 percent of the average value of the underlying variable. It thus appears that covariate risk is substantial in Tanzania, and could account for significant vulnerability.

From the time series data we calculated coefficients and coefficients of variation for the prices of commodities, as well as cross correlation coefficients. Similarly for the production of the various products. These coefficients were utilized in conjunction with the shares of production in total crop income of the different crops for each household, obtained from the survey, to compute the mean and variance of crop income for each household. It is clear that the production and crop profile of each household will depend on the year of the survey, and may not give a good description of the longer term structure of production of the household. In other words the shares in formula (4.21) may be biased. There is not much one can do about this except average over several years, and since a two year panel was available in our survey we took the average shares over the two years.

4.4 Empirical results.

Table 4.2 indicates for each income decile, the average gross total income per adult equivalent (ae), the average crop income per ae, and the average CV of crop income. The first notable observation is that the share of crop income in total income declines considerably as total income increases. Despite the fact that there is a very large disparity between the average gross incomes of the top and the bottom deciles (about 49 to 1 in Kilimanjaro and 26 to 1 in Ruvuma), the disparity in crop incomes per ae are smaller (about 25 to 1 in Kilimanjaro and about 10 to 1 in Ruvuma). More importantly the CVs of crop incomes seem to be quite similar across deciles, despite differences in crop patterns. The CV of crop income is quite large at 44.6 percent on average for households in Kilimanjaro, and 35 percent on average for households in Ruvuma. The lower value of the average CV of crop income in Ruvuma is justified by the more stable rainfall and hence yield patterns there. For instance the CV of the regional yield of maize, the main food staple in both regions, is 44 percent in Kilimanjaro and only 14 percent in Ruvuma, as indicated in Table 4.1b.

Table 4.3 exhibits the results of the (instrumental variable) regressions on consumption and the squared residuals of consumption as per equations (4.15) and (4.17). The key variable for the vulnerability analysis is the coefficient in the consumption regressions of crop income per acre. Concerning the consumption per equivalent adult, it can be seen that it depends positively and significantly on aggregate crop productivity, the size of land, the size of household, several wealth variables such as the lagged value of the number of animals owned and the lagged value of consumer durables, the age of the household head (significant in Ruvuma), access to credit variables, and some education variables.

The Durbin-Wu-Hausman test of the exogeneity of the crop productivity strongly rejects the hypothesis of exogeneity, so IV is appropriate. Table 4.4 presents the first stage regressions for the IV estimates. We use as instruments a variety of exogenous land characteristics, as well as weather shock variables, and lagged dummies for whether the farm household used fertilizer and chemicals, as well as the lagged number of coffee and cashew trees. The Sargan test does not invalidate the use of these instruments.

It must be mentioned that in the consumption regressions the IV regression coefficient of crop income per acre is significantly larger in the IV regressions compared to the OLS estimates (the OLS estimates for these coefficients are 0.028 for Kilimanjaro and 0.174 for Ruvuma, compared to 0.144 and 0.411 for the IV regressions in table 4.3 for the two regions).

The consumption regressions explain about 47 and 51 percent of the variance of consumption in Kilimanjaro and Ruvuma respectively. The regressions of the squared residuals from the consumption regressions on the same explanatory variables as the ones in the consumption regressions (excluding the variables that are related to covariate and idiosyncratic shocks) reveal that fewer of the variables are significant. In Kilimanjaro the dependency ratio, the value of the dwelling, the number of small animals, and the membership in a social group are significant, while in Ruvuma, the only two significant variables are the dummies for whether the household receives remittances and whether the household has easy access to seasonal credit. The regressions explain a rather small proportion of the error less than 10 percent in both regions). This suggests that unexplained components of consumption variability dominate any parts that maybe due to structural household specific factors.

Tables 4.5 and 4.6 indicate the average vulnerability index in Kilimanjaro and Ruvuma by district, along with the proportions of the variance of consumption that are due to covariate factors, the average consumption per capita and the average headcount measures of poverty rates in both years of the survey. The first observation is that average vulnerability in Kilimanjaro is much lower than in Ruvuma (31 percent versus 60 percent). This is in line with the much larger poverty incidence in Ruvuma compared to Kilimanjaro that was indicated earlier (63.3 percent versus 39.5 percent).

As Chaudhuri *et al.* (2002) have indicated, in a normal year one would expect that the average vulnerability in a region, based on a concept as the one used here, should be similar to the headcount ratio of poverty. From the tables it can be seen that the poverty incidence in 2003 and 2004 in Ruvuma is quite similar to the average vulnerability, while in Kilimanjaro the average poverty incidence in both periods is about 25 percent larger than the average vulnerability level.

The reason for this maybe the fact that in Ruvuma in both years of the surveys the rainfall patterns appeared normal, while for Kilimanjaro both years of the survey seem to have been years of low rainfall. In Ruvuma while less than 4 percent of households in both years of the surveys declared that the rainfall was much below normal, in Kilimanjaro the same percentage was 21 percent in the first survey and 35 percent in the second survey. The consequence of this could be that the observed production of several key crops (e.g. maize) for several households could be lower than normal, with the implication that the shares for some major products utilized for the calculation of the variance of income, as well as the variance itself (and hence vulnerability), could be smaller than what would be calculated if the production had been normal.

Concerning regional variations, it can be seen that these are much more marked in Kilimanjaro, compared to Ruvuma, despite the fact that Ruvuma exhibits much higher overall vulnerability indicators. The ratio of the average vulnerability index between the most vulnerable district in Kilimanjaro (Same) and the least vulnerable (Hai) is more than 2.5, while the same ratio in Ruvuma, between Tunduru (most vulnerable) and Mbinga (least vulnerable) is around 1.4. The reason for this could also be the much more erratic and unstable pattern of rainfall in Kilimanjaro, compared to Ruvuma.

Another striking difference between Kilimanjaro and Ruvuma is that in Kilimanjaro the share of the covariate factors in the overall variance of consumption (which, of course induces the vulnerability) is much lower at 11 percent than the share in Ruvuma, which is 30 percent on average. This, despite the fact that Kilimanjaro exhibits much more unstable rainfall patterns than Ruvuma. A factor in this difference is the share of crop income in total income, which is around 58 percent in Kilimanjaro versus 71 percent in Ruvuma. However, such a large difference in the share of covariate factors cannot be accounted simply by the different shares of crop income in total income, The second major factor is the risk coping and consumption smoothing strategies of households in the two regions. Notice from table 4.3 that the coefficient of crop productivity in the consumption regression is three times larger in Ruvuma, compared to Kilimanjaro. This implies that a given negative crop income shock results in much smaller consumption reduction in Kilimanjaro than in Ruvuma. Hence covariate crop income related shocks affect the variance of consumption to a much less extent in Kilimanjaro.

Tables 4.7 and 4.8 present the same results as Tables 4.5 and 4.6, organized by economic status, rather than region. In both regions the average vulnerability of the poor is much larger than that of the non-poor, as expected, and the average vulnerability of both poor and non-poor is much larger in Ruvuma compared to vulnerability of the same groups in Kilimanjaro. In Kilimanjaro net food buyers appear to be more considerably more vulnerable than net food sellers, but in Ruvuma this is not the case. The reason seems to be that in Kilimanjaro the average per capita expenditure is lower and the poverty incidence is higher among net food buyers, while the opposite seems to be the case in Ruvuma. Distinguishing producers according to different types of cash crop production, results in no observable difference in Kilimanjaro. However, in Ruvuma, it is clear that cashew nut producers are much more vulnerable than coffee and tobacco producers. This is because cashew nut producers are much poorer than coffee and non cash crop producers in Ruvuma.

It is notable that the share of total consumption variance that is due to covariate factors does not differ much by functional group in Kilimanjaro but differs considerably more in Ruvuma. For instance it appears that coffee producers in Ruvuma are much more subject to covariate risks compared to all other types of producers in that region. The reason has to do with the share of cash and total income from crops, which is much higher among coffee producers in Ruvuma (87 percent) compared to that of coffee producers in Kilimanjaro (66 percent).

The final set of results concerns the number of households that are likely to become poor, given their current poverty status. In other words we examine the issue of how many of the current non-poor or poor are likely to become or stay poor in the next period. Of course, to answer this question, one must define a threshold probability level which defines the likelihood that a household's consumption will fall below the poverty level.

Table 4.9 indicates that with a vulnerability threshold of 0.4, out of all the rural households that are initially non-poor (and these constitute 115.9 thousand households, namely the sum of the numbers 100.8 and 15.1 thousand indicated in the first row of table 4.9, or 60.5 percent of all rural households in Kilimanjaro), about 13 percent, are likely to become poor (namely have a probability larger than 40 percent of becoming poor) in the next period. For the poor households (which in Kilimanjaro constitute 39.5 percent of all households initially), more than half (60.3 percent) are likely to remain poor in the next period (namely have a 40 percent or higher chance of being poor), while the remaining 40 percent are likely to be non-poor in the next period. Hence in Kilimanjaro, 31.7 of the households have a chance of 40 percent or larger of being poor in the next period.

In Ruvuma the table indicates a much bleaker picture. While 63.3 percent are classified as poor, 66.6 percent of the households have a probability larger than 0.4 of being poor in the next period, namely a higher share of those in current poverty. The share is much higher among the already poor, but even among the currently non-poor (who are 46.7 percent of the households) a full 38.5 percent is likely to be poor in the next period. Clearly rural households in Ruvuma are quite vulnerable to poverty. If we define as "hard core poor" those that are currently poor and are expected to be poor in the next period, then it can be seen that these constitute 23.8 percent of the households in Kilimanjaro (more than half of the poor), while in Ruvuma they constitute about 52.5 percent of the households or 82.9 percent of the poor. Clearly poverty is much more persistent and entrenched in Ruvuma.

If we repeat the analysis of Table 4.9 with vulnerability thresholds of 0.5 and 0.6 then we find, as expected, that all the numbers in the second columns under each region in table 4.9 go down but not by too much. For instance, with a threshold of 0.5, the number of the "hard core poor" in Kilimanjaro go down to 21 percent (from 23.8 percent under a threshold of 0.4) and in Ruvuma to 49.8 percent (from 52.5 percent). With a threshold of 0.6 the number of hard core poor go down to 19 percent in Kilimanjaro and 47 percent in Ruvuma. Hence irrespective of the threshold level hard core vulnerability and poverty is significant overall and much more so in the poorer region of Ruvuma.

4.5 Conclusions and policy implications

We applied a methodology that integrates a major source of covariate shocks, with established techniques for estimating idiosyncratic shocks to estimate vulnerability of rural households in two regions of Tanzania. Both of these regions are subject to significant covariate risks, and rural households are exposed to them. The major covariate risk relates to weather induced production variations as well as price variations that give rise to agricultural income variations. Such risks make households vulnerable, and force households to adopt ex-ante risk exposure strategies (such as income and crop diversification) and consumption smoothing strategies. It is interesting to inquire whether in spite of these strategies households are still vulnerable to both covariate as well as idiosyncratic risks.

The results of this paper revealed that vulnerability is quite high in the rural regions of Tanzania, and considerably higher in the region which is regarded as generally poorer, namely Ruvuma. Of considerable interest is the finding that the proportion of the consumption variability that is due to covariate shocks is much smaller in the Kilimanjaro region, compared to the poorer Ruvuma region, where it comprises the bulk of consumption variability. Vulnerability appears to differ considerably among different regions in Kilimanjaro as well as in Ruvuma, but the differences are much higher in Kilimanjaro, despite the fact that this is a generally better off region. Vulnerability also is much more a function of overall income status in Kilimanjaro, with the richer rural households exhibiting much lower vulnerability than the poor ones, something that does not occur in Ruvuma, where all income deciles exhibit considerable degrees of vulnerability. Among different types of rural households those that are cashew nut producers appear to be much more vulnerable, compared to coffee and tobacco producing households. Finally it was shown that the likely persistence of poverty from period to period is much lower in Kilimanjaro compared to Ruvuma. The levels of hard core poverty, defined as those among the poor who are likely to stay poor are considerable in both regions, and more than half of all poor households in both regions are likely to remain poor in a subsequent period. Finally it was revealed that the levels of vulnerability are high even among the non-poor especially in the poorer overall region, Ruvuma.

The policy implications of the chapter is that policies to deal with vulnerabilities, such as appropriate safety nets, while more appropriate in the poorer regions, are needed n all regions. It also appears that there is a degree of hard core poverty that may need special attention with policies to tackle the long term causes of that poverty. Given that vulnerability is more district specific in Kilimanjaro than in Ruvuma, it also appears to be the case that targeted social safety nets are a more appropriate policy in Kilimanjaro, while in Ruvuma it would be best to implement non-targeted overall safety net policies.

Table 4.1a: Descriptive statistics of the time series data of prices and production

	Kilimanjaro			Ruvuma		
	Av. Price	StDev	CV*	Av. Price	StDev	CV*
	Tsh/kg			Tsh/kg		
Maize	186.6	101.1	0.54	140.7	72.4	0.51
Beans	577.2	201.7	0.35	581	175.1	0.30
Coffee	1364.1	432.4	0.32	1364.1	432.4	0.32
Bananas	81.6	67.8	0.83	82.8	50.7	0.61
Millet	689	300.2	0.44	380.5	238.1	0.63
Rice	663.7	344.6	0.52	643.1	214.9	0.33
Cassava	280.5	118.5	0.42	262.2	139.9	0.53
Sweet potatoes	284.1	123.2	0.43	294.8	223.3	0.76
Irish potatoes	390.5	101.8	0.26	379.8	100.9	0.27
Groundnuts	1031.4	395.6	0.38	825.4	307.8	0.37
Onions	670.6	342.6	0.51	878.1	425.3	0.48
Tomatoes	516.9	215.4	0.42	477.2	183.9	0.39
Cowpeas	692.5	254.5	0.37	518	231.8	0.45
Cabbages	373.4	184.2	0.49	529.4	418.9	0.79
Oranges	55	29.8	0.54	102.9	83.2	0.81

* CV=coefficient of variation

Prices are deflated using the monthly Tanzanian CPI from the IMF statistics database (edition May 2004). Prices are monthly starting from January 1983 to October 2002 and deflated using the monthly Tanzanian CPI from the IMF statistics database (edition May 2004). Production data are yearly (from 1961 to 2004).

Source: Computed by authors.

Table 4.1b: Descriptive statistics of the time series data of regional yields

	Kilimanjaro			Ruvuma		
	Av. yield	StDev	CV	Av. yield	StDev	CV
	Kg/ha			Kg/ha		
Maize	1230.5	538.7	0.44	1732.2	248.3	0.14
Sorghum	829.6	207.9	0.25	1311.5	370.9	0.28
Millet	1498.3	1200.6	0.80	1126.1	167.1	0.15
Rice	3086.8	868.6	0.28	1472.3	505.6	0.34
Sweet potatoes	2500	624.5	0.25	1632.1	550.5	0.34
Pulses	681.7	257.2	0.38	795.7	147.7	0.19
Banana	2614.8	447.7	0.17	2669.9	405	0.15
Cassava	2404	372	0.15	2449.2	315.8	0.13
Coffee*	8535	4692.7	0.55	7618.3	1847.3	0.24
Wheat	795.1	234.1	0.29			
Cashew*				6005.2	2117.3	0.35

Regional yields come from yearly data (from 1992 to 2001).
* For coffee and cashew nuts regional production (in tonnes) is reported and used for the estimations (there was no available data on area planted).

Source: Computed by authors.

Table 4.2: Coefficient of crop income variation by deciles of gross income per adult equivalent

	Kilimanjaro				Ruvuma			
	Mean gross income per ae[1)] (Tsh000)	Mean crop income per ae (Tsh000)	Share of crop in total gross income (%)	Coefficient of variation of crop income	Mean gross income per ae (Tsh000)	Mean crop income per ae (Tsh000)	Share of crop in total gross income (%)	Coefficient of variation of crop income
1	16.7	11.6	69.5	46.5	21.4	17.3	80.8	34.1
2	38.5	20.1	52.2	47.6	37.2	28.1	75.5	34.5
3	57.2	28.2	49.3	45.5	50.5	34.5	68.3	37.2
4	77.1	36.9	47.9	40.7	64.0	44.1	68.9	35.4
5	100.8	49.5	49.1	42.5	79.3	51.2	64.6	34.9
6	125.2	50.8	40.6	46.1	99.0	62.6	63.2	35.1
7	159.7	61.9	38.8	41.3	124.0	80.0	64.5	34.7
8	213.6	81.7	38.2	44.7	159.1	94.9	59.6	33.9
9	315.9	115.3	36.5	46.2	223.9	134.4	60.0	33.6
10	821.3	288.3	35.1	44.4	553.0	182.4	33.0	36.8
Total	193.9	74.9	38.6	44.6	144.7	74.4	51.4	35.0

1) adult equivalent

Source: Computed by authors.

Table 4.3: Determinants of the average consumption per adult equivalent and its variance

	Kilimanjaro		Ruvuma	
	(1)	(2)	(3)	(4)
	Log annual per adult equivalent consumption	Log consumption variance	Log annual per adult equivalent consumption	Log consumption variance
Log value crop inc. per acre	0.14443		0.41144	
	(2.21)**		(3.06)***	
Log acres of land cultivated lagged	0.13711	-0.25275	0.36323	-0.26494
	(3.92)***	(1.21)	(6.31)***	(1.31)
Dependency ratio	-0.08519	-0.70718	-0.07999	0.28385
	(1.35)	(1.74)*	(1.05)	(0.68)
Log age of head	-0.04894	0.18761	-0.14860	0.00345
	(0.82)	(0.49)	(2.47)**	(0.01)
Log adult equivalent hh size	-0.86148	-0.09611	-0.85613	0.09447
	(19.61)***	(0.34)	(17.49)***	(0.33)
Log years education of head	0.00196	-0.13200	0.06867	-0.08856
	(0.07)	(0.76)	(2.34)**	(0.53)
Female-headed household	-0.02663	0.14370	0.00022	0.40578
	(0.57)	(0.48)	(0.00)	(0.85)
Log value of dwelling	0.00969	0.18665	0.00727	-0.01985
	(0.77)	(2.40)**	(0.60)	(0.27)
Log value of cons durables lagged	0.11881	-0.05711	0.09874	-0.01592
	(7.32)***	(0.61)	(4.38)***	(0.18)
Log number of big animals lagged	0.07959	-0.17580	0.05390	0.02082
	(3.59)***	(1.27)	(1.41)	(0.10)
Log number of small animals lagged	0.02862	0.21793	0.00319	0.08215
	(2.33)**	(2.80)***	(0.19)	(1.02)
Receiving remittances dummy	0.00562	0.02860	0.16508	-0.46429
	(0.16)	(0.12)	(3.80)***	(1.84)*
Dummy: 1=belong to sacco	0.09136	-0.12462	0.12071	-0.16286
	(1.95)*	(0.40)	(2.30)**	(0.53)
Access to seasonal credit	0.12337	0.29923	0.00297	0.65226
	(2.92)***	(1.15)	(0.07)	(2.59)***
Dummy if any adult female completed primary educ	0.11978	-0.05131	0.04752	0.08461
	(3.22)***	(0.22)	(0.36)	(0.10)
Dummy: 1=death shock since 1998	0.01524		0.05713	
	(0.47)		(1.41)	
Dummy: 1=illness shock since 1998	-0.00173		0.08692	
	(0.05)		(2.19)**	
At least one member in social group	0.00764	-0.33677	-0.04218	0.08647
	(0.26)	(1.84)*	(1.22)	(0.43)
Dummy coffee production	-0.02160	0.21446	-0.13944	-0.29042
	(0.49)	(0.77)	(1.43)	(0.56)
Dummy cashew production			0.01911	0.27484
			(0.24)	(0.57)
Dummy tobacco production			-0.36206	0.06503
			(3.28)***	(0.09)
Constant	5.39559	-4.88696	4.24651	-2.68939
	(14.97)***	(2.78)***	(7.30)***	(1.62)
Observations	957	957	892	892
R-squared	0.47	0.08	0.51	0.07

Absolute value of t statistics in parentheses * significant at 5%; ** significant at 1%

Tests of endogeneity for log crop inc per acre

	Kilimanjaro	Ruvuma
Durbin-Wu-Hausman		
Chi-sq(1)	3.88652	3.91466
P-Value	0.04868	0.04787

Source: Computed by authors.

Table 4.4: First stage regressions for crop income per acre and cultivated land

	(1)	(2)
	Log value crop inc. per acre	Log value crop inc. per acre
Log acres of land cultivated lagged	-0.26591	-0.35678
	(3.37)***	(7.44)***
Dependency ratio	0.15848	0.21066
	(1.04)	(2.10)**
Log age of head	-0.02291	-0.12032
	(0.16)	(1.44)
Log adult equivalent hh size	0.09325	0.06214
	(0.87)	(0.88)
Log years education of head	0.06997	0.04250
	(1.03)	(1.02)
Female-headed household	-0.12916	0.07120
	(1.14)	(0.64)
Log value of dwelling	0.04644	0.01535
	(1.57)	(0.90)
Log value of cons durables lag	0.10459	0.11457
	(3.00)***	(5.43)***
Log nb big animals lag	-0.01171	0.11993
	(0.21)	(2.38)**
Log nb small animals lag	-0.02862	0.08132
	(0.95)	(4.33)***
Receiving remittances dummy	0.04604	-0.00604
	(0.53)	(0.10)
Dummy: 1=belong to sacco	0.07712	0.08730
	(0.67)	(1.19)
Access to seasonal credit	0.05176	0.04564
	(0.50)	(0.77)
Dummy if any adult female completed primary educ.	0.11867	-0.10640
	(1.34)	(0.56)
Dummy: 1=death shock since 1998	0.00011	-0.00905
	(0.00)	(0.15)
Dummy: 1=illness shock since 1998	0.06776	-0.07531
	(0.81)	(1.36)
At least one member in social group	0.00690	0.00703
	(0.10)	(0.14)
Proportion of irrigated land	0.05290	0.15840
	(0.47)	(1.13)
Dummy rain on parcel is below normal	-0.30395	-0.02149
	(3.90)***	(0.42)
Dummy rain on parcel is much below normal	-0.43679	-0.16799
	(4.39)***	(1.37)
Proportion of good or medium quality land	0.38902	0.25223
	(2.44)**	(3.06)***
Proportion of flat or gently sloped land	-0.04653	0.09556
	(0.49)	(1.76)*
Proportion of land with any improvements	0.15751	0.03526
	(1.80)*	(0.72)
Dummy for lagged chemical fertilizer	0.21457	0.06612
	(2.27)**	(1.23)
Dummy for lagged other chemicals	0.08355	0.08005
	(1.02)	(1.47)
Log no of coffee trees per acre lagged	0.02455	0.00410
	(0.86)	(0.14)
Dummy coffee production	0.00936	0.27139
	(0.06)	(1.50)
Dummy cashew production		-0.08226
		(0.62)
Dummy tobacco production		0.31106
		(2.12)**
Log no of cashew trees per acre lagged		0.07075
		(2.08)**
Constant	3.51831	3.46714
	(5.07)***	(8.44)***

Table 4.4 (continued) First stage regressions for crop income per acre

	(1)	(2)
	Log value crop inc. per acre	Log value crop inc. per acre
Observations	957	892
R-squared	0.28	0.40

Robust t statistics in parentheses * significant at 5%; ** significant at 1%
Source: Computed by authors.

Tests for the validity of instruments for log crop inc per acre			
Kilimanjaro		**Ruvuma**	
Tests of over-identifying restrictions		Tests of over-identifying restrictions	
Sargan Chi-sq(8)	11.755	Sargan Chi-sq(9)	9.036
P-Value	0.1625	P-Value	0.4339

Source: Computed by authors.

Table 4.5: Vulnerability by district in Kilimanjaro

District	Vulnerability index	Proportion of consumption variance due to covariate factors	Per capita total expenditure	Per capita total gross income	Poverty incidence in 2003 (headcount)	Poverty incidence in 2004 (headcount)
Rombo	0.45	0.12	190.3	127.3	0.56	0.59
Mwanga	0.40	0.07	217.3	156.0	0.43	0.45
Same	0.55	0.06	169.2	154.7	0.61	0.55
Moshi rural	0.22	0.13	249.3	176.5	0.32	0.36
Hai	0.16	0.12	259.4	177.7	0.24	0.23
Total	0.31	0.11	227.9	162.6	0.40	0.41

Source: Computed by authors

Table 4.6: Vulnerability by district in Ruvuma

District	Vulnerabilit y index	Proportion of consumption variance due to covariate factors	Per capita total expenditure	Per capita total gross income	Poverty incidence in 2003 (headcount)	Poverty incidence in 2004 (headcount)
Songea rural	0.55	0.32	183.5	152.8	0.58	0.58
Tunduru	0.77	0.18	128.2	88.2	0.77	0.77
Mbinga	0.51	0.36	193.1	127.3	0.56	0.56
Namtumbo	0.64	0.27	152.6	100.3	0.70	0.66
Total	0.60	0.30	170.0	118.4	0.63	0.63

Source: Computed by authors

Table 4.7: Vulnerability by economic status in Kilimanjaro

	Number of hhlds	Mean vulnerability	Proportion of consumption variance due to covariate factors	Per capita total expenditure	Per capita total gross income
ALL	191,585	0.31	0.11	227.9	162.6
Non-poor	115,903	0.15	0.12	298.5	212.4
Poor	75,682	0.55	0.11	119.9	86.4
Coffee producers	117,299	0.31	0.13	224.6	158.7
Non-coffee producers	74,287	0.29	0.09	233.2	168.7
Net Food Sellers	30,570	0.13	0.12	272.8	383.5
Net Food Buyers	161,015	0.34	0.11	219.4	120.6

Source: Computed by authors

Table 4.8: Vulnerability by economic status in Ruvuma

	Number of hhs	Mean vulnerability	Proportion of consumption variance due to covariate factors	Per capita total expenditure	Per capita total gross income
ALL	173,932	0.60	0.30	170.0	118.4
Non-poor	63,801	0.34	0.33	282.2	201.6
Poor	110,131	0.75	0.28	105.4	70.2
Coffee producers	57,213	0.50	0.37	199.1	130.1
Cashew nuts producers	44,057	0.74	0.18	132.0	92.2
Tobacco producers	7,091	0.69	0.14	137.9	127.4
Non cash crop producers	66,847	0.58	0.33	172.3	124.3
Net Food Sellers	59,047	0.57	0.30	148.9	119.9
Net Food Buyers	114,885	0.62	0.30	180.9	117.6

Source: Computed by authors

Table 4.9: Vulnerability to poverty of different types of households under a probability threshold of 0.4

	Kilimanjaro		Ruvuma	
	Vulnerability <0.4	Vulnerability >0.4	Vulnerability <0.4	Vulnerability >0.4
Initial household classification				
Non-poor	100,822	15,081	39,224	24,577
Percent of non-poor	87.0	13.0	61.5	38.5
Percent of total	52.6	7.9	22.6	14.1
Poor	30,021	45,661	18,834	91,297
Percent of poor	39.7	60.3	17.1	82.9
Percent of total	15.7	23.8	10.8	52.5
All households	130,843	60,743	58,058	115,874
% of total	68.3	31.7	33.4	66.6
Total number of households	**191,585**		**173,932**	

Source: Computed by authors.

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5. The Effects of Shocks on Welfare and Poverty

by Luc Christiaensen, Vivian Hoffmann and Alexander Sarris

5.1 Introduction

Commodity price declines, droughts and health shocks have been identified by agricultural households in Tanzania as their major risk factors both in terms of the frequency of their occurrence as well as the severity of their effects. While we also find that households actively mitigate the effect of these shocks *ex post* through self insurance and reliance on informal assistance, the net effects of these shocks for rural households' welfare and poverty in Tanzania remain unclear.

This chapter examines the immediate effects of commodity price declines, droughts and health shocks on household welfare in the context of rural Kilimanjaro and Ruvuma while accounting for households' coping capacity and differential effects across livelihoods. Three broad questions are addressed. First, the chapter explores the welfare effect of the health and drought shocks and reflects on the welfare effects of the more systemic commodity price shocks. Second, the chapter examines the effectiveness of different *ex post* coping and ex ante risk reducing strategies in mitigating the negative welfare effects associated with these risks. It will focus in particular on self and informal insurance schemes and irrigation respectively. Finally, the determinants of people's coping capacity are investigated.

The chapter proceeds by outlining the empirical methodology in Section 5.2. The empirical results regarding the effects of the different shocks on household welfare and poverty are presented in Section 5.3, including the correlates of households' coping capacity. Section 5.4 concludes.

5.2 Empirical methodology

Economic theory holds that, households prefer smooth to volatile consumption. Given access to well functioning credit or insurance markets, these preferences will generate stable consumption paths, even when shocks occur. If credit and insurance markets are imperfect, household consumption may be susceptible to shocks (Deaton, 1992; Besley, 1995). These theoretical insights provide a practical framework to empirically explore whether and to what extent shocks and households' coping capacity affect their consumption levels.

More formally, suppose households at time t maximize inter-temporal expected utility U_t. Let u (c_t) be instantaneous utility derived from consumption c_t (≥0) and u'(.)>0, u''(.)<0 such that:

$$U_t = E_t \sum_{\tau=t}^{T} (1+\delta)^{t-\tau} u(c_\tau) \tag{5.1}$$

with δ the rate of time preference and T the end of the life-cycle. Households face risky income yt and income can be used to obtain consumption at prices p_t. Define *r* as the rate of returns to savings between periods and A_{t+1} as the value of assets at the beginning of period *t+1*. Assets evolve from one period to the next according to:

$$A_{t+1} = (1+r)(A_t + y_t - p_t c_t) \tag{5.2}$$

Solving (5.1) and (5.2) using the envelope condition and assuming that households have full access to credit and/or (formal or informal) insurance yields:

$$\frac{u'(c_t)}{p_t} = \frac{(1+r)}{(1+\delta)} E_t\left[\frac{u'(c_{t+1})}{p_{t+1}}\right] \tag{5.3}$$

Discounted marginal utilities suitably corrected for relative price change will be equated. In the absence of uncertainty, with r equal to δ and prices constant over time, the optimal consumption path implies equal consumption over time. In the tradition of Hall (1978) and Morduch (1990) we assume constant relative risk aversion with instantaneous marginal utility defined at t as $c_t^{-\rho} e^{\theta_t}$ with ρ the coefficient of relative risk aversion and θt a general taste shifter to parametrize (5.3) and obtain an empirical specification. Taking logs, and introducing subscript i and j to denote households i in location j, (5.3) can be written as:

$$\ln \frac{c_{ijt+1}}{c_{ijt}} = \frac{1}{\rho}\left(\ln(1+r) - \ln(1+\delta) + \ln \frac{p_t}{p_{t+1}} + (\theta_{ijt+1} - \theta_{ijt}) \right) + e_{ijt+1} \tag{5.4}$$

with eijt+1 the expectation error which has mean zero and is orthogonal to all variables known at time t given rational expectations. According to equation (4) the path of consumption over time is only affected by taste shifters and price changes, as long as there are no binding liquidity constraints over time and provided the underlying factors determining wealth (or permanent income) are not changing. In other words, under the hypothesis of perfect consumption smoothing, the optimal consumption path is not affected by idiosyncratic and/or covariate (income) shocks S_{ijt+1} and introduction of these shocks overidentifies equation (5.4). This provides an empirical framework to explore the effects of shocks on welfare. We further allow differential ability across households to cope with shocks *ex post*, leading to the following linear empirical specification:

$$\ln \frac{c_{ijt+1}}{c_{jit}} = \alpha_0 + \alpha_1 Z_{ijt} + \alpha_2 S_{ijt+1} \otimes M_{ijt} + e_{ijt+1}` \tag{5.5}$$

with Z_{ijt} comprising price changes and taste shifters (such as changes in household composition) and Mijt a vector of variables such as initial wealth, social capital, access to credit, availability of safety net programmes, capturing the household's capacity to mitigate the effect of income shocks *ex post*. Differential ability to cope with shocks *ex post* is likely to condition the effect of income shocks on consumption.

Alternatively, assume X_{ijt} the comprehensive set of observable (and exogenous) household and location characteristics affecting preferences, permanent income and coping capacity (after shocks S_{ijt} have materialized)[1], such that $c_{ijt} = c(X_{ijt}, v_{ij}, \omega_j)$ with vij and ωj reflecting unobserved (time invariant) household and location heterogeneity respectively. Equation (5.5) can then also be written and estimated as:

[1] These include but are not limited to Z_{ijt} and $M_{ijt.}$

$$\ln c_{ijt+1} = \beta_0 + \beta_1 X_{ijt} + \beta_2 S_{ijt+1} \otimes X_{ijt} + v_{ij} + \omega_j + \varepsilon_{ijt+1} \tag{5.6}$$

When panel data are available, equation (5.5) could be estimated (either as a difference or a fixed effects model) and unobserved household (and location) heterogeneity would be explicitly controlled for. Yet in practice, panel data are often not available, and when available, they tend to focus on a limited set of livelihoods/populations and usually span relatively short time periods. This poses a particular challenge when studying the effect of slow onset, systemic shocks such as broad economic crises or a decline in commodity prices. The period covered by the panel may be too short to fully encompass the period of the shock (e.g. precipitous commodity price decline) and the shock may affect all households in the sample leaving the researcher in effect without a control group. Estimates of the welfare effect of an economy wide shock based on welfare before and after the shock will be biased, if there are secular trends.

Furthermore, the availability of repeated observations on a household's consumption and income does not eliminate the need for explicit information on shocks to estimate the welfare effects of shocks. While changes in consumption are sometimes regressed on changes in income (Harrower and Hoddinott, 2005), attenuation bias due to oft observed measurement error in the latter, would lead us to underestimate the effect of an income shock. At the same time, imputation errors in valuing consumption from own food production in constructing the consumption and income variables may lead to a spurious positive correlation between total household consumption and income, biasing the income coefficient upwards (Deaton, 1997). Direct information on shocks usually provides the necessary instruments to address this problem. It also enables inference on the effect of shocks on income and consumption.

In the absence of panel data, but given cross sectional data on household consumption (C_{ijt+1}), explicit information on shocks experienced during t+1 (S_{ijt+1}) and comprehensive recall data on households' assets and their coping capacity (X_{ijt}) the differential effect of different shocks across households could be explored through estimation of equation (5.6), in effect using a retrospective panel approach and assuming $E(X_{ijt}v_{ij}) = E(S_{ijt}+_1 v_{ij})=0$. In practice, an exhaustive description of the household characteristics (X_{ijt}) helps reduce the likelihood of potential bias due to unobserved household heterogeneity. Furthermore, potential endogeneity issues related to the shock variables can be avoided through the use of external shock information as opposed to self reported measures of shocks from the household questionnaire. The use of village fixed effects controls for bias due to correlation of X and S with unobserved village effects. Yet as this may cause an underestimate of the full effect of covariate shocks, it is useful to also explore models with an explicit comprehensive description of the location/village characteristics when available.

Given that slow onset commodity price shocks such as the systemic coffee and cashew price shocks only directly affect producers of these crops, the effect of these shocks could in principle be explored when the sample includes a sufficiently large control group of non-coffee or cashew crop growers with similar characteristics. The shock variable (Sijt) in this case becomes being a coffee (cashew) crop grower at t or not. Yet, caution is warranted in interpreting the empirical results. First, it is implicitly assumed that cash and non-cash crop growers are ceteris paribus equivalent (i.e. $E(S_{ijt}+_1 \cdot v_{ij})=0$) such that the effect of being a cash crop grower only captures the effect of the systemic price shock. Second, if the overall economic activity in the region declines as a result of the price decline, the approach is likely to underestimate the direct negative effect as non-coffee growers are likely to have suffered as well, albeit indirectly. Bearing these caveats in mind and using a comprehensive specification to minimize potential bias due to unobserved differences between cash crop and non-cash crop growers, the proposed approach also sheds light on the effect of the cash crop price decline in Kilimanjaro and Ruvuma.

5.3 Data considerations

We take (the logarithm of) total household expenditures per adult equivalent excluding expenditures on health, education and functions (baptism, funerals) from the first survey round as our measure of welfare.[1] To capture differences in household preferences, their permanent income potential and their coping capacity we include age of the household head (a life cycle proxy), the dependency ratio, gender of headship and the years of formal education achieved by the household head (allowing for differential effects across primary, secondary and post secondary education). As cultivation of certain cash crops may be traditionally dominated by certain ethnicities (see below), we also control for the ethnic origins of the household head. This also helps control for people’s social capital and thus their capacity to cope with shocks *ex post*. For example, the Chagga, which make up 74 percent of the total rural population in Kilimanjaro, are known to be highly mobile and well connected in Tanzania.

To proxy households’ productive capacity and thus also their permanent income potential, we include the size of their landholdings owned, the numbers of their large (cattle, oxen, horses) and small (goat, sheep, pigs) livestock owned, and the value of their agricultural equipment and vehicles (all normalized by the number of adult equivalents) as well as their squared terms to capture non-linearities in their effects on consumption. A self reported measure of ease in obtaining seasonal credit for inputs is included to proxy access to production (as opposed to consumption) credit.

The effect of the fall in coffee prices is explored through inclusion of the number of coffee trees owned by the household in 2000 when the coffee price decline set in. Where the data allow it, we correspondingly also lag our asset variables to 2000 to be consistent. We furthermore divide the coffee growers in our sample in five quintiles based on their number of coffee trees in 2000 to allow for differential effects among smaller and larger coffee farmers. The omitted category is the non-coffee growers, which makes up about one third of the total sample in Kilimanjaro. A similar approach is followed in Ruvuma, though we also include quintile categories for cashew growers based on their number of cashew trees and a category for tobacco growers.[2] As our data in Ruvuma allowed us only go to two years back these were based on tree ownership in early 2002.[3]

Tables 5.1, 5.2 and 5.3 review differences among coffee growers in the different quintiles and non-coffee growers in Kilimanjaro and Ruvuma along a series of (observed) characteristics.

[1] See Appendix 3 for a detailed description of the construction of the expenditure variable. Comparison of health expenditures among households with and without an illness shock shows that households who experienced a health shock have on average two to three times more health expenses. However, we don’t find that expenditures on functions are systematically larger among households who experienced a death over the past two years. Since we can’t distinguish between health expenditures for preventive reasons, which may be an expression of larger household welfare, and health expenditures for curative reasons or between expenditures on functions for funerals and baptisms, we opt to exclude all expenditures on health and functions to avoid a downward bias in the estimated coefficient of the welfare effects of health shocks.

[2] Given that only 4 percent of the households in our Ruvuma sample were tobacco growers, we did not disaggregate the group of tobacco growers further.

[3] The first survey rounds for Kilimanjaro and Ruvuma were conducted in the fall of 2003 and the spring of 2004 respectively.

Consistent with the agro-ecological requirements of coffee production coffee growing households in Kilimanjaro live at higher altitudes. They are also more likely to be Chagga than Pare in Kilimanjaro and almost exclusively Matengo in Ruvuma, confirming the importance of controlling for ethnicity when exploring the effect of coffee price shocks through a retrospective panel approach. Cashew production is largely confined to the Yao. There is a large difference in the amount of coffee trees owned across the different quintiles with the amount of trees estimated at about 40 in the lowest quintile and more than doubling from quintile to quintile to about 1,325 trees in the highest quintile in Kilimanjaro. In Ruvuma, coffee growing households have on average three times as many trees than in Kilimanjaro with those in the highest quintile owning on average 5 times as many trees as those in the lowest quintile.

Coffee growers in the lowest quintile in Kilimanjaro tend to own less land, livestock and consumer durables compared with non-coffee growers while coffee growers in the largest quintile tend to have more land, have more valuable housing and receive more remittances compared with non-coffee growers. Further exploration does not show much difference across coffee and non-coffee growers in the likelihood of using one's savings or receiving aid from others when experiencing a shock (see Table 3.11). Coffee growers in higher quintiles in Ruvuma tend to own more livestock and have more valuable compounds. The larger cashew growers tend to have much more land, though they do not appear richer along other dimensions compared with other households in Ruvuma. They are however more likely to use savings when faced with shocks.

Households' coping capacity is approximated both directly through the inclusion of a dummy that is equal to one when the household reported coping through saving or receipt of aid in case of a health and drought shock, and indirectly through the value of household consumer durables (per adult equivalent) in the year preceding the survey. We also control for the proportion of time in non-farming activities and the amount of remittances (per adult equivalent) received as further indirect determinants of households' coping capacity. The amount of acres irrigated (per adult equivalent) indicates exposure to drought shocks. Similarly, the proportion of time spent on non-farming activities also indirectly captures exposure to drought shocks.

To mitigate potential endogeneity problems arising from the self reporting of drought shocks we use an index of a household's qualitative assessment of the rainfall amount across its plots as opposed to the self-reported occurrence of a drought shock from the directly administered shock module in the questionnaire.[1] According to the former measure, 21 percent of all households in Kilimanjaro experienced rainfall much below normal on their plots in 2003 and 42 percent rainfall below normal. Drought shocks are much less frequent in Ruvuma with four percent of all households experiencing rainfall much below normal in 2003 and 34 percent rainfall somewhat below normal. To better capture actual exposure to the rainfall shock, the rainfall shock indicator is multiplied by the household's cultivated land area per adult equivalent.

Our health shock variable includes both the occurrence of a death and/or an illness shock in the two years preceding the survey. While death shocks are arguably not infected by self-reporting bias, illness shocks may be. The literature on the accuracy of self-reported health

[1] In particular, households were asked for each plot whether the rainfall was much below normal, below normal, normal, above normal, much above normal. A plot size weighted average of these rainfall assessments was calculated and rounded off to the nearest digit to obtain a qualitative assessment for each household.

shocks (Foster, 1994; Groot, 2000; Gertler and Gruber, 2002; Baker, Stabile and Deri, 2004) suggests that the likelihood of reporting a health shock is associated with a household's reference group (the poor tending to report fewer health problems), the intensity of the problem (the more severe the illness, the more likely it is it will be reported), and the need for justification (for example to rationalize absenteeism from work). While the two latter motivations are less of a concern in the current context, the former might bias our results. Inclusion of the comprehensive vector of households' assets and consumer durables described above capturing household wealth will however substantially mitigate the potential bias from self-reporting illness shocks. We also provide robustness tests using non-self village means of self-reported illness incidence as an instrument. Being a coffee or cashew crop grower is treated as exogenous to the household's current living standards.

While we use village dummies in our base models to control for unobserved heterogeneity across locations, we also present a model unbundling the village effects. This will allow us to further explore whether our shock variables underestimate the welfare effects of shocks when they cannot fully capture the covariant nature albeit at the expense of potentially introducing endogeneity related to unobserved village effects. We measure in particular how connected a village is, proxy the quality of its infrastructure through the availability of electricity at the village level, and use the altitude at which the village is located to help define its agro-ecological characteristics and thus also its agricultural potential. To capture the connectivity of the village we use information on the presence of a tarmac road in the village, the availability of a public phone and a cell phone signal, the regular organization of a market, and the availability of a bus service to the village.

5.4 Determinants of welfare and welfare effects of shocks

Given the divergent nature of the economies in Kilimanjaro and Ruvuma, we ran separate consumption regressions for both regions. The results are in Tables 5.4 and 5.5. The baseline model in column (1) includes the shock variables and controls for location effects through village dummies. Models incorporating interaction terms of coping strategies (aid, use of own savings, and remittances) with the different shocks are in column (2). The differential effects of the different health shocks (death and illness of an adult member) are explored in column (3). A model explicitly identifying the location effects through inclusion of village proxies of connectivity, access to electricity and agro-ecological conditions is presented in column (4). The different specifications fit the data very well and explain almost half the variation in the observed (log) expenditures (R-squared between 0.45 and 0.50).

The coefficients on the household characteristics and assets are highly significant and largely consistent with predictions from theory. Households with higher dependency ratios tend to be poorer and households with better educated heads enjoy higher consumption. However, the latter effect only holds when the heads have secondary education in Kilimanjaro and only when heads have primary education in Ruvuma, possibly reflecting the fact that Kilimanjaro finds itself further on the path of structural transformation than Ruvuma. Surprisingly, household heads with post secondary education appear disadvantaged in Kilimanjaro though not in Ruvuma, which may reflect the current lack of remunerative employment opportunities for the well educated in Kilimanjaro. Once a household's possession of assets and education are controlled for, female headed households tend to be better off, though the results are only weakly significant.

Households with more asset variables (landholdings, livestock ownership, total value of productive assets) tend to be richer. These effects were found to be highly statistically significant and the marginal returns were often observed to be declining as asset possessions increase. Households with easy access to credit for modern inputs were on average estimated to be about ten percent richer in Kilimanjaro underscoring the importance of access to capital and the use of modern inputs. Surprisingly, the opposite appears to hold in Ruvuma, where those with easy access to seasonal credit appear worse off.

Consumption is also positively associated with possession of consumer durables albeit at a declining marginal rate. Access to irrigation substantially enriches households with consumption in Kilimanjaro estimated to increase on average by 19 percent per acre per adult equivalent irrigated. While irrigation also positively affect consumption in Ruvuma, it is not found to be statistically significant. This is likely related to the limited use of irrigation in Ruvuma, consistent with its more reliable rainfall pattern, and thus the limited variability in the sample. Only 2.1 percent of all households in Ruvuma irrigate (some of) their land, while 21 percent do so in Kilimanjaro. Income from remittances positively contributes to consumption both in Kilimanjaro and Ruvuma, though the effect is (again) somewhat less precisely estimated in the latter sample. Also, households with a larger proportion of productive time spent in non-agricultural activities tend to be richer.

Farmers in Kilimanjaro who have faced a drought shock over the past year (ie, those who reported receiving much below normal rainfall on their plots) experienced a reduction of consumption of 10 percent per acre cultivated per adult equivalent. While the corresponding reduction in gross total agricultural revenue was estimated to be much more severe at about 50 percent per acre (Sarris, Savastano and Christiaensen, 2006), households in Kilimanjaro clearly cannot fully protect their consumption from drought shocks.

The availability of (cash) savings may help offset the effect of the drought shocks, though its effect is imprecisely estimated (column 2). While access to irrigation is associated with larger overall consumption levels, it does not mitigate the effect of severe rainfall shocks. As most irrigation in Kilimanjaro is gravitation irrigation and when rainfall failure is relatively widespread as in 2003, this does not come as a surprise. More generally, rivers are reported to dry up which reduces their effectiveness in acting as an insurance device. The result should thus be seen in the particular context of Kilimanjaro and not as a statement on the ex ante risk mitigation capacity of irrigation more generally. Our results further suggest that the reception of aid may exacerbate the effect of a drought shock. While it is quite plausible that aid received is not sufficient to offset the negative effect of covariate shocks, the estimated negative relationship seems counterintuitive. It may reflect the fact that those getting aid from neighbours and relatives even in times of a covariate shock are actually the very poorest. About one fifth of all households in Kilimanjaro experienced a drought shock in 2003 with double this number reporting suffering from drought in 2004.

In contrast, households who experienced on average somewhat below normal rainfall on their plots did not see their consumption decline. The 35 percent estimated average reduction in households' gross total agricultural revenues associated with somewhat below normal rainfall on their plots (Sarris, Savastano and Christiaensen, 2006) does not translate into a reduction in households' consumption levels. Households in Kilimanjaro appear able to cope with milder rainfall shocks.

Household consumption in Ruvuma appears not to be negatively affected by drought shocks. The effect of the drought shock may however be imprecisely estimated due to the small number of households who experienced a drought shock in 2003 (less than 4 percent of the sample). Somewhat surprisingly those who experienced somewhat below rainfall were even found to be slightly better off, though this result was only statistically significant at the 10 percent level.

The results in column (1) of Tables 5.4 and 5.5 would suggest that household welfare is unaffected by death and/or illness shocks experienced over the past two years. Yet, when we also control for the household's coping behavior through the self reported use of savings and/or receipt of aid when faced with an illness or death of an adult member (column (2)), health shocks are found to have a strong negative effect on consumption. In particular, households in Kilimanjaro who were unable to cope with the shocks suffered a 16 percent loss in consumption. It furthermore appears that households who used savings (often cash) to cope with health shocks managed to almost completely offset the negative effects associated with the shock. Receipt of aid from others appeared less effective. Finally, and somewhat surprisingly, health shocks appear not to affect household welfare in Ruvuma, even after controlling for households' use of coping strategies.

Further decomposition of the health shock into illness and death shocks to explore whether illness and death have differential effects (results in column 3), suggest that households suffer especially from illness shocks, and less so from the death of an adult member. This is in line with the findings from Kagera, in northwest Tanzania by Beegle (2005) who reports that wage employment of adult men declines substantially in response to a future female or male adult death, but that past deaths are not associated with changes in either wage employment or non-farm self-employment. Similarly, she finds that coffee farming is reduced in households with a death within 6 months, but not for deaths after 6 months.

Welfare loss from health shocks comes about through 1) increased medical expenditures and 2) foregone opportunities through a loss in labour supply (and thus earnings) and/or a decrease in the return to labour (Gertler and Gruber, 2002). While we do not have directly comparable information on the opportunity cost related to changes in labour supply and returns to labour in both regions, the survey did record expenses related to illness and death shocks on two separate occasions in the questionnaire. First, it asked the expenses (medical and others) the household incurred in case of an illness or death shock of one of its members. Second, health expenditures (and expenditures on functions) during the last 30 days were recorded separately as part of the expenditure module. In both cases, expenditures in case of illness and death shocks are substantially larger in Kilimanjaro than in Ruvuma which might suggest larger immediate welfare losses in Kilimanjaro than in Ruvuma, in line with the results of the regression analysis (Table 5.6).

Moreover, regular (preventive) health expenditures (i.e. health expenditures when there is no illness shock) in Ruvuma (see second part Table 5.6) are only about half those in Kilimanjaro (when expressed in per adult equivalence)[1]. This is consistent with the much lower reported use of health providers in case of illness/injury.[2] While this might be because illnesses/injuries are generally less severe in Ruvuma, the larger average distance to a dispensary or health centre in rural Ruvuma (4.5 km) compared with rural Kilimanjaro (2 km) would suggest that lower accessibility of health care partly underpins this difference in

[1] Health expenditures during previous 30 days per adult equivalent are not reported in Table 5, but available from authors upon request.

[2] While about the same proportion of households reported an illness/injury over the past 4 weeks in Kilimanjaro and Ruvuma (23 and 24 percent respectively) during the 2000/01 HBS, 74 percent of all households (includes both rural and urban) in Kilimanjaro consulted a health provider, compared with 47 percent of all households in Ruvuma (National Bureau of Statistics, 2002, Table C16).

health spending.[1] In addition, lower overall welfare levels in Ruvuma might also have led to lower spending on health care. In other words, the absence of a significant result on the health shock in Ruvuma should not be taken to mean that there is no welfare loss associated with illness and/or dealth shocks in Ruvuma.

The estimated welfare loss from the regression analysis is also consistent with those emerging from the related directly reported expenditures. First, our regression results indicated that the welfare loss is much more pronounced when there is an illness shock. This is largely consistent with the results from the bi-variate analysis in Table 5.7 which shows that consumption among households who experienced a death shock is sometimes even larger than among those without a death shock. Second, we estimated an average welfare loss of 16 percent associated with a health and in particular an illness shock in Kilimanjaro or an average reduction of Tsh 38,800 per adult equivalent given the estimated average consumption per adult equivalent of Tsh 242,500 in Kilimanjaro 2003. The directly reported health expenditures during the first survey round in Kilimanjaro in case of an illness are around Tsh 31,000. This does not only provide confidence in the reported estimates, but also suggests that the welfare loss is largely due to medical expenses and less due to labour supply effects and income loss. The latter is also consistent with the low marginal productivity of labour (and labour surplus) reported by Sarris, Savastano and Christiaensen (2006) in Kilimanjaro. Labour seems even more abundant in Ruvuma, and when combined with the limited medical expenditures, the absence of a welfare loss in Ruvuma does no longer come as a surprise.

Finally, the overall absence of welfare loss in case of the death of an adult member, despite expenditures equivalent to those in case of an illness shock suggests that 1) households don't appear to suffer major labour supply or income losses as mentioned above and especially that 2) households manage to insure themselves from such shocks both through their savings and reliance on traditional/informal insurance schemes such as group based funeral insurance as illustrated in Dercon, *et al*. (2006).[2]

Kilimanjaro coffee growers in the lowest quintile category of tree ownership are on average ceteris paribus about 20 percent poorer than rural households not growing coffee, while those in the richest quintile tend to enjoy higher consumption levels. Households in the intermediate quintiles do not appear to differ from non-coffee growers in their consumption levels, though the signs of the coefficients are all negative. As in the case of health shocks, when we include interactions with the amount of remittances received (one of the coping strategies)[3], the negative effects are exacerbated, though still not statistically significant for the intermediate quintiles, and coffee growers in the richest quintile are no longer statistically significantly richer.

Given our comprehensive controls for differences in wealth among households at the time of the onset of the coffee price shocks, these result would suggest that while most coffee growers have managed to cope with the coffee price decline, or at least did not see their

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[1] National Bureau of Statistics, 2002, Table C17.

[2] The reported amount of contributions to (other) funerals, at an average of Tsh 10,400 per household per year, and ranging up to Tsh 500,000, also suggests substantial solidarity in bearing the funeral costs. Rutherford (2001) has documented the existence of insurance mechanisms for funerals across the developing world and highlights funeral insurance as one of the most popular products offered by more formalized micro-finance institutions.

[3] Unlike for the health and rainfall shocks, no data has been collected on the particular strategy coffee growers used to cope with the systemic coffee price shock (e.g. use of savings and/or aid).

consumption levels fall below those of the non-coffee growers, for example through the use of remittances and cash savings, the smallest among them experienced a substantial decline in their consumption. Given several years of high prices preceding the collapse in coffee prices starting in 2000, it is indeed plausible that coffee growers largely managed to smooth their consumption, albeit at the expense of their (cash) savings. In sum, while it cannot be excluded that coffee growers' welfare declined, most of them appear not worse off nowadays compared with non-coffee growers, apart from the smaller coffee growers who clearly suffered substantially.

Similarly, coffee growers in Ruvuma appear not worse off than non-cash crop growers and the larger ones actually enjoy substantially higher consumption levels despite the decline in coffee prices since 2000.[1] Again, given that we control extensively for asset holdings, though not for cash savings, this may reflect the availability of large amounts of cash savings held by the larger coffee growers following windfall earnings from coffee production during the late 1990s. This hypothesis is further supported by the fact that the likelihood of using (cash) savings in case of a drought or health shock is largely unassociated with a household's asset holdings as discussed in Section 3.3

While cashew growers also appear better off than non-cash crop growers, this picture reverses when we replace the village dummies (column 2) by village characteristics (column 4). This follows from the fact that cashew growers live concentrated in one district in Ruvuma and that virtually all households in our sample villages have at least some cashew trees. The overall lower consumption levels among cashew crop growers are thus captured through the village dummies. As there are no reasons to believe that the cashew crop growing villages systematically differ from the non cash crop growing villages beyond the village characteristics included in the analysis, the results in column four suggest that the smaller cashew growers are substantially worse off than the non cash crop growers. This is consistent with the observed collapse in cashew prices since the late 1990s and the fact that the smaller cashew growers are likely to hold less cash savings to help smooth their consumption compared with the larger cashew farmers.

Finally, the models with the village dummies unbundled are presented in columns 4 of Tables 5.4 and 5.5. Especially noteworthy is the fact that households in villages with a tarmac road are on average about 16 percent richer in Kilimanjaro and about 33 percent richer in Ruvuma. While these effects may partly reflect placement effects, the effects are sufficiently large to underscore the critical importance for overall household welfare of being connected through all weather roads. As indicated above, village dummies may also capture some of the covariant effect of shocks. This is borne out by the slight reinforcement of the shock effects observed in the Kilimanjaro estimations when replacing the village dummies with the village characteristics. Yet, for all practical purposes the observed changes are negligible.

5.5 Welfare effects of shocks and the effectiveness of coping strategies

To gauge the overall effects of the shocks and coping on average welfare in our sample, we perform a series of simulations. As the evidence does not reveal a negative effect of health or drought shocks on household welfare in Ruvuma, we focus on the estimated results for Kilimanjaro. In particular we estimate by how much average consumption in our sample would have improved in the absence of shocks (and thus also coping) compared with the

[1] Given the limited number of observations receiving remittances in each of the coffee and cashew quintile categories, we did not interact these with the receipt of remittances.

currently observed situation and by how much it would have deteriorated if there hadn't been any coping in the face of the observed shocks. To do so, we use the village fixed effect model including interaction terms with households' coping strategies (column 2, Table 5.4). Given that our model is loglinear, we can examine the effects of the different shocks and coping strategies on log consumption directly by adding or subtracting the relevant terms $\hat{\beta}_{21} S_{ijt+1}$ and $\hat{\beta}_{22} S_{ijt+1} X_{ijt}$. We focus on the use of savings and receipt of aid from others when faced with a shock as coping strategies. When coping more than offsets the effect of the shock itself, the positive compensating effect of coping is set equal to the negative effect of the shock. The results of these simulations are presented in Table 5.8.

The gross total loss among Kilimanjaro households in 2003 due to health and drought shocks is estimated at about Tsh 11,100 per adult equivalent or about 6 percent of annual consumption on average. Put differently, households who experienced either one or both shocks lost on average Tsh 33,369 per adult equivalent gross or about 18 percent of their annual consumption. This amounts to a total gross loss of about Tsh 8.43 billion or US$ 8.43 million in 2003 among rural households in Kilimanjaro alone.[1] Clearly the gross costs of shocks to the economy can be substantial.

As about 12 percent of all rural households in Kilimanjaro experienced an illness or death of an adult member in the two years preceding the survey and almost twice as many households experienced a drought shock in 2003 (Table 5.9), drought shocks contributed more to the aggregate loss (Tsh 7,000 per adult equivalent) than health shocks (Tsh 4,100 per adult equivalent), even though the individual welfare loss associated with a health shock was estimated to be slightly larger than the estimated gross loss from a drought shock.[2] Put differently, the total gross loss in personal consumption among rural households in Kilimanjaro attributed to drought is estimated at Tsh 5.32 billion , while the loss associated with illness and death of adult household members is estimated at Tsh 3.11 billion.

Yet, some households managed to (partly) smooth their consumption in the face of these shocks. Consequently, the actual reduction in consumption experienced by the population was smaller than it would have been in the absence of coping. The difference between the observed average consumption in our sample and the average consumption in the absence of any (or the use of other) coping strategies[3] provides an estimate of the effectiveness of households' coping strategies. On average about 53 percent of the loss due to health and rainfall shocks was compensated for either through use of one's own savings or reliance on aid from family and neighbours or traditional funeral insurance schemes. This could also be taken as an upper bound estimate of the potential crowding out effect of private insurance, were public insurance to be introduced either through public health or rainfall based insurance. Furthermore, households were better able to cope with health shocks than with rainfall shocks. This follows from the fact that in the former case, which is more idiosyncratic

[1] From Table 5.8, it can be seen that 63,134 households experienced either a health or a drought shock in 2003, corresponding to 252,536 adult equivalents at an estimated average of 4 adult equivalents per household. Given an average loss of Tsh 36,707 this results in a total estimated gross loss of Tsh 8 billion 427 million or about US$ 8.43 million at an exchange rate of about Tsh 1,000 per US$ in 2003.

[2] The gross negative effect of the health and drought shock are estimated at 16 and 11 percent respectively (see column 2,Table 5.4).

[3] In the simulations we focus on the use of savings and aid from others as coping strategies. When coping more than offset the effect of the shock, only the effect of the shock is subtracted from the actual consumption.

in nature, households could rely on both their own savings as well as aid from others, while in the latter case their coping strategies were confined to use of their own savings only.

Finally, assuming the decline in welfare among the small coffee growers could be completely ascribed to the coffee price decline, we estimated that the coffee price decline resulted in a net average loss of about Tsh 3,900 per adult equivalent. Given that larger farmers may have used their (unobserved cash) savings to cope with the coffee price decline, this is likely to be an underestimate.

5.6 Correlates of households' *ex post* coping capacity

Rural households in Kilimanjaro and Ruvuma largely rely on self insurance (i.e. use of their own savings) and informal mutual insurance (i.e. receipt of aid from neighbours and family) to cope with shocks. From Tables 5.4 and 5.5 we see that the use of savings is more efficient in helping farmers cope with rainfall shocks while both savings and aid are used to mitigate the effect of health shocks. To explore who is more likely to be able to cope with shocks either through savings or through aid, we run probit models of having received aid or having used savings in case of a shock on the nature of the shock (drought versus illness or death), the household's demographic characteristics (educational attainment, gender of head, ethnicity), its possession of assets (small and large livestock, land, number of cash crop trees), and a series of village characteristics. This information is critical in targeting social protection interventions. The estimated results for Kilimanjaro and Ruvuma are in Tables 5.10 and 5.11 respectively.

Consistent with the covariate nature of rainfall shocks, households are more likely to use their own savings to cope with droughts, though savings are also used to cope with illness and death shocks. External formal assistance (e.g. food aid or formal social protection interventions) has been rare in our study areas. When faced with a health shock (especially when it concerns the death of an adult member) which is idiosyncratic in nature, a household is more likely to receive aid. Aid appears not responsive to drought shocks.

There appears no clear pattern of association between the amount of assets possessed by the household and its use of coping strategies. The Ruvuma results suggest that the more coffee trees a household had two years ago, the higher the likelihood was that it coped either through use of savings and the reception of aid. This is consistent with our earlier finding that coffee growing households in Ruvuma are not worse off than non-cash crop growers despite the decline in coffee price during the early 2000s. We do not find a positive association between the number of coffee trees owned in 2000 and the use of self-insurance or mutual insurance in Kilimanjaro, suggesting that overall their coping capacity is by now no different from the non-coffee grower. Yet, when we include the quintile categories of coffee trees owned (as opposed to the number of coffee trees and its squared term) (results not presented), we find that those in the highest quintile are more likely to use savings (though not aid), consistent with the results in Table 5.4 indicating that this group is still better able to cope and that it might still be better off than the non-coffee growers. Cashew tree growers were not found to be different in their coping capacity than the other non-cash crop growers.

While educational attainments do not affect households' coping capacity in Kilimanjaro, in Ruvuma secondary education of the head is associated with a lower probability of receiving assistance, and primary schooling negatively correlated with the use of either coping strategy. Female headed households in Kilimanjaro appear much more likely to receive aid, and much less likely to use savings to cope with shocks. A similar pattern was observed in Ruvuma, though the coefficients were imprecisely estimated. In Kilimanjaro, the probability of receiving aid decreases with the age of the household head up to 36 years, and becomes positively associated with age at 72 years. In Ruvuma, we see a corresponding increase in likelihood of using savings up to the age of 43.

The availability of bus service in a village positively affect households' likelihood of using savings in Ruvuma, while electrification and cell phone reception in the village, both indicators of general wealth levels, are positively associated with the use of savings in Kilimanjaro.[1]

5.7 Concluding remarks

This chapter has explored the immediate effects of drought and health shocks on welfare and poverty in Kilimanjaro and Ruvuma and reflected on the effect of the coffee and cashew price decline since 2000. About one third of the rural population in Kilimanjaro suffered either from drought or health shocks in the survey year and those households suffered on average a direct 18 percent gross loss in their annual consumption in 2003 as a consequence. Yet, through reliance on savings and aid from others they were able to partly smooth their consumption and reduce the immediate negative welfare effect of these shocks to 8 percent loss on average.

No immediate (negative) welfare effects were found from the drought and health shocks in Ruvuma. The former result is related to the generally more secure rainfall patterns and the low incidence of drought shocks in Ruvuma in 2003. The lower medical expenditures in case of illness due to limited use of health care providers which is in turn associated with lower access to health facilities, underpins the estimated absence of an immediate welfare loss in Ruvuma. This does not necessarily imply that households in Ruvuma suffer less from illness shocks, but rather that they spend less to deal with them.

In addition, the potential income loss either due to reduced labour supply or reduced return to labour following illness or death, appears sufficiently small to not change this picture for Ruvuma. Also in Kilimanjaro, appears the estimated welfare loss largely associated with the medical expenses and not due to substantive income loss. This is consistent with the relative abundance of labour in both Kilimanjaro and even more so in Ruvuma. Sarris, Savastano, and Christiaensen (2006) estimate for example that the ratio of the marginal product of labour in agriculture to the agricultural wage is only 0.22 in Ruvuma (compared to 0.32 in Kilimanjaro). Finally, while the direct reported expenses related to death shocks are on par with those related to illness shocks, death shocks have much smaller immediate welfare effects, likely related to the existence of effective group based funeral insurance schemes (Dercon *et al*., 2006). How such schemes evolve as HIV/AIDs puts increasing pressure on these mechanisms must be closely followed.

Ceteris paribus, coffee growers in Kilimanjaro appear no worse off than non-coffee growers in Kilimanjaro, apart from the smallest ones, whose consumption level is on average 20 percent lower. Similarly, coffee growers in Ruvuma enjoy *ceteris paribus* similar consumption levels on average as non-cash crop growers, with indications that the larger ones are actually even better off. This suggests that coffee growers (apart from the smallest) have managed to weather the effects of the coffee price decline, at least to the point of not falling below the welfare levels of the non-cash crop growers and most likely at the expense of a depletion of their (cash) savings. Indeed, the decline in coffee prices since 2000 came on the heels of an income windfall from coffee during the late 1990s. In addition, many coffee

[1] None of the villages in Ruvuma has electricity, and only one village has cell phone reception.

growers in Kilimanjaro, who have access to the market in Dar-es-Salaam, have also been able to switch into bananas as an alternative cash crop. Consistent with this hypothesis is the finding that even in 2003 coffee growers in Ruvuma (as well as the richer coffee growers in Kilimanjaro) tend to be more inclined to use their own savings in case of health or drought shocks compared with non-cash crop growers. Cashew crop growers on the other hand, especially the smaller ones, appear worse off than non-cash crop growers in Ruvuma. Consumption levels among the two bottom quintiles of cashew trees are 15 to 20 percent lower than those among non-cash crop growers. Several years of low cashew prices are beginning to take their toll.

While there are little formal insurance or assistance schemes available to help households smooth their consumption, households rely heavily on self insurance through a depletion of their cash savings (and to a lesser extent their assets) as well as informal mutual insurance schemes including group based funeral societies. Aid from others is frequently received in case of death shocks, and to a lesser extent in case of illness, though not in case of a drought shock. Own savings on the other hand are the more important recourse in case of drought shocks, though they are also relied upon to deal with health shocks, especially illness shocks. Somewhat surprisingly, physical asset ownership and educational attainment appear to be poor predictors of the use of savings, pointing to the importance of cash savings in rural Tanzania. Coffee farmers in Ruvuma (as well as the richer coffee farmers in Kilimanjaro) are still more inclined to use their savings to cope with drought or health shocks. Female headed households tend to rely more on aid and less on their own savings. Households in Kilimanjaro in electrified villages and villages with cell phone signals, both signs of wealth, also tend to be more likely to receive aid and use their own savings to cope with shocks.

While these coping strategies help households smooth consumption, not all households have equal coping capacity and as documented in the 2002/03 Tanzanian Participatory Poverty Assessment these strategies may come at the expense of future earnings. Moreover, given that this study has abstracted from estimating the long run effects of shocks on welfare, the *ex ante* behavioral effects (Binswanger and Rosenzweig, 1993; Dercon, 1996) as well as their effects on human development outcomes (Ainsworth, Beegle and Koda, 2005), it must be underscored that the results presented here are only a lower bound on the actual welfare losses associated with health, drought and price shocks.

In looking for effective vulnerability reducing interventions, public policies aimed at improving health conditions and reducing the effect of droughts emerge as important, especially in Kilimanjaro. This includes the need for continued efforts to combat the HIV/AIDS epidemic, especially as this expanding epidemic may put the traditional funeral societies under increasing pressure to effectively deal with death shocks, as well as concerted efforts to prevent malaria infections. The ability to control water levels for example through irrigation emerges as an important general instrument to help enhance household consumption even though it has lost its effectiveness as an insurance instrument in Kilimanjaro which largely depends on gravitation irrigation. There are substantial uninsured welfare losses due to drought, suggesting a role for weather based insurance schemes, an innovative approach to protect consumption from drought shocks currently piloted in a series of developing countries (Ethiopia, Morocco, India). Farmers also expressed substantial demand for market based coffee price insurance schemes to help them insure against coffee price declines. Access to non-agricultural employment and enterprise further helps raising overall welfare levels and reduces exposure to drought shocks. Finally, the importance of connectivity in raising overall income levels and thus also households' ability to cope with shocks cannot be sufficiently underscored. Consumption levels were found to be ceteris paribus 15 to 30 percent higher in villages with a tarmac road compared with those without a tarmac road.

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Table 5.1: Comparison of socio-economic characteristics and past coping behaviour among quintile categories of coffee and non-coffee growers in Kilimanjaro

	No trees	Lowest quintile[1)]	2nd quintile	3rd quintile	4th quintile	Highest quintile	Total
Altitude (meters)	3578	4575**	4548**	4694**	4546**	4451**	4177
% Pare	36.2	9.4**	2.4**	8.7**	6.7**	3.4**	17.9
% Chagga	44.8	90.6**	9.7**	90.3**	92.4**	96.6**	74.3
Land (2000)	2.9	1.6**	2.2***	2.4	2.9	3.6***	2.7
Goats/sheep/pigs (2000)	2.8	1.1***	1.3	1.6	1.9	1.5	2.0
Cattle/horses/oxen (2000)	4.4	2.3	3.0	3.5	3.1	2.2	3.5
Value Consumer Durables Tsh 1000, (2002)	264	140**	248	233	234	315	246
Value of compound (2003)	2342	2194	4051***	3243**	4943***	7851***	3681
Remittance income (Tsh 1000) (2003)	24.4	25.4	38.9	42.4**	62.1**	44.1**	35.4
Coffee trees (2000)	0	39***	109***	235***	502***	1326***	269
Of those who faced a shock, % who received aid	47.2	44.4	43.6	63.1**	55.7	60.1	50.9
Of those who faced a shock, % who used own savings	67.4	78.3	69.1	81.4	68.0	67.4	78.3
Number of households	74,593	23,287	23,034	23,301	22,974	23,123	190,312

[1)] based on number of coffee trees owned in 2000
denotes significance at 1%, * at 5%, * at 10% when comparing characteristics to the non-coffee growers

Table 5.2: Comparison of socio-economic characteristics among quintile categories of coffee growers and non-coffee growers in Ruvuma

	No trees	Lowest quintile[1)]	2nd quintile	3rd quintile	4th quintile	Highest quintile	Total
Altitude (meters)	2658	4362***	4531***	4660***	4682***	4833***	3275
% Matengo	16.6	91.2***	96.5***	96.6***	100.0***	95.5***	41.6
% Ndendeule	8.8	1.8	1.9	0.0*	0.0*	2.1	6.4
% Ngoni	20.3	5.1*	0.0***	1.6**	0.0***	2.4**	14.5
% Yao	32.5	0.0***	0.0***	0.0***	0.0***	0.0***	22.3
% Nyasa	0.9	0.0	0.0	0.0	0.0	0.0	0.6
Land (2002)	9.76	9.76	9.29	8.94	8.63	9.26	9.57
Goats/sheep/pigs (2002)	2.87	4.14**	5.46***	5.24***	4.33**	4.30**	3.44
Cattle/horses/oxen (2003)	0.16	0.49***	1.04***	0.91***	0.75***	1.39***	0.40
Value Consumer Durables Tsh 1000, (2002)	139.4	109.9	137.4	141.5	125.7	192.4	139.9
Value of compound (2003)	433.3	399.4	931.1***	1196.8***	1168.3***	1024.6***	596.0
Remittance income Tsh (1000) (2003)	169.8	45.1	130.9	94.9	41.0	116.7	144.1
Coffee trees (2000)	0.0	432.5***	847.7***	1304.4***	1592.4***	2084.5***	393.9
Of those who faced a shock, % who received aid	45.2	43.3	41.7	59.1	56.1	58.5	47.0
Of those who faced a shock, % who used own savings	69.7	66.4	70.8	74.8	83.5	82.2	71.3
Number of households	119,022	11,089	10,899	11,159	11,024	10,728	173,921

[1)] based on number of coffee trees owned in 2002
denotes significance at 1%, * at 5%, * at 10% when comparing characteristics to the non-coffee growers

Table 5.3: Comparison of socio-economic characteristics among quintile categories of cashew growers and non-cashew growers in Ruvuma

	No trees	Lowest quintile[1)]	2nd quintile	3rd quintile	4th quintile	Highest quintile	Total
Altitude (meters)	3684	1997***	1864***	1991***	1994***	2054***	3275
% Matengo	53.9	13.3***	0.0***	0.0***	0.0***	0.0***	41.6
% Ndendeule	7.5	7.5	3.0	0.0*	1.6*	1.9	6.4
% Ngoni	16.9	5.8*	12.4***	10.1**	4.3***	1.7**	14.5
% Yao	9.6	36.5***	56.1***	62.6***	71.2***	86.3***	22.3
% Nyasa	0.5	0.0	1.8	0.0	1.7	1.6	0.6
Land (2002)	8.87	7.45*	7.48	9.83	13.74***	20.60***	9.57
Goats/sheep/pigs (2002)	3.81	2.31**	1.47***	2.17***	3.32**	2.11**	3.44
Cattle/horses/oxen (2003)	0.47	0.57***	0.00***	0.00***	0.18***	0.00***	0.40
Value Consumer Durables Tsh 1000, (2002)	147.8	139.7	72.4**	111.9	125.9	124.4	139.9
Value of compound (2003)	668.9	212.4	356.1***	317.9***	426.1***	539.9***	596.0
Remittance income (Tsh 1000) (2003)	158.6	142.0	27.2	57.6	46.5	83.3	144.1
Cashew trees (2000)	0.0	32.9***	92.4***	157.7***	336.1***	905.9***	72.9
Of those who faced a shock, % who received aid	45.4	50.6	54.3	38.7	60.6	56.9	47.0
Of those who faced a shock, % who used own savings	69.3	78.8	53.5***	87.9**	71.4	93.6**	71.3
Number of households	132,195	8,440	8,307	8,328	8,362	8,289	173,921

[1)] based on number of cashew trees owned in 2002
denotes significance at 1%, * at 5%, * at 10% when comparing characteristics to the non-coffee growers.

Table 5.4: Shocks, coping and consumption in Kilimanjaro

Log consumption per adult equivalent (ae) (exclusive of health and education expenditures, and expenditures on functions)	baseline	Shocks interacted with coping strategies	Health shocks unbundled	Village dummies unbundled
	(1)	(2)	(3)	(4)
Shocks, exposure and coping				
major illness or death of adult member	-0.020	-0.161		-0.205
	(0.47)	(1.82)***		(2.29)*
used savings to cope with major illness or death of adult member		0.148		0.202
		(1.55)		(2.19)*
received aid to cope with major illness or death of adult member		0.070		0.074
		(0.87)		(0.93)
death of adult member last 2 yrs			-0.150	
			(0.78)	
death of adult member last 2 yrs * received aid			0.025	
			(0.13)	
death of adult member last 2 yrs * used savings			0.271	
			(1.99)*	
major illness of adult member last 2 yrs			-0.170	
			(1.63)	
ill adult member last 2 yrs * received aid			0.068	
			(0.70)	
ill adult member last 2 yrs * used savings			0.101	
			(0.90)	
acres/adult equivalent * very low rainfall	-0.104	-0.112	-0.108	-0.116
	(2.82)**	(3.04)**	(2.94)**	(3.24)**
acres/adult equivalent * very low rainfall * got aid for drought		-0.243	-0.245	-0.253
		(2.02)*	(2.05)*	(2.07)*
acres/adult equivalent * very low rainfall * used savings for drought		0.131	0.131	0.137
		(1.21)	(1.20)	(1.25)
acres/adult equivalent * somewhat low rainfall	0.044	0.025	0.027	0.029
	(1.19)	(0.72)	(0.76)	(0.87)
acres/adult equivalent * somewhat low rainfall * got aid for drought		-0.214	-0.195	-0.136
		(1.35)	(1.18)	(0.87)
acres/adult equivalent * somewhat low rainfall * used savings for drought		0.166	0.165	0.158
		(2.93)**	(2.97)**	(2.70)**
lowest quintile coffee trees 2000	-0.205	-0.217	-0.210	-0.233
	(3.45)**	(3.59)**	(3.47)**	(3.85)**
lowest quintile coffee trees 2000 * remittance income Tsh 100,000/adult equivalent		-0.119	-0.124	-0.051
		(1.18)	(1.23)	(0.53)
second quintile coffee trees 2000	-0.065	-0.092	-0.093	-0.085
	(1.14)	(1.60)	(1.61)	(1.58)
second quintile coffee trees 2000 * remittance income Tsh 100,000/adult equivalent		0.150	0.148	0.163
		(1.08)	(1.07)	(1.22)
third quintile coffee trees 2000	-0.043	-0.065	-0.062	-0.071
	(0.72)	(1.03)	(1.00)	(1.27)
third quintile coffee trees 2000 * remittance income Tsh 100,000/adult equivalent		0.150	0.147	0.207
		(1.18)	(1.15)	(1.75)***
fourth quintile coffee trees 2000	-0.022	-0.051	-0.051	-0.044
	(0.38)	(0.86)	(0.86)	(0.85)
fourth quintile coffee trees 2000 * remittance income Tsh 100,000/adult equivalent		0.179	0.172	0.227
		(1.97)*	(1.89)***	(2.68)**
highest quintile coffee trees 2000	0.145	0.114	0.118	0.156
	(2.10)*	(1.56)	(1.63)	(2.48)*
highest quintile coffee trees 2000 * remittance income Tsh 100,000/adult equivalent		0.155	0.155	0.111
		(1.15)	(1.15)	(0.92)

Table 5.4 (continued): Shocks, coping and consumption in Kilimanjaro

Log consumption per adult equivalent (ae) (exclusive of health and education expenditures, and expenditures on functions)	baseline	Shocks interacted with coping strategies	Health shocks unbundled	Village dummies unbundled
	(1)	(2)	(3)	(4)
irrigated acres/adult equivalent * very low rainfall	0.039	0.060	0.053	0.099
	(0.42)	(0.66)	(0.58)	(1.10)
irrigated acres/adult equivalent * somewhat low rainfall	-0.265	-0.241	-0.245	-0.234
	(3.10)**	(2.92)**	(2.99)**	(2.90)**
irrigated acres cultivated 2003 per adult equivalent	0.188	0.188	0.188	0.195
	(2.89)**	(2.96)**	(3.07)**	(3.36)**
Remittance income, Tsh 100,000/adult equivalent	0.149	0.060	0.065	0.030
	(2.81)**	(0.68)	(0.74)	(0.37)
Demographic characteristics				
dependency ratio	-0.186	-0.181	-0.180	-0.178
	(3.00)**	(2.89)**	(2.88)**	(2.89)**
age of head	-0.028	-0.027	-0.027	-0.027
	(4.07)**	(4.00)**	(4.02)**	(4.14)**
age of head squared	0.000	0.000	0.000	0.000
	(3.83)**	(3.74)**	(3.77)**	(3.98)**
female-headed household	0.068	0.063	0.068	0.089
	(1.51)	(1.40)	(1.53)	(1.97)*
yrs primary education of head	0.006	0.005	0.006	0.008
	(0.89)	(0.74)	(0.83)	(1.21)
yrs secondary education of head	0.034	0.033	0.033	0.034
	(1.68)***	(1.65)***	(1.63)	(1.66)***
whether head has post-sec education	-0.206	-0.222	-0.219	-0.238
	(1.80)***	(1.95)***	(1.93)***	(2.09)*
head is Chagga	0.149	0.158	0.152	0.132
	(2.41)*	(2.52)*	(2.43)*	(2.40)*
head is Pare	0.125	0.125	0.112	0.036
	(1.82)***	(1.81)***	(1.64)	(0.59)
proportion of time in non-agricultural activities in 2002	0.185	0.203	0.205	0.212
	(2.80)**	(3.05)**	(3.09)**	(3.12)**
Productive assets and consumer durables				
land owned 3 years ago/adult equivalent	0.094	0.095	0.094	0.072
	(2.62)**	(2.64)**	(2.62)**	(2.21)*
land owned 3 years ago/adult equivalent sqr	-0.000	0.000	0.000	0.002
	(0.04)	(0.06)	(0.03)	(0.94)
value of productive assets in 2002, Tsh 100,000 per adult equivalent	0.043	0.042	0.042	0.040
	(3.17)**	(3.04)**	(3.03)**	(2.35)*
value of productive assets in 2002 squared, Tsh 100,000	-0.000	-0.000	-0.000	-0.000
	(3.37)**	(3.24)**	(3.23)**	(2.53)*
relatively easy to obtain seasonal credit for inputs	0.114	0.119	0.119	0.128
	(2.50)*	(2.54)*	(2.53)*	(2.71)**
head of cattle, oxen, horses 3 years ago/adult equivalent	0.088	0.091	0.091	0.105
	(4.54)**	(4.70)**	(4.79)**	(5.49)**
head of cattle, oxen, horses 3 years ago/adult equivalent sqr	-0.001	-0.001	-0.001	-0.001
	(2.58)*	(2.80)**	(2.85)**	(3.59)**
head of goat, sheep, pigs 3 years ago/adult equivalent	0.031	0.032	0.032	0.024
	(2.39)*	(2.48)*	(2.58)**	(1.93)***
head of goat, sheep, pigs 3 years ago/adult equivalent sqr	-0.001	-0.001	-0.001	-0.001
	(2.21)*	(2.34)*	(2.41)*	(1.97)*
value of consumer durables in 2002, Tsh 100,000 per adult equivalent	0.304	0.297	0.297	0.311
	(8.49)**	(8.53)**	(8.57)**	(9.35)**

Table 5.4 (continued): Shocks, coping and consumption in Kilimanjaro

Log consumption per adult equivalent (ae) (exclusive of health and education expenditures, and expenditures on functions)	baseline	Shocks interacted with coping strategies	Health shocks unbundled	Village dummies unbundled
	(1)	(2)	(3)	(4)
value of consumer durables in 2002 squared,Tsh 100,000	-0.027	-0.024	-0.024	-0.025
	(4.96)**	(4.72)**	(4.72)**	(5.01)**
Village connectivity, infrastructure and agro-ecological potential				
tarmac road reaches village				0.161
				(2.36)*
village has public phone				0.036
				(0.97)
village has cell phone signal				0.024
				(0.35)
bus service to village				0.010
				(0.25)
village has a market				0.040
				(1.13)
village has electricity				0.102
				(2.14)*
village has health center, dispensary, or hospital				-0.084
				(0.89)
Altitude of village, 1000 m				0.200
				(0.09)
Constant	5.268	5.268	5.260	5.136
	(22.61)**	(22.45)**	(22.53)**	(24.12)**
Observations	914	914	914	914
R-squared	0.49	0.50	0.50	0.47

Models (1)-(3) include village dummies which are not presented to save space. Absolute value of t statistics in parentheses; *** significant at 10%; * significant at 5%; ** significant at 1%

Table 5.5: Shocks, coping and consumption in Ruvuma

Log consumption per adult equivalent (ae) (exclusive of health and education expenditures, and expenditures on functions)	baseline	Shocks interacted with coping strategies	Health shocks unbundled	Village dummies unbundled
	(1)	(2)	(3)	(4)
Shocks, exposure and coping				
major illness or death of adult member	-0.005	0.030		0.067
	(0.11)	(0.42)		(0.99)
used savings to cope with major illness or death of adult member		-0.083		-0.074
		(1.06)		(0.94)
received aid to cope with major illness or death of adult member		-0.004		-0.024
		(0.05)		(0.29)
death of adult member last 2 yrs			0.075	
			(0.93)	
death of adult member last 2 yrs * received aid			-0.414	
			(2.72)**	
death of adult member last 2 yrs * used savings			0.164	
			(1.15)	
major illness of adult member last 2 yrs			0.003	
			(0.04)	
ill adult member last 2 yrs * received aid			0.057	
			(0.62)	
ill adult member last 2 yrs * used savings			-0.021	
			(0.20)	
acres/adult equivalent * very low rainfall	-0.018	-0.020	-0.019	-0.017
	(0.34)	(0.36)	(0.36)	(0.28)
acres/adult equivalent * very low rainfall * got aid for drought		-0.078	-0.078	0.014
		(0.69)	(0.69)	(0.19)
acres/adult equivalent * somewhat low rainfall	0.031	0.030	0.030	0.036
	(1.83)***	(1.73)***	(1.74)***	(2.11)*
acres/adult equivalent * somewhat low rainfall * got aid for drought		-0.326	-0.325	-0.328
		(1.52)	(1.51)	(1.61)
acres/adult equivalent * somewhat low rainfall * used savings for drought		0.004	0.006	-0.010
		(0.09)	(0.11)	(0.17)
lowest quintile coffee trees 2002	0.134	0.138	0.131	0.071
	(1.49)	(1.54)	(1.46)	(0.83)
second quintile coffee trees 2002	0.156	0.156	0.158	0.066
	(1.81)***	(1.81)***	(1.86)***	(0.80)
third quintile coffee trees 2002	0.079	0.083	0.075	0.003
	(0.94)	(0.97)	(0.89)	(0.04)
fourth quintile coffee trees 2002	0.336	0.338	0.345	0.243
	(3.87)**	(3.86)**	(3.94)**	(2.85)**
highest quintile coffee trees 2002	0.290	0.289	0.291	0.199
	(3.21)**	(3.17)**	(3.22)**	(2.16)*
lowest quintile cashew trees 2002	0.066	0.068	0.065	-0.148
	(0.79)	(0.81)	(0.77)	(2.01)*
second quintile cashew trees 2002	0.103	0.107	0.110	-0.234
	(0.99)	(1.02)	(1.05)	(3.12)**
third quintile cashew trees 2002	0.312	0.312	0.304	-0.034
	(2.67)**	(2.67)**	(2.60)**	(0.39)
fourth quintile cashew trees 2002	0.312	0.326	0.316	-0.042
	(2.76)**	(2.87)**	(2.79)**	(0.52)
highest quintile cashew trees 2002	0.394	0.401	0.393	0.025
	(3.27)**	(3.32)**	(3.24)**	(0.29)
irrigated acres/adult equivalent * somewhat low rainfall	0.039	0.036	0.052	0.037
	(0.16)	(0.15)	(0.22)	(0.16)
irrigated acres cultivated 2003 per adult equivalent	0.142	0.141	0.137	0.147
	(1.03)	(1.03)	(1.00)	(1.15)
cultivated tobacco in 2004	-0.160	-0.156	-0.150	-0.091
	(1.46)	(1.42)	(1.37)	(0.84)
remittance income,Tsh 100,000/adult equivalent	0.184	0.183	0.186	0.184
	(1.45)	(1.44)	(1.49)	(1.35)

Table 5.5 (continued): Shocks, coping and consumption in Ruvuma

Log consumption per adult equivalent (ae) (exclusive of health and education expenditures, and expenditures on functions)	baseline	Shocks interacted with coping strategies	Health shocks unbundled	Village dummies unbundled
	(1)	(2)	(3)	(4)
Demographic characteristics				
dependency ratio	-0.196	-0.195	-0.189	-0.162
	(2.44)*	(2.41)*	(2.34)*	(1.94)***
age of head	-0.046	-0.046	-0.046	-0.043
	(5.66)**	(5.67)**	(5.64)**	(5.15)**
age of head squared	0.000	0.000	0.000	0.000
	(4.88)**	(4.89)**	(4.83)**	(4.45)**
female headed household	0.105	0.107	0.110	0.101
	(1.75)***	(1.77)***	(1.83)***	(1.64)
yrs primary completed by head	0.024	0.024	0.024	0.024
	(2.70)**	(2.68)**	(2.72)**	(2.61)**
yrs secondary completed by head	0.015	0.013	0.015	0.007
	(0.61)	(0.55)	(0.60)	(0.29)
head has post-sec education	0.209	0.207	0.182	0.261
	(1.17)	(1.17)	(1.06)	(1.56)
head is Matengo	-0.063	-0.061	-0.057	-0.004
	(0.71)	(0.68)	(0.64)	(0.06)
head is Ndendeule	-0.009	-0.011	-0.009	0.116
	(0.09)	(0.10)	(0.09)	(1.27)
head is ngoni	-0.132	-0.134	-0.137	-0.025
	(1.64)	(1.65)***	(1.70)***	(0.32)
head is yao	-0.062	-0.065	-0.065	-0.056
	(0.78)	(0.80)	(0.79)	(0.85)
head is nyasa	0.010	0.007	0.019	0.024
	(0.07)	(0.05)	(0.13)	(0.17)
proportion of time in non-agricultural activities in 2003	0.218	0.212	0.217	0.286
	(2.39)*	(2.33)*	(2.39)*	(3.05)**
Productive assets and consumer durables				
land owned 1 year ago/adult equivalent	0.035	0.035	0.035	0.042
	(3.24)**	(3.19)**	(3.27)**	(3.87)**
land owned 1 year ago/adult equivalent sqr	-0.001	-0.001	-0.001	-0.001
	(2.56)*	(2.52)*	(2.57)*	(2.85)**
value of productive assets in 2003,Tsh 100,000 per adult equivalent	0.047	0.046	0.046	0.039
	(1.76)***	(1.73)***	(1.76)***	(1.47)
value of productive assets in 2003 squared, Tsh 100,000	-0.001	-0.001	-0.001	-0.001
	(2.12)*	(2.10)*	(2.10)*	(1.72)***
relatively easy to obtain seasonal credit for inputs	-0.070	-0.068	-0.072	-0.072
	(1.76)***	(1.72)***	(1.79)***	(1.84)***
head of cattle, oxen, horses one year ago per adult equivalent	0.389	0.385	0.401	0.353
	(4.43)**	(4.36)**	(4.55)**	(3.98)**
head of cattle, oxen, horses, one year ago squared per adult equivalent	-0.146	-0.143	-0.150	-0.146
	(3.68)**	(3.54)**	(3.88)**	(3.98)**
head of goat, sheep, one year ago per adult equivalent	0.080	0.082	0.081	0.101
	(2.88)**	(2.91)**	(2.91)**	(3.58)**
head of goat, sheep, one year ago squared per adult equivalent	-0.007	-0.007	-0.007	-0.009
	(1.53)	(1.61)	(1.57)	(1.94)***
value of consumer durables in 2003, Tsh100,000 per adult equivalent	0.470	0.470	0.465	0.466
	(5.91)**	(5.92)**	(5.89)**	(5.66)**
value of consumer durables in 2003, Tsh100,000 per adult equivalent, sqr	-0.004	-0.004	-0.004	-0.004
	(4.76)**	(4.72)**	(4.65)**	(4.70)**

Table 5.5 (continued): Shocks, coping and consumption in Ruvuma

Log consumption per adult equivalent (ae) (exclusive of health and education expenditures, and expenditures on functions)	baseline	Shocks interacted with coping strategies	Health shocks unbundled	Village dummies unbundled
	(1)	(2)	(3)	(4)
Village connectivity, infrastructure and agro-ecological potential				
tarmac road reaches village				0.331
				(3.02)**
village has cell phone signal				-0.059
				(0.75)
village has a market				-0.073
				(1.95)***
bus service to village				0.035
				(0.72)
Health facility in village				0.046
				(1.28)
altitude				0.154
				(0.06)
Constant	5.235	5.491	5.477	5.446
	(21.79)**	(23.75)**	(23.61)**	(24.61)**
Observations	878	878	878	878
R-squared	0.47	0.47	0.47	0.42

Models (1)-(3) include village dummies which are not presented to save space. Absolute value of t statistics in parentheses; *** significant at 10%; * significant at 5%; ** significant at 1%; rainfall very low * acres cultivated/adult equivalent * used savings to cope with drought, rainfall very low * irrigated acres/adult equivalent, village electricity, village public phone, are all dropped due to collinearity

Table 5.6: Expenses incurred as result of an illness or death shock, 1999-2004

Average expenses (Tsh 000) incurred per household in case of an illness or death shock over the past 5 years	Illness of adult member (15-64 yrs old)	Death of adult member (15-64 yrs old)
Kilimanjaro		
- Round 1 [a]	137	143
- Round 2	102	108
Ruvuma		
- Round 1 [a]	38	94
- Round 2	49	51

Health expenditures (Tsh 000) per household during 30 days preceding survey	Illness shock		Death shock	
	No	Yes	No	Yes
Kilimanjaro				
- Round 1 [a]	33	68	34	55
- Round 2	35	117	42	40
Ruvuma				
- Round 1 [a]	21	40	23	28
- Round 2	19	55	23	12

Source: Authors' calculations

a) While the reported expenses in case of a shock in round 1 are averaged across the 5 years preceding the survey given a shock, those in round 2 only to the year preceding the survey.

Table 5.7: Household welfare with and without illness or death shocks

Expenditures per adult equivalent (ae)[1]	Illness or death	# obs	illness	# obs	death	# obs
Kilimanjaro						
Round 1						
no shock	192.5	832	193.7	881	190.7	893
shock	186.7	117	166.0	66	209.4	56
difference	*5.8*		*27.7*		*-18.7*	
Total	191.8	949	191.8	949	191.8	949
Round 2						
no shock	142.0	806	142.0	836	139.3	883
shock	118.2	109	108.2	79	141.0	32
difference	*23.7*		*33.8*		*-1.7*	
Total	139.4	915	139.4	915	139.4	915
Ruvuma						
Round 1						
no shock	158.4	789	160.1	824	157.5	855
shock	163.5	103	146.5	68	193.5	37
difference	*-5.1*		*13.6*		*-36.0*	
Total	159.0	892	159.0	892	159.0	892
Round 2						
no shock	156.1	723	156.2	751	156.0	810
shock	156.4	115	155.5	87	159.5	28
difference	*-0.3*		*0.7*		*-3.4*	
Total	156.1	838	156.1	838	156.1	838

1) Expenditures exclude expenditures on education, health and functions and have been deflated for comparison with HBS expenditures.

Table 5.8: Welfare and poverty effect of shocks and coping in Kilimanjaro[1)]

	Health & rainfall	Health only	Rainfall only	Coffee shock only
Consumption per adult equivalent (ae) (Tsh 000)[2)]				
no shock, no coping	197.0	192.9	195.8	195.7
shock and coping (=actual)	191.8	191.8	191.8	191.8
shock, no coping	185.9	189.0	188.6	191.8
Poverty incidence (%)				
no shock, no coping	14.4	14.8	14.5	14.3
shock and coping (=actual)	15.0	15.0	15.0	15.0
shock, no coping	16.7	16.0	15.8	15.0

1) The simulations were performed using the village fixed effect model including interaction terms with households' coping strategies (column 2, Table 3).
2) These consumption levels have been deflated for comparability with the 2000/01 HBS

Table 5.9: Incidence of rainfall and health shocks in Kilimanjaro and Ruvuma in 2002-2004

	Kilimanjaro		Ruvuma	
	Percent of households	Number of households	Percent of households	Number of households
Adult health shock last 2 years	12.2	23,336	11.9	20,706
Adult illness shock last 2 years	6.9	13,172	8.1	14,105
Adult death shock last 2 years	5.8	11,194	4.0	7,035
Very low rainfall this year	20.8	39,798	3.8	6,547
Somewhat low rainfall this year	41.9	80,234	33.8	58,822
Either very low rainfall or adult health shock	33.0	63,134	15.7	27.253

Table 5.10: Correlates of use of savings, aid and remittances in case of a shock in Kilimanjaro

	(1)	(2)	(3)
	received aid	used savings	received aid or used savings
Shocks			
shock was any death	1.896	0.559	1.891
	(8.89)**	(3.05)**	(6.01)**
shock was any illness	0.894	0.758	1.057
	(4.47)**	(3.77)**	(4.85)**
shock was drought	-0.053	0.852	0.741
	(0.29)	(4.98)**	(4.33)**
Productive assets			
head of cattle, oxen, horses one year ago per adult equivalent	0.365	-0.196	0.185
	(1.89)***	(1.35)	(0.99)
head of cattle, oxen, horses, one year ago squared per adult equivalent	-0.057	-0.000	-0.047
	(1.63)	(0.01)	(1.53)
head of goat, sheep, one year ago per adult equivalent	-0.134	0.022	-0.033
	(2.24)*	(0.41)	(0.55)
head of goat, sheep, one year ago squared per adult equivalent	0.005	0.001	0.002
	(2.27)*	(0.80)	(1.00)
land owned 3 years ago/adult equivalent	0.037	-0.119	0.024
	(0.26)	(0.91)	(0.17)
land owned 3 years ago/adult equivalent sqr	0.001	0.009	0.000
	(0.14)	(1.01)	(0.03)
coffee trees owned in 2000, hundreds per adult equivalent	0.013	0.115	0.054
	(0.16)	(1.05)	(0.52)
coffee trees owned in 2000 per adult equivalent squared, hundreds	-0.003	0.002	0.002
	(0.70)	(0.24)	(0.45)
Demographics			
dependency ratio	-0.205	-0.020	0.071

Table 5.10 (continued): Correlates of use of savings, aid and remittances in case of a shock in Kilimanjaro

	(1)	(2)	(3)
	received aid	**used savings**	**received aid or used savings**
	(0.68)	(0.07)	(0.21)
female-headed household	0.611	-0.432	0.120
	(3.00)**	(2.22)*	(0.54)
age of head	-0.072	0.028	-0.016
	(2.45)*	(1.19)	(0.63)
age of head squared	0.001	-0.000	0.000
	(2.89)**	(1.35)	(0.56)
yrs primary education of head	0.021	-0.006	-0.026
	(0.60)	(0.20)	(0.72)
yrs secondary education of head	0.058	0.021	0.022
	(0.56)	(0.23)	(0.22)
whether head has post-sec education	-0.424	0.170	-0.089
	(0.94)	(0.37)	(0.19)
head is Chagga	-0.505	-0.385	-0.279
	(1.90)***	(1.36)	(0.91)
head is Pare	-0.195	-0.355	-0.167
	(0.67)	(1.17)	(0.52)
Village connectivity, infrastructure and agro-ecological potential			
tarmac road reaches village	0.045	0.070	0.183
	(0.17)	(0.25)	(0.59)
village has public phone	-0.201	-0.248	-0.197
	(0.97)	(1.29)	(0.92)
village has cell phone signal	0.251	0.728	0.910
	(0.68)	(2.09)*	(2.67)**
village has a market	-0.113	-0.158	-0.150
	(0.60)	(0.87)	(0.73)
village has electricty	0.294	0.520	0.631
	(1.21)	(2.11)*	(2.30)*
bus service to village	0.076	0.192	0.046
	(0.38)	(1.02)	(0.22)
village has bank or other formal credit inst.	-0.336	-0.075	-0.181
	(1.52)	(0.31)	(0.70)
altitude	0.003	-0.002	-0.002
	(0.27)	(0.24)	(0.16)
Constant	0.500	-1.273	-0.318
	(0.49)	(1.44)	(0.34)
Observations	484	484	484
F stat	5.41	2.43	3.12
Prob > F	0.000	0.000	0.000
Pseudo R-squared [1)]	0.2873	. 1230	0.2249

Absolute value of t statistics in parentheses; *** significant at 10%; * significant at 5%; ** significant at 1%; results presented allow for different correlation structures within districts, except for pseudo R-squared statistics, which are taken from a model which does not.

Figure 5.1: Kernel distribution of consumption in Kilimanjaro

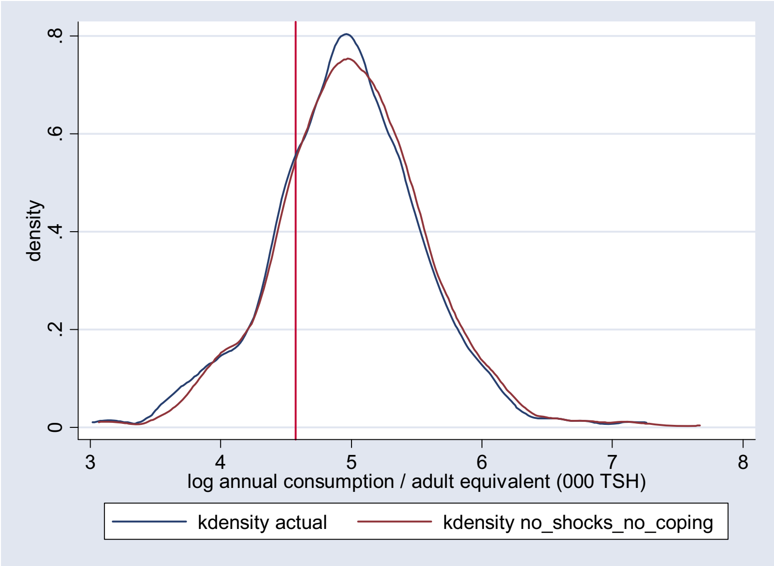

Figure 5.2: Kernel distribution of consumption in Ruvuma

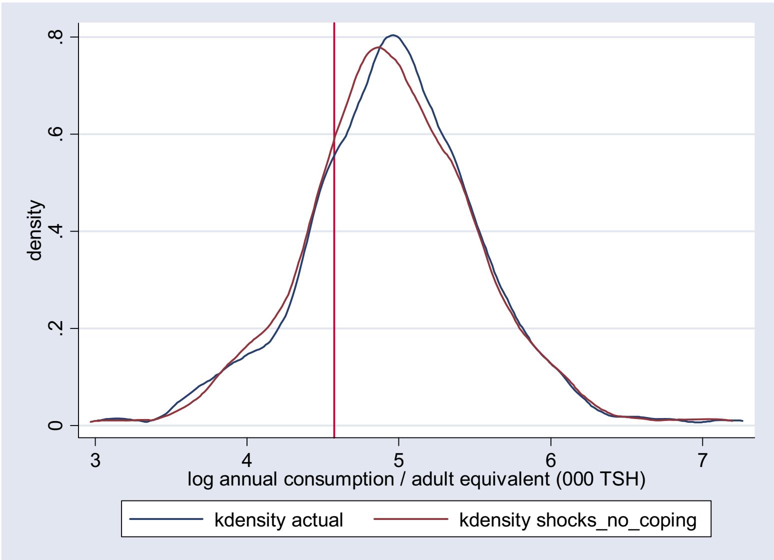

Table 5.11: Correlates of use of savings, aid and remittances in case of a shock in Ruvuma

	(1)	(2)	(3)
	receipt of aid	use of savings	receipt of aid or use of savings
Shocks			
shock was death	1.769	0.553	1.321
	(5.37)**	(1.88) ***	(3.30)**
shock was illness	0.129	0.773	1.424
	(0.50)	(2.58)*	(3.23)**
shock was drought	-0.377	0.902	0.657
	(0.88)	(1.82) ***	(1.31)
Productive assets			
head of cattle, oxen, horses one year ago per adult equivalent	-0.676	-0.560	-3.012
	(0.94)	(0.80)	(2.30)*
head of cattle, oxen, horses, one year ago squared per adult equivalent	0.485	0.036	1.333
	(1.67) ***	(0.13)	(1.77) ***
head of goat, sheep, one year ago per adult equivalent	0.374	-0.535	-0.322
	(1.53)	(2.16)*	(1.10)
head of goat, sheep, one year ago squared per adult equivalent	-0.095	0.075	0.014
	(1.78) ***	(1.48)	(0.26)
land owned 1 year ago/adult equivalent	0.041	0.141	0.196
	(0.36)	(1.27)	(1.44)
land owned 1 year ago/adult equivalent sqr	-0.000	-0.006	-0.008
	(0.04)	(0.82)	(0.99)
coffee trees owned in 2002, hundreds per adult equivalent	0.331	0.339	0.902
	(1.29)	(1.29)	(2.81)**
coffee trees owned in 2002 per adult equivalent squared, hundreds	-0.056	-0.034	-0.146
	(1.08)	(0.73)	(2.63)**
hundreds of cashew trees owned in 2002 per adult equivalent	0.169	-0.770	-1.007
	(0.55)	(0.78)	(0.93)
hundreds of cashew trees owned in 2002 per adult equivalent, squared	-0.027	0.663	0.573
	(0.72)	(1.31)	(1.20)
whether produced tobacco this year	0.577	-0.168	-0.272
	(0.77)	(0.24)	(0.35)
Demographics			
dependency ratio	-0.279	0.442	-0.217
	(0.59)	(0.87)	(0.39)
head is female	0.466	-0.578	0.050
	(1.13)	(1.37)	(0.11)
age of head	-0.038	0.086	0.108
	(0.68)	(1.71) ***	(1.82) ***
age of head squared	0.000	-0.001	-0.001
	(0.53)	(1.99)*	(2.13)*
yrs primary completed by head	0.038	-0.031	-0.145
	(0.72)	(0.54)	(2.10)*
yrs secondary completed by head[2)]	-0.411	0.113	0.235
	(2.30)*	(0.82)	(1.63)
head is Matengo	-0.178	0.144	-0.285
	(0.45)	(0.37)	(0.64)
head is Ndendeule	-0.772	-0.379	-0.311
	(1.47)	(0.76)	(0.60)
head is Ngoni	0.265	-0.110	-0.088
	(0.59)	(0.26)	(0.19)
head is Yao	0.429	0.297	0.648
	(1.16)	(0.76)	(1.38)
head is Nyasa	-0.394		
	(0.57)		

Table 5.11 (continued): Correlates of use of savings, aid and remittances in case of a shock in Ruvuma

	(1)	(2)	(3)
	receipt of aid	use of savings	receipt of aid or use of savings
Village connectivity, infrastructure and agro-ecological potential			
tarmac road reaches village	-0.134	0.647	0.286
	(0.17)	(0.87)	(0.39)
village has cell phone signal	-0.470		
	(0.89)		
village has a market	0.302	-0.107	-0.099
	(1.14)	(0.39)	(0.30)
bus service to village	-0.007	0.709	0.689
	(0.03)	(2.16)*	(1.96)***
village has bank or other formal credit inst.	-0.020	-0.187	-0.577
	(0.05)	(0.44)	(1.12)
Constant	-1.087	-1.366	-0.373
	(0.53)	(0.69)	(0.16)
Observations	202	195	195
F stat	1.63	1.43	1.53
Prob > F	0.0289	0.0865	0.0550
Pseudo R-squared	0.2025	0.1686	0.2847

Absolute value of t statistics in parentheses; *** significant at 10%; * significant at 5%; ** significant at 1%; rainfall very low * acres cultivated/adult equivalent * used savings to cope with drought, rainfall very low * irrigated acres/adult equivalent, village electricity, village public phone, are all dropped due to collinearity; results presented allow for different correlation structures within districts, except for pseudo R-squared statistics, which are taken from a model which does not.; post-secondary education of head predicts use of savings and no receipt of aid perfectly; differing number of observations between regressions is due to the fact that observations are dropped when a variable is perfectly collinear with the dependent variable.

6 The Stated Benefits from Commodity Price and Weather Insurance

by Alexander Sarris, Panayotis Karfakis and Luc Christiaensen

6.1 Introduction

As illustrated in Chapter 3, global agricultural commodity markets for tropical products such as coffee, cashew, and others, are characterized by considerable price instability. Under the current prevailing marketing system in Tanzania, much of this price instability is transmitted to the producers, many of whom are smallholders. This induces considerable income risk, as reported in Chapter 3. Price interventions to help farmers deal with price instability usually focus on direct intervention in the product markets with the purpose of altering the price distribution either through price support policies, often backed by buffer stock policies, or through international commodity agreements. While most of the international commodity agreements have failed (Gilbert, 1996), there are still many national policies that attempt to control domestic agricultural commodity markets.

Since the 1980s a growing process of globalisation has witnessed the proliferation of markets for many financial instruments to manage risks, such as futures, options, swaps, etc. This development has also generated new ways to help farmers hedge against unforeseen price declines, based on the use of such market instruments, either directly by farmers, or via marketing and financial intermediaries.[1] Recently, these market based insurance schemes are also being piloted in developing countries. For instance, a recent initiative of the International Task Force (ITF) on Commodity Risk management, has proposed using market based derivative instruments to provide price insurance for internationally traded commodities (ITF, 1999), while other proposals have suggested using market based weather insurance to cover yield or crop income risks (Skees, Hazell and Miranda, 1999). Varangis, Larson and Anderson (2002) have suggested using combinations of the above instruments to manage agricultural market risks in developing countries.

The institution of any policy or instrument designed to insure producers against the risk of an unexpected price or yield decline must be evaluated based on a benefit cost analysis. While the costs can be estimated relatively easily, the benefits are often more difficult to ascertain, as the underlying demand for such policies by the affected groups must be assessed. Yet, this information is important to help governments decide on the usefulness and modalities of such market based price insurance schemes in helping smallholder farmers deal with commodity price and weather risks.

Moreover, given that agricultural commodity price and weather risks are only few of the many risks farmers face, the demand for agricultural price and weather based insurance, must be seen in the context of the farmer's overall exposure to a variety of shocks, as well as the already available options for the farmer to manage and cope with these risks and shocks through other means (Dercon, 2004b). As discussed in Chapter 5, while rural households manage to cope with some of the idiosyncratic and covariant shocks, rural agricultural households in Tanzania face substantial uninsured consumption risk and the currently used (self or informal group based) insurance schemes may also be costly. In other words,

[1] Harwood *et al*. (1999) survey the theoretical and empirical literature on applications of these ideas in developed countries.

estimates of the demand for price and especially weather based insurance do not only provide an estimate of the benefits from providing insurance against price and especially weather risk. They can also be seen as (lower bound) estimates of the implicit welfare cost of agricultural households' residual uninsured consumption.

This chapter helps shed light on the potential for market based insurance schemes in Tanzania by empirically exploring the demand for minimum price insurance for coffee and cashew among coffee and cashew growing farmers in Kilimanjaro and Ruvuma as well as the demand for weather based insurance among agricultural households in these two regions. We begin by describing our empirical methodology and its theoretical grounding in section 2. We then proceed by describing the cash crop marketing arrangements, the survey methodology and the estimated wtp and overall demand for coffee and cashew price insurance in Section 3. Section 4 reviews the same issues for weather based insurance. Section 5 concludes.

6.2 Empirical methodology and theoretical grounding

Assume that for a farm household time is measured in crop years, indexed by an integer T. Each crop year is divided into two, not necessarily equal, periods 1 and 2, indexed by j. The first period within each crop year is meant to represent the period after planting, but before the resolution of production and price uncertainty. The second period is meant to represent the resolution of production and price uncertainty, and the realization of annual crop income. In the first period the household income consists of sources other than agriculture, while all agricultural income is assumed to be realized in the second period (in addition to other possible sources of income). Time is indexed by an integer variable t=2T+j, where j=1 or 2. Hence, odd values of t denote the first part of any crop year, while even values the second part.

Denote the vector of consumed goods (it may include leisure) of the farm household in period t by C_t , the vector of quantities of assets in the beginning of period t by A_t , the vector of decision variables (such as inputs, land allocation, amount of insurance instruments to buy, savings and investment decisions, etc.) that are determined in period t by x_t , the information available to the decision maker at the beginning of period t by I_t (such as values of all realized economic variables as well as states of nature in previous years), and the state of nature that is revealed in the beginning of period t by S_t (this may include uncertainty about income affecting variables such as weather, prices, sickness, etc.). Also denote by p_{At} , p_{Ct} and p_t , the vectors of prices of assets, consumption goods, and income earning activities (including labour) respectively at time t. Denote by $U(C_t)$ the instantaneous household utility in period t.

The household is postulated to maximize the ex-ante expected value of the discounted sum of instantaneous utilities, over n crop years:

$$W = E\{\left[\sum_{t=1}^{2n} \delta^t U(C_t)\right] / I_1\} \tag{6.1}$$

where δ is an appropriate discount factor. The expectation in (6.1) is taken over all states of nature S_t (t=1,2,,.,2n), based on information at the beginning of the relevant horizon for the household. The maximization will be assumed to be over all sets of decision vectors x_t. The restrictions relating the various variables are the following.

$$p_{At}A_{t+1} = p_{At}A_t + p_t y_j(A_t, x_t, S_t) - p_{Ct}C_t \equiv R_t - p_{Ct}C_t \tag{6.2}$$

$$x_t \in X_t \tag{6.3}$$

Equation (6.2) defines the value of end of period assets at period t prices. The variable R_t denotes the value of resources available to the household at the beginning of period t, namely previous period assets valued at current period prices, plus current income from these assets. X_t is an appropriate constraint set for the decision variables, and y_j (.) denotes the vector of quantity of netput activities (positive if outputs, negative if inputs) affecting the income of the household in period t.[1] The subscript j in the income function denotes the possibility that income sources may be different in the two periods of each crop year. Notice that no restriction is placed on the sign of assets. Hence negative assets (namely liabilities such as borrowing) are allowed in this general formulation. If the household is liquidity constrained, then the restriction that some or all assets should be non-negative must be imposed (Deaton, 1991).

The nature of the solution to such a problem is theoretically well known, (e.g. Deaton, 1992a, Zeldes, 1989). In general the solution is not analytically tractable, and can be written as:

$$C_t = f(A_t, y_j(A_t, S_t), p_t, p_{At}, p_{Ct}) \tag{6.4}$$

If an equation like (6.4) is the solution to the overall optimization problem (6.1)-(6.3), then the utility function in (6.1) can be rewritten as follows.

$$W = E\left\{ \{\sum_{T=0}^{n} \delta^{2T} \left[U(C_{2T+1}) + \delta E\left(C_{2T+2} \middle| I_{2T+1}\right)\right]\} \middle| I_0 \right\} \equiv E\left\{ \sum_{T=0}^{n} \delta_1^T V(C_{2T+1}, I_{2T+1}) \middle| I_0 \right\} \tag{6.5}$$

In (6.5) $\delta_1 = \delta^2$, the consumption within the various parentheses and brackets has a form like (6.4), and the function V just defines the quantity inside the bracket in the left had side of (6.4). The expectation inside the brackets are taken conditional on information available in the first period of a given crop year T, while the unconditional expectations outside the brackets are taken with information available in the beginning of the planning horizon, namely year 0[2].

Consider the provision of an insurance contract to the farmer in the first period of the crop year, whose outcome depends on events of the second period. The contract considered could be in the form of an option to sell all or a portion of a produced crop at a minimum "strike" price.[3] Denote the amount of the crop that is insured as q (can be fixed or variable), and the return to the insurance contract per unit of the insured crop as r. Alternatively, the insurance contract could guarantee a minimum return per acre (r) in case of a weather/rainfall shock and q could be seen as the amount of acres insured.

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[1] The returns to any financial assets, such as interest on deposits or loans, are included in the income terms. Similarly the depreciation of physical assets can also be considered as included in y in this general notation.

[2] If the two periods within the crop year are different in duration, the discount rate within the bracket in the left hand side of (5) will be different than the discount rate outside the same bracket.

[3] Commodity minimum price insurance for an agricultural producer functions like a put option, or a minimum price guarantee. In other words it guarantees for the amount of contracts purchased or quantity covered, and over a period stated in the contract, a minimum price (the strike price of the option like contract), but allows the producer to obtain a higher price.

If we assume that the nature of the function f in (6.4) is not affected by the provision of this contract, then we can define the benefit of this contract as the amount that must be subtracted from income of the first period in the crop year, so that the two-period utility with the contract is equal to the utility without it. Analytically we define the benefit in year T to be the solution B to the following implicit equation.

$$U(C_{2T+1}(y_1 - B)) + \delta E\left[U(C_{2T+2}(y_2 + rq)) \middle| I_{2T+1}\right] = U(C_{2T+1}(y_1)) + \delta E\left[U(C_{2T+2}(y_2)) \middle| I_{2T+1}\right] \quad (6.6)$$

The key assumption that allows the definition in (6.6) is that the nature of the income generating function $y_j(.)$, as well as the consumption function (6.4), are not altered by the provision of insurance. This, of course, is not strictly correct, as the household may adjust its long term exposure to risk as is implied by theory. Given that the nature of the changes in the income functions as well as the consumption function under insurance are quite intractable, the assumption can be considered as a first approximation, and one that can facilitate the estimation of the "minimum value" of WTP, for such insurance contracts. In other words, the estimated benefit, and WTP can be considered as the minimum demand for price insurance. Any changes in production structure, induced by the provision of the insurance, will provide an additional benefit, and will not be considered here.

The implicit function B that can be derived from (6.6) is generally impossible to solve analytically. Sarris (2002) derived one such function analytically from (6.6) by approximating the consumption by a linear function of current resources R_t, and making several other simplifying assumptions. He showed that this function depends on the degree of consumption smoothing, the degree of farmer risk aversion, the current level of resources of the household, the expected value and variability of the returns of the insurance contract, and on the correlation between the return of the insurance contract with the current level of resources.

His analysis, led to several conclusions compatible with intuition. For instance, the larger is the degree of risk aversion, and the smaller is the degree of consumption smoothing, the larger is the benefit of insurance. Second, the larger is the degree of (unpredictable) deviation of current resources from normal/average (positive or negative), the larger is the WTP for insurance. Third, the larger is the variance of the return of the insurance contract, the lower the WTP for it. Finally the WTP for an insurance contract is larger with a more negative correlation between the return to insurance and the second period resource uncertainty. These are all variables that should enter in an estimation of the WTP for insurance.

There are direct and indirect ways to estimate the willingness of households to pay (WTP) to avoid adverse price or weather related agricultural income shocks. One method involves utilizing household surveys, coupled with exogenous time series information on shocks of variables such as prices and yields (for an application of this method see Sarris, 2002). The weakness of these indirect methods lies in the fact that the surveys utilized are not designed for the purpose of exploring issues of vulnerability and insurance. Direct methods on the other hand involve household surveys designed specifically to elicit the estimates of vulnerability and demand for insurance by households. There are very few such studies, a recent example being McCarthy (2003). This paper follows the direct approach.

The direct or "contingent valuation" (CV) methods are based on direct questioning of agents (producers, households, etc.) on how much they are willing to pay for avoiding an undesirable event, or for having available a possibly welfare improving instrument such as a given amount of an insurance contract. The major problems with this approach have largely to do with the specification of the "scenario" or the "benchmark" against which the agent is supposed to compare the current situation, and express a monetary value for what it is worth to him/her to move to the new situation, or avoid a bad one. It is not always easy to specify this scenario well, especially if it involves a rather improbable event, and this lies at the heart of most criticisms of this approach (see e.g. the papers in Hausman (1993)). However, in the case of well specified risks, such as price or yield variations, it is likely that farm households are familiar not only with their normal values, but also with their variability over time, and hence the above criticism may not be valid.

The basic theory of the CV approach has been known for some time, and a comprehensive survey can be found in Hanemann and Kanninen (1998) (herein HK). The idea favoured by current CV practice is to ask each respondent a closed form question, namely whether they would accept to pay a given amount to obtain a given change in their status quo. Hence the answers obtained are of the "Yes" or "No" type, necessitating a theory of how to translate these discrete responses into meaningful WTP estimates. Following HK, suppose that a respondent is asked to consider the change from the status quo q^0 to q^1, where q^1 refers to the value of an as yet non-existent good, such as an insurance contract, and presumably the latter choice is preferable to the former. Denote the indirect utility of the respondent as v(p,q,y,s,ε), where p is a vector of prices for all the market goods currently available, y is the respondent's income, s is a vector of respondent characteristics, and ε is the stochastic component of utility. This utility, for the problem at hand corresponds to the indirect utility defined in (6.5). Then if the respondent is asked whether he would be willing to pay an amount A to obtain q^1, his answer would be "Yes" if the following condition holds (where Pr denotes the probability):

$$\Pr\{response \quad is\,"Yes"\} = \Pr\{v(p,q^1,y-A,s,\varepsilon) \geq v(p,q^0,y,s,\varepsilon)\} \tag{6.7}$$

If we denote by B the maximum WTP for the change from q^0 to q^1, corresponding to what was defined in (6.6), then B is defined implicitly by the condition:

$$v(p,q^1,y-B,s,\varepsilon) = v(p,q^0,y,s,\varepsilon)\,. \tag{6.8}$$

This implies that B is a function of all the same variables that enter the function v(.). Hence condition (6.7) can be written equivalently as:

$$\Pr\{response \quad is\,"Yes"\} = \Pr\{B(p,q^0,y,s,\varepsilon) \geq A\}\,. \tag{6.9}$$

As B is a random variable, let $G_B(.)$ be the cumulative distribution function (cdf) of B. Then (3) translates into the following:

$$\Pr\{response \quad is\,"Yes"\} = 1 - G_B(A)\,. \tag{6.10}$$

When G=Φ, namely the standard normal cdf, and when B has mean equal to μ and variance equal to σ2 then one has a probit model:

$$\Pr\{response \quad is\,"Yes"\} = \Phi(\frac{\mu - A}{\sigma})\,. \tag{6.11}$$

Hence if we estimate a probit model of the type:

$$\Pr\{response \quad is\,"Yes"\} = \Phi(\sum_{i=1}^{n} \beta_i X_i - \gamma A)\,. \tag{6.12}$$

The no stochastic part of the WTP can be derived by the simple formula:

$$B = \frac{\sum_{i=1}^{n} \beta_i X_i}{\gamma} \qquad (6.13)$$

The same formula is derived if the assumed cdf of B is logistic, giving rise to a logit model. As B is specified to be stochastic, the assumed distribution of the error term entering B, gives rise to estimable equations identical to (6.10). Under the assumption that the utility function is linear (the most common assumption), and that the error term is normal, the same probit model as in (6.12) arises. In this paper we utilize the probit approach, and hence formula (6.13) for the estimation of the WTP.

6.3 The demand for coffee and cashew price insurance

6.3.1 Cash crop marketing and price variability

Despite the fact that cash crops constitute significant shares of cash income, especially in Ruvuma, the amounts produced and marketed by each household are quite modest. In Kilimanjaro the average amount of coffee produced per household is only 50-60 kg, while in Ruvuma it is around 250-350 kg. This is in line with the larger shares of cash income derived from coffee in Ruvuma, as indicated in Chapter 2. Cashew nut producers sell on average 200-300 kg per year, while tobacco producers sell on average 300-350 kg.[1]

The majority of those selling coffee sell their coffee to primary cooperative societies. Only about 15-20 percent of coffee producers in both regions sell to private buyers highlighting the continuing importance of cooperatives. There are only very few who sell to both primary societies as well as private buyers. Cashew producers sell largely to private buyers, while tobacco is largely sold either on contract to tobacco companies, or to private buyers for these companies.

The average prices received, including both initial and subsequent payments, appear similar among those selling to primary societies and those selling to private buyers. However, there is considerable variation in the prices received by producers in the same year (Figures 6.1 and 6.2). While the distribution or prices received by producers from primary societies has lower variance than the distribution of prices received by private buyers, in both cases the dispersion of the distributions are substantial, indicating that prices received are influenced by a variety of factors other than the price in the main auction market. Figure 6.3 illustrates the prices received in Ruvuma by cashew producers (selling mostly to private buyers) in 2003 and 2004. Again, apart from the large difference in the average prices received in 2003 and 2004 (Tsh 441/kg in 2003 versus Tsh 624/kg in 2004), there is considerable dispersion of prices received within the same period. Tobacco producers constitute only a small portion of the total sample and the prices they receive seem to be more uniform.

Figures 6.4 and 6.5 illustrate a statistic designed to capture the degree of coffee price variability to producers. The survey asked about the maximum and minimum prices received by farmers over the past ten years. It also asked about the average prices (from all types of buyers) received in the season of the survey, as well as the two previous seasons. We

[1]These figures are based on a small sample of tobacco growers in Ruvuma. As very few among them indicated an interest in insurance, we did not estimate their demand for insurance.

calculate the ratio of the difference between the maximum and minimum reported total price during the last decade and the average total weighted (from all buyers) coffee price received over the last three years and plot its distribution for coffee in Kilimanjaro (Figure 6,4) and cashew nuts in Ruvuma (Figure 6.5).

Again, there is a wide spread in this statistic. While part of this variability for coffee is due to the secular decline of coffee prices over the past 10 years, it nevertheless implies that there has been very high variability in the price received for coffee and cashew nuts by producers in the last ten years. More importantly the degree of price variability varies considerably among various producers. The variability faced by tobacco producers is much smaller than that of coffee producers (about 25-30 percent of that experienced by coffee producers, as derived by comparing the mean values of the type of statistic indicated in figures 6.4 and 6.5). This may be due to the fact that most tobacco is produced under contract.

6.3.2 Interest in and demand for minimum price insurance

The survey asked a variety of questions related to coffee and cashew price insurance. All these questions immediately followed a series of questions about the prices coffee farmers received during the past decade. Their memories about the distribution of coffee prices and their evolution were thus refreshed. The insurance module first asked whether farmers were familiar with the functioning of an insurance contract works. Subsequently, a detailed description was given of how the minimum price contract that resembles a put option on price would work. After this description they were asked whether such a contract would interest them. If the answer was positive, the questionnaire proceeded to ask whether farmers would be willing to pay various amounts for given minimum price contracts.

In particular, coffee farmers were asked about their WTP for a contract paying a minimum of Tsh 400 per kg, or one paying a minimum of Tsh 600 per kg or one paying Tsh 800 per kg for coffee marketed in 4-5 months time from the period of the survey. The 4-5 month advance period over which the hypothetical contracts were structured relate to the time of the survey relative to the time of the new crop harvested in the next marketing year. For cashew nuts the contracts were for Tsh 300, 450 and 600 per kg, and the advance period was 6-10 months.

Each farmer was asked whether he/she would be willing to pay a certain amount for each of these contracts, and the answer was yes or no. For each contract five different bid values (namely prices to pay) were selected. For instance, for the coffee contract that stipulated a minimum price of Tsh 400 the bid values were Tsh 5, 10, 20, 50 and 100. Each farmer was randomly assigned to answer whether he/she would be willing to pay one of these bid values. In other words each farmer was asked about only one bid value for each contract.

In particular, in each village, the sample was randomly assigned in 5 groups and each group was presented with a bid. The first group was asked whether they are willing to pay Tsh 5 for the contract with minimum price Tsh 400, Tsh 10 for the contract with minimum price Tsh 600, and Tsh 20 for a contract with minimum price Tsh 800. The second group was asked whether they were willing to pay Tsh 10, 20 and 50 for each of the above three contracts respectively. The third was asked whether they were willing to pay Tsh 20, 50 and 100 for each of the above three contracts, the fourth was asked whether they were willing to pay Tsh 50,100 and 200 for each of the above three contracts, and the fifth group was asked whether they were willing to pay Tsh 100,150 and 300 for each of the above three contracts.

Tables 6.1 and 6.2 indicate the expressed interest of farmers in minimum price insurance for coffee and cashew nuts, after it was explained to them how it would work. It can be seen that this interest shifts over time. About a third of the heads of coffee producing households who indicated that they were interested in minimum price insurance in the first round, indicated that they were not interested in the second. However, about half of those who in the first round indicated that they were not interested in minimum price insurance, changed their mind in the second round. Similar results obtain for cashew nut producers in Ruvuma. These changes maybe related to the experiences of producers in each year, and highlight the fact that demand for insurance is state dependent. It may also be that while the households sampled were the same the respondents were different.

The WTP questions were administered only to those household heads who declared that they were interested in price insurance. This procedure could have introduced a sample selection bias in the estimations below, and for this reason we examine the determinants of those more likely to be interested in participating in price insurance.

Tables 6.3 and 6.4 indicate the probit selection equation among coffee producers in Kilimanjaro and Ruvuma respectively, while Table 6.5 reports the same equation for the cashew nut producers in Ruvuma. The selection equations fit relatively well, despite the low pseudo-R squared. The percentage of correct predictions (based on probability fitted values from the regressions of larger or not than 0.5) is more than 70 percent in most cases.

In general the following types of variables are utilized. First, we use household characteristic variables, such as education. Second, we use income structure and level variables such as per capita income, wealth, shares of cash to total income, share of coffee in total income, whether cash income from coffee is important, a banana production dummy, the share of coffee input costs in total coffee production value, easy access to seasonal credit, and the Herfindhal index of cash income concentration. Third, we use variable designed to proxy for recent conditions, such as the level recent prices received. Fourth, we use variables designed to indicate the level of instability faced, such as the range or prices received in the last ten years (already discussed), the number of years in the last 10 years when coffee cash income or total income fell below 50 percent of normal, or whether the household perceives cash crop income as very unreliable. Finally, we use variables designed to capture the importance of different coping mechanisms to shocks affecting livelihoods. The four mechanisms we capture with respective dummies are whether in response to a shock in the past (the shocks can be any of a variety of inquired shocks, such as an illness, death, drought, theft, loss of crops or livestock, etc.) the household used its own savings or other own resources, assistance from other non-household family, assistance from non-family (including friends, neighbours, NGOs, government, etc), or whether it ought to find new ways to generate income. In all empirical regressions village level effects were included, but are not reported.

These groups of variables are designed to proxy for the types of variables suggested by the theory. For instance the degree of risk aversion can be related to the level of wealth and income, while the degree of consumption smoothing to the dummies discussed above. The degree of deviation of current resources from normal/average is proxied by the variables relating to income instability and price instability, the conditional variance of the return of the insurance contract by the recent price coupled with the price variability variables. Finally the correlation between the return to insurance and the second period resource uncertainty can be proxied by the structural variables relating to the importance of coffee to the overall income.

There are not many variables that appear to affect the desirability of insurance by farmers. Concerning coffee producers in Kilimanjaro it is only the price received and variability dummies that are significant. These dummies are designed to control for households that did not report a price for coffee sales, and there are several of those. They are equal to 1 if the household, despite the fact of being a coffee producer has not made any sales this year, and hence does not report a price. The same holds for the price variability. In round 1 it is only the dummy for price received that is significant, while in the second round the total number of coffee trees is significant and positive, and the dummy which is equal to 1 if the family uses family assistance as a shock mitigating strategy is significant.

For coffee producers in Ruvuma, round 1 indicates that the interest in insurance increases with the variability of coffee income, when coffee income is important for the household, and decreases when own savings and resources are used as coping mechanisms. All these are consistent with intuition. In the second round the same variables are significant with the same signs, except for the savings coping variable, which now is insignificant, while the coping mechanism relating to new ways of earning income is significant and positive.

Concerning cashew nut producers in Ruvuma, in round 1 only the variable denoting that cashew nut sales are important in the household is significant and positive, while in round 2 wealth is negatively significant, the unreliability of cashew income is negatively significant the easy access to credit is positively significant, and three of the four coping mechanisms are significant, of which one (coping with own savings) is negative, while the other two (use family assistance, and seek new ways to earn income are positive).

The above results suggest that there does not seem to be clear differentiation between those that are interested in insurance and those that are not, at least not as far as the main income variables are concerned. Any differentiation seems to be mostly with respect to the income instability variables and the household coping mechanisms, something that is reasonable.

Tables 6.6 and 6.7 exhibit the results of the WTP probit regression (akin to equation (6.11) earlier) for coffee in Kilimanjaro and Ruvuma respectively from round 1, while Table 6.8 indicates the results for cashew nuts in Ruvuma from round 1. Each column in these tables presents the results concerning one of the three hypothetical administered contracts. The first notable observation is that in all regressions the coefficient of the bid value is negative and significant as expected. In Kilimanjaro income and the number of coffee trees affect negatively the WTP, while the total value of wealth affects it positively. Income structure variables, such as whether cash income from coffee is important, as well as instability variables, and exposure variables such as the Herfindhal index, are positive, while coping mechanism variables, as well as easy access to credit affect the WTP negatively, as expected. The predictive power is quite high, with more than 70 percent correct predictions.

The results for coffee in Ruvuma in Table 6.7 are a bit weaker in the sense that not as many variables are significant, though with more than 80 percent of the answers correctly predicted, the share of correctly predicted values is very good. Income, the importance of coffee in income, easy access to seasonal credit, affect the demand for insurance positively, while the share of cash to total income, the number of coffee trees, past price variability, and the coping mechanism involving the use of new ways to earn income, affect it negatively.

The results for cashew nuts in Ruvuma in Table 6.8 are similar to those for coffee. Income, the number of cashew trees, the importance of cashew income, and whether cashew income declined in the recent past, affect the WTP positively, while the ease of access to seasonal credit, and the coping mechanism relating to use of new ways to earn income affect it negatively.

Tables 6.9 and 6.10 for coffee in Kilimanjaro and Ruvuma respectively, and Table 6.11 for cashew nuts in Ruvuma indicate the summary statistics of the individual WTP values computed for each household. These values were computed for each household as indicated earlier in equation (6.13), utilizing the directly estimated values of the coefficients, and the household specific values for its characteristics, and averaging the results. The estimated WTP values for some households were negative. For such households this result can be interpreted as indicating low or no interest in insurance, and for them the individual WTP was set at zero in estimating the averages. Such households accounted for about 17-19 percent of households for the lowest priced contract, but for much lower shares for the middle priced contract (2-7 percent), and for less than one percent for the higher prices contract.

The results indicate that in Kilimanjaro coffee producing households that are interested in minimum price insurance, are willing to pay on average 23-29 percent of the underlying contract value as premium for the insurance. In Ruvuma, a poorer region, coffee producers that are interested in minimum price insurance are willing to pay on average between 13 and 30 percent of the underlying contract value. For Ruvuma, cashew nut producers the WTP averages also between 12 and 20 percent. These are considerable values, given the generally low incomes of producers.

The round 2 results are not as robust as the ones of round 1. For the Tsh 400 and 600 coffee contracts in Kilimanjaro, the coefficients of the bid value are positive and significant, which is counterintuitive. For Ruvuma coffee producers, the bid value coefficients are all negative, as expected, but the ones for the two lowest prices are not significant. For cashew nuts in Ruvuma, the bid value coefficients are negative, and only the first one is non-significant. The reason for these results may be that the average price of coffee as well as cashew nuts increased considerably between the first and the second rounds, while the contract values were not adjusted in the second round survey. In Kilimanjaro the average price received by producers went from Tsh 481/kg in the first round to Tsh 619 in the second, and in Ruvuma from Tsh 385 to 619/kg. For cashew nuts the average prices increased from Tsh 437 to 633 per kg. This may have affected the perception of producers concerning several variables in the desirability of minimum price insurance, as well as the amounts producers are willing to pay for it. Nevertheless, the variables affecting households' willingness to pay in the second round regressions are quite similar to those in the first round.

Table 6.12 indicates the summary statistics for the WTP for the cases where the probit regressions in the second round result in a significant and negative coefficient for the bid value. The average WTP for minimum price insurance in round 2 for the third coffee contract is higher in Kilimanjaro than the one estimated in round 1 (338 versus 233). The opposite holds for Ruvuma coffee producers, for the two contracts exhibited, and with much higher differences between the two rounds (for instance for the Tsh 600 minimum price contract the second round average WTP for insurance is Tsh 27.7 versus 110.7 in round 1). For cashew nuts the results are similar, with the average WTP for the first of the two exhibited contracts much lower in the second round (Tsh 36.56 versus 59.7 in round 1).

The results reported thus far have been based on estimations only among those who declared that they were interested in insurance. This may create problems of selection bias. For this reason, we also tried re-estimating the WTP probit regressions correcting for selection bias.

In all cases, however, the selection coefficient turned out to be not significantly different than zero, and this implies that there is no selection bias in our estimates.

6.3.3 The societal benefits from providing minimum price insurance

Given that the results suggest that there is considerable demand for minimum price insurance, it is interesting to ascertain the overall demand curve for such type of insurance. To do this we first rank all estimates of WTP for the households in descending order. For each point estimate, we compute the value of the cash crop that has been produced by the respective household. As the questions asked in the survey implied that any price insurance would involve all produced quantity, we assume that the farmer, when answering "yes" to a WTP question he/she implies that all quantity produced would be insured. The quantity produced by each household was then multiplied by the sampling weight corresponding to the household. For each new value of the WTP, the quantity desired is equal to the quantity desired at the immediately larger value plus the quantity desired for the specified value.

Figures 6.6, 6.7, and 6.8 indicate the scatter plots so derived for the three hypothetical contracts administered in Kilimanjaro in round 1, along with the best quadratic fits. Figure 6.9, 6.10, and 6.11 repeat this for coffee producers in Ruvuma, while Figures 6.12, 6.13, and 6.14 do the same for cashew nut producers in Ruvuma. All plots clearly show a relatively smooth downward pattern (which of course was by design, but could have been much less smooth than indicated). The quadratic fits are very good, with R squared in all cases larger than 0.88. The figures indicate, as expected, that for a given premium (namely value for the WTP) the demand increases as the insured price increases.

Given the demand curves, it is simple to compute the total consumer surplus, namely the area above a given WTP and below the demand curve, for any given contract. Tables 6.13, 6.14, and 6.15 present these estimates for a range of hypothetical premiums, along with the estimates of the amount of coffee that would be insured, the number of producers affected, and the total cost and consumer surplus (welfare) of the insurance. The premiums for which the computations have been carried out are the average WTP, the same average plus one standard deviation, and the average minus one and two standard deviations. In some cases the average WTP minus 2 standard deviations was less than zero, and in this case the surplus was not computed.

The results indicate that the majority of coffee producers, as well as production in both regions of Kilimanjaro and Ruvuma, would be benefit substantially from the provision of insurance. The welfare benefit, net of cost, as proxied by the consumer surplus, increases considerably with decreases in the premium, and reaches more than 50 percent of total coffee sales for some contracts and for very low values of the premium.

6.4 The stated demand for and societal benefits from weather based insurance

6.4.1 Perceptions concerning rainfall

In order to elicit households' demand for weather based insurance it is important to have an idea of how households perceive the incidence of drought. While a rainfall based insurance contract could be based on an objective rainfall index, such an index is certainly not available at the village level, and the farmers are not aware of it, and hence one has to rely on perceptions of rainfall. In this study the responses are based on questions that are anchored around various levels of rainfall, as perceived by the farmers.

Table 6.16 gives a first indication of this. Households were asked to report in how many years out of the last ten the rainfall in their farms was much below normal, somewhat below normal, normal, somewhat above normal and much above normal. The table reports the percentage of households in each rainfall category that report a given number of years in the given class. For instance in Kilimanjaro, 32 percent of households report that in 2 out of the last 10 years rainfall on their farms was much below normal. Similarly 81.1 percent of households reported that there was only 1 out of the past 10 years when rainfall was much above normal. From Chapter 2 we know that the incidence of drought (or rain much below normal) was much higher in Kilimanjaro than in Ruvuma. Table 16 corroborates this. There is much higher incidence of reporting of 2-4 years out of 10 of rainfall much below normal in Kilimanjaro compared to Ruvuma.

The survey asked not only household perceptions of rainfall in their farms, but also the perceptions of village officials for the village as a whole. Table 6.17 reports the average number of years perceived by households in the various rainfall classes, and compares them with those of the village chairmen or other officials interviewed for the village questionnaires (the sum of the entries across columns is equal to 10). While as far as the two extreme rainfall ranges (much below normal and much above normal) the average responses of households and village chairmen are quite similar, this is not the case with the responses in the next range (somewhat below and above normal). It appears that there are differing perceptions about what constitutes somewhat below and somewhat above normal rainfall, while much less disagreement as to what constitutes major rainfall shortages and excesses.

In this context it is interesting to explore the similarity of responses of farmers. This is interesting not only to elicit perceptions, but also to gauge whether rainfall patterns are similar for all farmers within a village. In Tanzania, farms within villages are quite dispersed, with distances between farms within the same administrative village sometimes or more than 10 kilometres. Hence it is important to understand the uniformity of rainfall patterns, at least as perceived by farmers. Tables 6.18 and 6.19 illustrate with two different indices the similarity between the responses of farmers to the questions of the types of rainfall experienced. Both indices manifest the same pattern. This is that in Kilimanjaro there seems to be considerable similarity in farmers' perceptions of rainfall in the various ranges, while in Ruvuma there is more disagreement in perceptions of farmers about what constitutes rainfall much below and much above normal, as well as in the other ranges.

Another issue concerns the relation between the subjective perception of rainfall, as falling in one of the various classes and the actual rainfall, again as perceived by farmers. Table 20 illustrates the responses of households concerning how they would classify rainfall when objectively the rain in a given year is a certain amount below normal. It can be seen that for small negative rainfall deviations ($^1/_{10}$ and ¼ below normal) the households have differences in perceptions (especially between classifying as rain being somewhat and much below normal). However, when it comes to rainfall below $^1/_3$ or ½ of normal, then there are uniform perceptions, namely that in such cases rainfall is much below normal. The reason for which these figures are important, is because the estimates on the basis of which the contracts specified for the questionnaire, as well as the amounts of income shortfall estimated are based on such perceptions.

6.4.2 Interest in and WTP for rainfall insurance

The survey subsequently asked a variety of questions related to rainfall based income insurance. At first the concept of rainfall insurance was explained and farmers were asked whether they were interested in such insurance. After this question, the questionnaire proceeded to ask whether farmers would be willing to pay various amounts for given rainfall based contracts. It is of considerable importance to design rainfall based contracts that are relevant to the farmers' income, as well as perceptions of rainfall. This is a difficult technical issue in itself, and is explained in detail in Appendix A to this chapter. The main point to highlight here is that the first round survey was utilized to design the contracts, namely the indemnity values, as well as the appropriate thresholds of rain for the different contracts. It is furthermore underscored that the questions discussed in the previous section preceded the WTP questions to implicitly help people refresh their memory about the concepts of probability and distribution of rainfall.

Table 6.21 indicates the reasons for which some households declared that they were not interested in the rainfall based insurance contracts. The interest in rainfall insurance is much higher in Kilimanjaro (47 percent of households), compared to Ruvuma (34 percent of households), but overall the interest is not universal. This reflects the fact that rainfall is much more reliable in Ruvuma, as already discussed. The major reason for lack of interest in Kilimanjaro was lack of funds to pay for it at any price. In other words, in the absence of liquidity constraints, interest in Kilimanjaro would be even higher. In Ruvuma, a large share declared that droughts were infrequent, and when occurring would not hurt them too much.

Each farmer was offered two different types of rainfall based contract. The first type involved a hypothetical rainfall reduction of 10 percent below normal rainfall, and the second a hypothetical rainfall reduction of 33 percent ($^1/_3$) below normal. For each hypothetical scenario three contracts were designed, offering a progressively higher indemnity under the given rainfall shortfall, for a correspondingly higher premium. This was done, in order to capture all the different income classes within the sample, and as it was impossible a-priori to know the income class of the farmer interviewed. Hence each farmer was offered six different hypothetical contracts. For each one of these there were five different options for the premium, structured around what was estimated (see Appendix A) as the actuarially fair premium for that type of contract. Farmers were split randomly in five even groups in each village and within each group each farmer was given a different unique choice among the five premiums.

Apart from the results of Table 6.21, we explored the desirability of drought insurance via a probit regression. Table 6.22 exhibits the results. Significant variables are education of head (positive but in Ruvuma only), per capita income (positive but in Kilimanjaro only), easy access to short term credit (positive in Ruvuma only), and a cashew production dummy. These results suggest that the more educated and the higher income a household head has, the more likely it is that he/she will understand and appreciate income insurance.

Irrespective of their answers to the desirability question all farmers were asked about their willingness to pay specific amounts for rainfall insurance. Tables 23 and 24 indicate the probit regressions concerning Kilimanjaro and Ruvuma, for the hypothetical contracts that stipulated 10 percent rainfall decline. Tables 6.25 and 6.26 repeat this for the contracts that stipulated $^1/_3$ below normal rainfall decline. In general the following types of variables are utilized. First we use household characteristic variables, such as education of head and household size. Then we use wealth variables such as per capita income and wealth, cultivated land size, number of trees and animals owned, and size of cultivated land. Thirdly we use diversification variables, such as the Herfindhal index of total gross income diversification and the share of cash in total gross income. Fourth we use variables designed to proxy for recent conditions, such as whether the household experienced recent drought. Fifth we use variables designed to indicate the level of instability faced, such as the number of years in last 10 when income was much below normal or cash crop income was much below normal. Sixth we use variables designed to indicate how households deal with adverse income shocks, such as dummies indicating what type of coping mechanism was used when faced with shocks. Finally we use specific crop production dummies, to capture attributes related to production of specific crops.

These groups of variables are designed to proxy for the types of variables that the theory mentioned earlier points to. For instance the degree of risk aversion can be related to the level of wealth, while the degree of consumption smoothing to the dummies discussed above. The degree of deviation of current resources from normal can be proxied by the variables relating to income instability, and the correlation between the return to insurance and the second period resource uncertainty can be proxied by the structural variables relating to the production of specific crops, or the share of cash in total income.

The coefficients of the bid values are everywhere negative as expected, and significant in all cases in Kilimanjaro but only in few cases in Ruvuma. In Kilimanjaro other significant variables appear to be the size of household (positive), per capita income (positive), the share of cash in total income (positive), and two coping variables, the one indicating that the household uses own savings when facing a shock (positive), and the one indicating that the household used family assistance when in shock (negative). These results suggest that higher income and exposure to the market make households more sensitive to income instability, and thus more open to paying for additional income insurance. It is likely also related to the liquidity constraint, as households with larger incomes are likely to be less liquidity constrained to pay the premium and buy the insurance. Also it appears that the type of coping mechanism makes a difference in their desire for weather insurance. If they use mostly own savings, namely if they self insure, they seem to be more open to external insurance. If, on the contrary they use family assistance, they seem to consider this enough of a safety net, and they are less open to paying for additional drought insurance. Alternatively, the cost of self insurance may be much larger than the cost of mutual insurance.

In Ruvuma, while all the coefficients of the bid values are negative, only one is significant. Other variables that appear significant are the level of education of the household head (positive), and the same types of coping mechanism dummies as in Kilimanjaro. The lack of significance of the bid values indicates much less interest in drought insurance in Ruvuma, a conclusion that is consistent with earlier results that indicated both less interest in drought insurance in Ruvuma as a result of more stable rainfall patterns, but also with the lower general incomes in Ruvuma. Despite the non-significance of most variables, however, and the low pseudo R-squared values, the proportion of correct predictions (on the basis of a probability larger than 50 percent is larger than 70 percent in all cases.

Tables 6.27 and 6.28 for Kilimanjaro and Ruvuma respectively indicate the summary statistics of the individual WTP values computed for each household. These values were computed for each household as indicated earlier in equation (13), utilizing the directly estimated values of the coefficients, and the household specific values for its characteristics, and averaging the results. The estimated WTP values for some households were negative. For such households this result can be interpreted as indicating low or no interest in insurance, and for them the individual WTP was set at zero in estimating the averages. Such households accounted for about 30-40 percent of households in Kilimanjaro and more than 50 percent of households in Ruvuma, consistent with the indicated interest in a weather based insurance contract.

The results indicate that in Kilimanjaro households who are willing to pay some amount for rainfall insurance, are willing to pay on average 12-23 percent of the underlying indemnity value as premium for insurance against a 10 percent rainfall decline. They are willing to pay considerably less, between 10-14 percent for insurance against the more improbable, but more detrimental event of 30 percent rainfall decline. In Ruvuma, a poorer region, and a more reliable one from a rainfall perspective, producers are much less interested in rainfall insurance, but those exhibiting a positive WTP for rainfall insurance, are willing to pay on average 18-40 percent of the underlying indemnity value for insurance against a 10 percent rainfall decline. They are willing to pay considerably less, 0.7-1.2 percent for insurance against the more improbable event of 30 percent rainfall decline. These results suggest that it is mainly in Kilimanjaro where rainfall insurance appears viable, while in Ruvuma, there is a small group of households (fewer than 20 percent) willing to pay considerable amounts for rainfall insurance against a rather frequent event, namely rainfall declines of 10 percent.

6.4.3 The demand curve for rainfall weather insurance and the welfare benefit for providing it

Given that the results suggest that there is considerable demand for weather insurance, at least in Kilimanjaro, it is interesting to ascertain the overall demand curve for such type of insurance. To do this we utilize the following method. We first rank all estimates of WTP for the households in descending order. For each point estimate, we have independent estimates from the questionnaire concerning the number of acres, households would be willing to insure at each contract. The area each household is willing to insure was then multiplied by the sampling weight corresponding to the household. For each new value of the WTP, the quantity desired is equal to the quantity desired at the immediately larger value plus the quantity desired for the specified value.

Figure 6.15 indicates the scatter plots so derived for the three hypothetical contracts administered in Kilimanjaro for the 10 percent rainfall reduction scenario. Figure 16 does the same for the 30 percent rainfall reduction scenario, Figures 6.17 and 6.18 repeat the same for Ruvuma. All plots clearly show a relatively smooth downward pattern (which of course was by design, but could have been much less smooth than indicated). The quadratic fits are very good in Kilimanjaro, with R squared in all cases larger than 0.9, and larger than 0.8 in Ruvuma. The figures indicate, as expected, that for a given premium (namely value for the WTP) the demand increases as the insured price increases. For Ruvuma, as already discussed the demand is much less, and the corresponding quadratic fits much weaker.

Given the demand curves, it is straightforward to compute the total consumer surplus, namely the area above a given WTP and below the demand curve, for any given contract. Tables 6.29 and 6.30 present these estimates for Kilimanjaro for a range of hypothetical premiums, along with the estimates of the number of acres that would be insured, the number of producers affected, and the total cost and consumer surplus (welfare) of the insurance. The premiums for which the computations have been carried out are the average WTP, and the same average plus one standard deviation (we would have liked to include also estimates for the average WTP minus one or two standard deviations, but as seen in Tables 6.27 and 6.28, the standard deviations of the WTP are in most cases larger than the mean, so this was not possible).

The results indicate that in Kilimanjaro for the 10 percent rainfall shortfall case, about 18-25 percent of households would purchase the insurance at the average WTP, insuring between 42-49 percent of their total acres cultivated. The premium paid would constitute 2.8-11 percent of total crop sales, and consumer surplus would be between 3.5-12.4 percent of total crop sales. For the case of insurance against a $^1/_3$ rainfall shortfall, participation would be between 10-14 percent of households, the cost would amount to 2.3-9 percent of total crop sales, and they would insure 46-57 percent of their cultivated acres. Consumer surplus in this case would amount to 4.2-11 percent of total crop sales.

For Ruvuma and for the case of 10 percent rainfall shortfall, the participation would be of only 5-7 percent of households, insuring about 16-26 percent of their total area cultivated. The cost of the insurance would constitute 0.3-2 percent of their crop sales, and the total consumer surplus would amount to 2.8-4 of total crop sales. For the case of insurance against $^1/_3$ rainfall reduction, only between 3-3.4 percent of households would insure, and they would insure 18-30 percent of their total cultivated area. The premiums would amount to 0.1-1 of total crop sales, and the total consumer surplus would amount to 1.6-3.7 of total crop sales.

6.5 Summary and conclusions

In this chapter we examined in more depth the cash crop price fluctuations and the erratic nature of rainfall patterns underpinning volatility in agricultural income, (and household consumption), and analyzed the effect of this volatility on household welfare using the stated preference approach or contingent valuation of willingness to pay to complement the immediate welfare loss estimates related to the experience of shocks obtained in Chapter 5. The strength of the stated preference methodology lies in the fact that it can estimate both the uninsured residual risks and the "latent demand" for insurance (price or weather based), given that the households already cope with shocks through self and mutual insurance mechanisms. The underlying assumption is that the way the households have adjusted to the recurring weather risks is by diversifying, as well as adopting different production patterns than what would be dictated through simple expected income calculations. As such, the empirical estimates involve the long run or steady state production pattern of the farm household, given the household's perceptions of crop price and drought risks.

The results confirm our earlier findings that commodity price and weather fluctuations in addition to health shocks pose an important challenge to agricultural producers, often resulting in substantial welfare loss. Households don't only face unexpected cyclical and downward trending commodity prices, even within the same year and area there appears a wide range in the actual prices households receive for their produce, even when these prices are low. Consistent with our analysis of rainfall patterns in Kilimanjaro and Ruvuma based on recorded rainfall, analysis of people's subjective perceptions of weather shocks indicates that weather shocks pose a substantial challenge in the Kilimanjaro Region. They are less of a problem for households in Ruvuma.

The demand for cash crop price and weather insurance insurance appears substantial. In case of coffee price insurance, households are on average willing to pay between 13 and 30 percent of the option value they will receive as a premium depending on the option value. This compares favourable with the actual costs of such option contracts in the New York stock exchange, where three-month put options trade for about 5-10 percent of the strike price, and more for six-month put options.. Setting the premium at the average wtp, about 25,000 to 30,000 households in Kilimanjaro (or about one quarter of all coffee growing households) would buy coffee price insurance insuring a total of about 1,200-1,700 tonnes or

20-30 percent of the total coffee production in Kilimanjaro. Were the premium to equal average wtp in Ruvuma, about one third of all coffee growing households (i.e. about 20,000 households) would buy the insurance, insuring about 7,000 ton of coffee or about 45 percent of Ruvuma's total production. Similarly, about one third of the cashew growers would buy cashew price insurance insuring about 4,000 tonnes or about 45 percent of Ruvuma's total cashew nut production. Were the coffee and cashew price contracts offered at a premium equal to households' average willingness to pay, the societal benefit (consumer surplus) would total between Tsh 78 and 700 million (between 3 and 25 percent of total respective cash crop sales depending on the contract). Clearly, the cost of uninsured consumption is large and the societal benefits from insurance substantial.

Given that agricultural income constitutes on average 57 and 71 percent of total income in Kilimanjaro and Ruvuma respectively, a more comprehensive measure of the cost of uninsured residual consumption risk is provided by our estimates of the wtp and consumer surplus related to weather based insurance. Households were more interested in Kilimanjaro, which is more exposed to rainfall, and they rather wanted more than less protection, i.e. a larger interest in contracts which paid out the indemnity when rainfall falls below 10 percent below normal as opposed to 30 percent below normal). This is reflected in a larger willingness to pay for the more secure contracts. For example, average WTP for the 10 percent below normal contracts was between 12 and 23 percent of the payout in Kilimanjaro compared with between 10 and 14 percent for contracts which pay out only when the rain drops 30 percent below normal. In Ruvuma, the average wtp was estimated between 18 and 40 percent and 0.7 and 1.2 percent respectively, though these results were estimated with imprecision. In Kilimanjaro the average WTP constitutes about 30-55 percent of the actuarially fair value of the contract, depending on the contract. In Ruvuma the average WTP is only 5-18 percent of the actuarially fair premium, in line with the lower WTP in that region.

Were the premium to be set at the average wtp, about one quarter of all households in Kilimanjaro would insure about 60000-77000 acres (about 18-24 percent of total land cultivated) resulting in a consumer surplus or benefit to society of about Tsh 1 billion or US$ 1 million. This is substantial and underscores the welfare loss associated with uninsured risks. About half of all households in Kilimanjaro and about one third of all households in Ruvuma indicated an interest in weather based insurance. More importantly, liquidity constraints were mentioned as the main reason for not being interested in such a scheme, at least in Kilimanjaro. Also the type of coping mechanism seems to affect the demand for rainfall insurance, with those that use own savings more interested and more willing to pay, compared with those that use other safety mechanisms, especially family based ones. This may be related both to differential liquidity constraints and different costs related to these coping strategies.

In sum, while households extensively use self and mutual insurance to cope with these price and weather induced income shocks, our findings indicate that there is substantial demand for both commodity price and weather based insurance, indicating both substantial uninsured risks as well as "latent demand" due to the costs of current ways of coping with shocks or the opportunities insurance opens up. Liquidity constraints at the household emerge as an important constraint to translate this stated demand into actual demand. Thus, while the demand and societal benefits are sizeable, great care will have to go into the design and institutional delivery mechanisms of market based insurance. The establishment of interlinked markets such as input, credit and insurance packages deserves special attention in this regard.

Appendix A: Methodology for defining the rainfall insurance contracts in Kilimanjaro and Ruvuma

The purpose of this Appendix is to describe the steps that have been utilized to specify the rainfall insurance contracts for the Kilimanjaro Round II Survey, and for the Ruvuma Round II Survey. These contracts are utilized in the surveys, to elicit farmers' WTP for them. As such they must be relevant to the farmer, in the sense that they should specify events and probabilities that are within the range of events that affect the farmer, and also specify likely losses and costs that are also within the range of events that are likely to affect the farmer. As will be seen below this is not an easy task, and requires a first round survey to assess them. As the surveys that are conducted in the context of the Tanzania vulnerability project involve two rounds, we utilize the first round information to specify the rainfall insurance contracts and the costs for the second round.

A rainfall insurance contract is one that specifies a certain payoff to the farmer, if a given event, related to weather takes place. Hence, in order to specify a rainfall insurance contract that is relevant to the farmer, one must assess several things. First, one must assess the probability distribution of the weather related uncertain event, so as to be able to specify the undesirable event. In addition, one has to be able to specify the likely loss from the uncertain event, in a way that is appropriate for the farmer. Finally, one must specify the expected value of the loss, so as to utilize it for specifying the actuarially fair price of the rainfall insurance contract. The sequel describes all the above steps.

The first issue concerns the probability distribution of rainfall. We have obtained data for monthly total rainfall in ten weather stations in Kilimanjaro and five weather stations in Ruvuma, for 33 years. The first thing that is done for each weather station is to aggregate the monthly rainfall data to yearly total rainfall figures, using the appropriate agricultural or marketing year for each region. Subsequently we pool all the yearly data from all stations into one group, and order them from lowest to highest. Apart from eight occurrences of zero rainfall in Kilimanjaro, all other yearly totals are positive. The data is ordered, the cumulative distribution is specified, and the mean as well as the median is computed.[1] Basically the way we treat the rainfall data, is as if the yearly rainfall of each rainfall station is an independent draw from the Kilimanjaro average annual weather distribution. It might have been more accurate to use for each village the weather data from the weather station closest to the village. But this turned out to be difficult, as the distances from a given village to the various weather stations are not well defined, and a village may be close in that sense to more than one weather station.

The second issue concerns objective and subjective estimations of the probabilities of below normal weather events. From the village questionnaires of each survey we have data on the frequency of occurrence of a "drought" for the village, in the last ten years. From these answers (which were provided by a group of village officials, and hence reflect consensus views), we estimate the average number of years out of ten in which villages think they had a drought. For Kilimanjaro this turned out to be 3.35 years out of ten, or almost exactly a 30 percent annual chance of a drought.

In the household questionnaires we asked households about the occurrence on their plots of five types of rain, namely much above normal, somewhat above normal, around normal, somewhat below normal and much below normal. We need to specify what is meant by

[1] For Kilimanjaro the average annual rainfall was equal to 1,234 mm and the median was 1,160 mm.

rainfall somewhat below normal and much below normal, as these variables are utilized in production function estimates to estimate losses from adverse weather.

We assumed that "drought" as defined at the village level was equivalent to the households' subjective estimates of rain "much below normal". The next issue is to define in terms of rainfall what is meant by a drought. By reference to the annual rainfall distribution we compute the annual rainfall that corresponds to a cumulative distribution point equal to 0.335. In other words we estimate the annual rainfall below which occurrences in the past have been observed with frequency equal to 0.335. For Kilimanjaro this was equal to a level of 884 mm, or about 24 percent below the median of the rainfall distribution. This cut-off point we regard as the borderline of what may be considered much below normal.

The next issue is to specify what is meant by rainfall "somewhat below normal". This was arbitrarily defined as the rainfall point in the cumulative rainfall distribution that corresponds to a probability mass equal to one half of the mass between the median (namely 50 percent of the mass) and the drought point (which as seen above corresponds to 33.5 percent of the mass). Hence, the arbitrary definition of the rainfall which will be considered somewhat below normal is the level that corresponds to a total probability mass of 0.335+(0.5-0.335)/2 =0.335+0.082=0.417. This rainfall from the rainfall probability distribution is equal to 1011 mm, or 13 percent below the median. Thus the probability of weather being below normal, an event that includes both the "somewhat below normal" and the "much below normal" possibilities, is 41.7 percent.

In the first round questionnaire we ask farmers to specify for each of their cultivated plots whether rain on that plot for the year before the survey was one of five possibilities, namely much above normal, somewhat above normal, around normal, somewhat below normal and much below normal. We assign sequentially the values of 1,2,3,4,5 to each one of the above possibilities, and then compute for each household a household specific rainfall index by weighting each plot specific subjective rainfall number by the plot size, and dividing by the total area of all plots. This procedure gives a non-integer number between 1 and 5. We take the nearest integer of this number and hence assign to each household an integer number, corresponding to one of the above five possibilities, which reflects the type of rainfall each household experienced in its farm in the year prior to the survey. From these integers we create five separate dummy variables, each corresponding to one of the five possibilities above. In other words the dummy indicating rain much below normal will be equal to 1 if the rainfall index for this household is equal to 5, and zero otherwise. These five dummy variables are the household specific weather variables that are utilized in the production function estimates to estimate the likely losses from weather below normal.

In the next step we estimate the average value of output that is normal without weather influences and the value of agricultural income losses due to weather. This is done by estimating an agricultural production function for all the households in the sample. The dependent variable is the (natural logarithm of) gross value of agricultural production per acre. This gross value is computed by multiplying the quantities produced of all products, by the prices that are specific to each household. In case the household sold some of the particular product, the price at which the total production of that product is valued is the average price for all sales. For products which are not sold on the market, the price is the average price of the same product sold by other households in the same village. For products for which no household in the village sold any quantity, the price is taken from an average of sales prices in the villages in the same district.

The production function includes four of the five weather dummy variables discussed above (the sum of all five is equal to the constant, and hence one must be omitted). In particular we omitted the dummy for weather equal to normal, and left all other dummies for weather above or below normal. As expected, the dummies for weather somewhat or much below normal were negative and significant. The dummies for weather above normal were positive but not significant. The production function included variables such as land cultivated, the value of capital utilized per hectare, the amount of labour per hectare, the value of purchased inputs per hectare, the number of permanent trees per hectare, and household and farm specific variables such as the education of the head, the altitude of the farm, etc.

Given the production function estimate, the "predicted" value of total output for each household is computed by omitting all the weather variables. In other words for each household we predict the value of output in the absence of weather induced variations. This value is the basis from which we estimated losses due to weather. As there is considerable size variation among farmers, we separate the predicted values of agricultural output in three terciles. For each tercile we compute the average value of "predicted" agricultural output, and the amount lost if the weather is somewhat below normal and much below normal, by multiplying this average by the corresponding coefficients of the respective dummies from the production function estimates. These numbers give us the average total losses if weather is somewhat below normal and the average total loss if weather is much below normal, for each of the three groups of households. We then compute the average loss if weather is below normal, by the weighted average of these losses (weights are the respective probabilities, namely 0.335 and 0.082). The actuarially fair price for a weather insurance contract that will pay this average loss if weather is below normal is the sum of the products of the probabilities of each of the two above events, multiplied by their respective estimated losses.

As an illustration, for the first tercile in Kilimanjaro, the average value of agricultural production without the weather effects is estimated to be Tsh 116 180. The regression coefficients of the weather_4 and weather_5 dummies in the production regression are -0.126 and -0.206 respectively[1]. Hence the estimated average losses in each respective case are Tsh 0.126*116180=Tsh 14 639, and 0.206*116180=Tsh 23 933. Since the first event occurs with probability equal to 0.082 and the second with probability equal to 0.335, the weighted average loss is equal to (0.082*14639+0.206*23933)/(0.082+0.335)=22105. The actuarially fair premium for an insurance contract that will pay this value (in the actual questionnaire this value is rounded to 22000) when the annual rainfall is less than 13 percent below normal (and normal in this case is understood as the median of the annual rainfall distribution) is equal to Tsh 0.082*14639+0.206*23933=9218. This is then the value around which we specify different premium values and ask the farmer whether he would be willing to pay them in order to obtain the payoff of 22000 (in the actual questionnaire the actuarially fair premium is rounded to Tsh 9 000).

The same procedure is applied to the other two terciles.

[1]These regression coefficients have been superseded by later more detailed analysis (Sarris, Savastano and Christiaensen, 2006), which indicated that the values of the negative coeffficients of the weather variables in the production functions losses were higher than those indicated above. This implies that the actual income losses which are incurred by farmers are larger under the weather scenarios indicated in the questionnaires than those on the basis of which the contracts were designed. Hence, this would tend to make the prices for the offered contracts less than what would be justified under the "true" loss assessment. Hence it is expected that farmers would be more willing to pay for them. This, however, should not bias the overall estimates of WTP.

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Table 6.1: Interest in minimum price coffee insurance among coffee producing households. (Number of households)

1a. Kilimanjaro

		Round 2		
		No	**Yes**	**Total**
Round 1	No	22,454	22,772	45,226
	Yes	19,976	38,843	58,819
	Total	42,430	61,615	104,045

1b. Ruvuma

		Round 2		
		No	**Yes**	**Total**
Round 1	No	3,959	3,198	7,157
	Yes	12,962	31,183	44,145
	Total	16,921	34,381	51,302

Source. Authors' calculations

Table 6.2: Interest in minimum price cashew nut insurance among cashew nut producing households in Ruvuma. (Number of households)

		Round 2		
		No	**Yes**	**Total**
Round 1	No	2,779	5,530	8,309
	Yes	8,916	19,470	28,386
	Total	11,695	25,000	36,694

Source. Authors' calculations

Table 6.3 : Probit selection regressions concerning interest in minimum price insurance by coffee producers in Kilimanjaro. (Dependent variable is dummy equal to one if the answer is "yes" to the interest question. The results indicate the marginal effects)

	Round (1)	Round (2)
Per capita income (Tsh)	0.0000001	0.0000003
	(0.77)	(1.80)
Share of cash to total gros income	-0.0018067	-0.0016812
	(1.55)	(1.32)
Share of coffee income to total hh income	0.0033801	0.0000968
	(1.05)	(0.04)
Per capita wealth (Tsh)	-0.0000000	-0.0000000
	(0.63)	(0.33)
Total no of coffee trees	0.0000248	0.0001517
	(0.62)	(2.38)*
Education level of the head (years)	0.0061214	0.0041409
	(0.68)	(0.38)
Coffee price received this year (Tsh/kg)	0.0002323	0.0004835
	(0.72)	(1.80)
Price control dummy for coffee price	-0.1935966	-0.2583106
	(2.82)**	(3.80)**
Price variability index	0.0007142	0.0011255
	(1.17)	(1.88)
Price variability control dummy	-0.1611438	-0.0188923
	(3.03)**	(0.38)
Number of yrs out of the past 10, when cash income from coffee was 50% below normal	-0.0230457	0.0065519
	(1.71)	(0.50)
Dummy: 1=cash income from sales of coffee is important	-0.0268230	0.0513168
	(0.44)	(0.57)
Have access to seasonal credit	0.0886969	0.1104928
	(1.30)	(1.50)
Dum=1 if in shock use savings	0.0453281	-0.0383499
	(0.78)	(0.67)
Dum=1 if in shock i use family assistance	0.0292113	0.1535873
	(0.47)	(2.32)*
Dum=1 if in shock i use other assistance	0.0911020	0.0639030
	(1.13)	(0.50)
Dum=1 if in shock i use new ways to earn income	-0.0354391	-0.0530817
	(0.54)	(0.82)
Number of yrs out of the past 10, when total hh income declined a lot below average	-0.0160176	-0.0116474
	(0.96)	(0.75)
Banana production dummy	-0.0651070	0.0425610
	(0.66)	(0.41)
Herfindhal index (cash income)	0.0002490	-0.0024394
	(0.23)	(1.96)*
Share of coffee input costs to coffee production value	0.0008214	0.0008427
	(1.16)	(0.95)
Observations	529	522
Pseudo R-squared	0.13	0.15

Robust z statistics in parentheses
* significant at 5%; ** significant at 1%

Proportion of correct predictions round 1	67.84
Proportion of correct predictions round 2	72.16

Source: Authors' calculations

Table 6.4: Probit selection regressions concerning interest in minimum price insurance by coffee producers in Ruvuma. (Dependent variable is dummy equal to one if the answer is "yes" to the interest question. The results indicate the marginal effects)

	Round (1)	Round (2)
Per capita income (Tsh)	-0.0000000	-0.0000001
	(0.08)	(0.47)
Share of cash to total gros income	-0.0002495	0.0028970
	(0.48)	(1.31)
Share of coffee income to total hh income	0.0011640	-0.0009364
	(1.33)	(0.35)
Per capita wealth (Tsh)	0.0000000	-0.0000002
	(1.64)	(0.81)
Total no of coffee trees	0.0000132	0.0001113
	(0.95)	(1.80)
Education level in years	-0.0124381	-0.0307801
	(2.54)*	(1.64)
Coffee price this year (Tsh/kg)	-0.0001836	0.0001288
	(1.80)	(0.67)
Price control dummy	0.0063056	0.0106148
	(0.18)	(0.08)
Price variability index	0.0000890	-0.0004022
	(0.79)	(1.21)
Price variability control dummy	-0.0000369	0.0717628
	(0.00)	(0.78)
Dum=1 cash income from coffee is most unreliable	0.0976008	0.2139364
	(5.12)**	(2.45)*
Dummy: 1=cash income from sales of coffee is important	0.0693971	0.2078365
	(2.79)**	(2.34)*
Dummy: 1=quite easy access to short term credit	-0.0056297	
	(0.22)	
Dum=1 if in shock i use savings	-0.0505688	-0.0322265
	(2.13)*	(0.31)
Dum=1 if in shock i use family assistance	0.0060861	-0.0433698
	(0.25)	(0.31)
Dum=1 if in shock i use other assistance	0.0358786	-0.0367579
	(1.27)	(0.17)
Dum=1 if in shock i use new ways to earn income	-0.0607318	0.2896774
	(1.30)	(2.17)*
Dum=1 hh income declined considerably previous years	-0.0199411	0.0712828
	(0.78)	(0.65)
Banana production dummy	-0.0026819	0.0852363
	(0.11)	(0.86)
Herfindhal index (cash income)	-0.0008508	0.0003951
	(1.68)	(0.21)
Share of coffee input costs to coffee production value	0.0000287	0.0065512
	(0.55)	(3.08)**
Observations	262	228
Pseudo R-squared	0.32	0.21

Robust z statistics in parentheses
* significant at 5%; ** significant at 1%

Proportion of correct predictions round 1	90.46
Proportion of correct predictions round 2	73.69

Source: Authors' calculations

Table: 6.5 Probit selection regressions concerning interest in minimum price insurance by cashew nut producers in Ruvuma. (Dependent variable is dummy equal to one if the answer is "yes" to the interest question. The results indicate the marginal effects)

	Round (1)	Round (2)
Per capita income (Tsh)	0.0000001	0.0000013
	(0.31)	(3.86)**
Share of cash to total gros income	-0.0000405	0.0005233
	(0.03)	(0.28)
Share of cashew nuts income to total hh income	0.0011764	0.0000703
	(0.94)	(0.03)
Per capita wealth (Tsh)	-0.0000001	-0.0000008
	(0.23)	(2.68)**
Total number of cashew nut trees	0.0000738	0.0000148
	(1.39)	(0.35)
Education level in years	0.0140423	-0.0231461
	(1.48)	(1.40)
Cashew nut price this year (Tsh/kg)	-0.0003795	-0.0003031
	(1.34)	(0.48)
Prive variability index	-0.0004630	-0.0013624
	(0.75)	(1.39)
Price variability control dummy	-0.0820426	-0.0490198
	(1.53)	(0.69)
Dum=1 cash income from cashew is least reliab	0.0544935	-0.1813993
	(1.03)	(2.35)*
Dummy: 1=cash income from sales of cashew nuts is important	0.1888393	0.0851402
	(3.37)**	(1.18)
Dummy: 1=quite easy access to short term credit	0.0952541	0.2084152
	(1.30)	(2.17)*
Dum=1 if in shock use savings	0.0006240	-0.3960840
	(0.01)	(3.82)**
Dum=1 if in shock use family assistance	-0.0227167	0.2115453
	(0.36)	(1.94)
Dum=1 if in shock use other assistance	0.0551890	-0.1282833
	(0.76)	(0.59)
Dum=1 if in shock use new ways	-0.0714488	0.2767859
	(0.95)	(3.91)**
Dum=1 hh income declined considerably in previous years	-0.0215371	0.0508458
	(0.32)	(0.63)
Banana production dummy	-0.1461249	-0.0433319
	(1.56)	(0.48)
Herfindhal index (cash income)	-0.0016534	-0.0016928
	(1.65)	(1.14)
Share of cashew nut input costs to cashew nuts production value	-0.0000845	0.0040732
	(0.21)	(2.96)**
Observations	280	285
Pseudo R-squared	0.15	0.26

Robust z statistics in parentheses
* significant at 5%; ** significant at 1%

Proportion of correct predictions round 1	81.4
Proportion of correct predictions round 2	76.31

Source: Authors' calculations

Table 6.6: WTP regressions for coffee producers in Kilimanjaro from round 1 (all coefficients shown are the marginal effects)

	Tsh 400 minimum price	Tsh 600 minimum price	Tsh 800 minimum price
Bid value for Tsh 400 contract	-0.0033366	-0.0028467	-0.0016604
	(3.67)**	(4.78)**	(6.57)**
This year's coffee price over 400	-0.0000257		
	(0.02)		
This year's coffee price over 600		0.0016143	
		(0.89)	
This year's coffee price over 800			-0.0000818
			(0.03)
Per capita income (Tsh)	-0.0000001	-0.0000003	0.0000000
	(1.33)	(2.17)*	(0.09)
Share of cash to total income	-0.0007700	0.0017628	0.0006019
	(0.57)	(1.28)	(0.47)
Share of coffee income to total hh income	-0.0031350	-0.0054050	-0.0030090
	(0.60)	(1.12)	(0.71)
Per capita wealth (Tsh)	0.0000001	0.0000001	0.0000000
	(1.81)	(1.98)*	(1.01)
Total no of coffee trees	-0.0000873	-0.0000620	-0.0001235
	(2.19)*	(1.55)	(3.27)**
Education level in years	0.0064465	0.0286317	0.0014548
	(0.56)	(2.55)*	(0.15)
No yrs out of the past 10, when coffee cash income was 50% or more below normal	0.0601228	0.0553138	0.0476327
	(2.83)**	(2.56)*	(2.66)**
Dummy: 1=cash income from sales of coffee is important	0.2377579	0.1828496	0.1339451
	(3.25)**	(2.62)**	(2.22)*
Easy access to seasonal credit	-0.0578120	0.0468831	-0.2419023
	(0.73)	(0.62)	(3.08)**
Dum=1 if in shock use savings	-0.1049879	-0.1492184	-0.0898400
	(1.43)	(2.17)*	(1.54)
Dum=1 if in shock use family assistance	-0.0568690	0.0355042	0.1067232
	(0.73)	(0.44)	(1.70)
Dum=1 if in shock use other assistance	-0.0906162	-0.1162114	-0.2958855
	(0.96)	(1.23)	(2.98)**
Dum=1 if in shock use new income earning ways	-0.1826361	-0.0228133	-0.0513829
	(2.19)*	(0.31)	(0.74)
Number of yrs out of the past 10, when total hh income declined a lot below average	0.0005537	-0.0267924	-0.0683653
	(0.02)	(1.06)	(3.27)**
Banana production dummy	0.3005355	0.5522005	0.2695673
	(2.48)*	(4.27)**	(2.37)*
Herfindhal Index (cash income)	0.0018468	0.0038701	0.0007722
	(1.35)	(2.89)**	(0.63)
Share of coffee input costs to coffee production value	-0.0022499	-0.0020619	-0.0001474
	(2.85)**	(2.66)**	(0.23)
Observations	313	284	290
Pseudo R-squared	0.23	0.28	0.32

Robust z statistics in parentheses
* significant at 5%; ** significant at 1%

Proportion of correct predictions Tsh 400 contract	72.28
Proportion of correct predictions Tsh 600 contract	77.06
Proportion of correct predictions Tsh 800 contract	79.66

Table 6.7: WTP regressions for coffee producers in Ruvuma from round 1 (all coefficients shown are the marginal effects)

	Tsh 400 minimum price	Tsh 600 minimum price	Tsh 800 minimum price
Bid value	-0.0090261	-0.0039038	-0.0012629
	(4.30)**	(4.81)**	(5.16)**
Past year's coffee price over 400	0.0006527		
	(0.46)		
Past year's coffee price over 600		-0.0026790	
		(1.71)	
Past year's coffee price over 800			-0.0006620
			(0.57)
Per capita income (Tsh)	0.0000012	0.0000003	0.0000003
	(2.42)*	(1.11)	(1.55)
Share of cash to total income	-0.0057706	-0.0023305	-0.0003189
	(2.59)**	(1.57)	(0.42)
Share of coffee income to total hh income	0.0003355	0.0004097	0.0006375
	(0.14)	(0.23)	(0.69)
Per capita wealth (Tsh)	-0.0000002	-0.0000000	-0.0000001
	(1.45)	(0.37)	(1.58)
Total no of coffee trees	-0.0001807	-0.0000646	-0.0000451
	(3.35)**	(1.94)	(2.31)*
Education level in years	0.0083298	-0.0108838	0.0090695
	(0.51)	(0.87)	(1.33)
Price variability index	-0.0008361	-0.0007092	-0.0001800
	(1.98)*	(2.18)*	(1.46)
Price variability dummy	0.0631541	-0.0429331	-0.0307178
	(0.71)	(0.62)	(0.76)
Dum=1 income from coffee is unreliable	-0.0337031	-0.0043483	0.0164874
	(0.38)	(0.07)	(0.47)
Dum=1 cash income from coffee is important	0.3216173	0.1201364	-0.0088543
	(3.70)**	(1.83)	(0.29)
Dum=1=easy access to short term credit	0.0636030	-0.0385618	0.0703546
	(0.74)	(0.53)	(2.23)*
Dum=1 if in shock use savings	0.0965305	0.1321136	0.0241094
	(0.97)	(1.80)	(0.55)
Dum=1 if in shock use family assistance	0.1687670	0.0237026	0.0541970
	(1.53)	(0.28)	(1.35)
Dum=1 if in shock use other assistance	-0.0721058	0.0673944	0.0251723
	(0.50)	(0.80)	(0.49)
Dum=1 if in shock use new ways	-0.3302539	-0.1517489	-0.3812963
	(2.21)*	(1.36)	(3.76)**
Dum=1 hh income declined considerably previous years	0.1043057	0.0039699	0.0938717
	(1.01)	(0.06)	(1.61)
Banana production dummy	-0.0222660	-0.0447769	0.0263547
	(0.28)	(0.77)	(0.71)
Herfindhal index (cash income)	-0.0001741	0.0002906	-0.0003379
	(0.09)	(0.20)	(0.43)
Share of coffee input costs to coffee production value	-0.0019161	-0.0003314	0.0000865
	(2.35)*	(2.28)*	(1.50)
Observations	222	219	220
Pseudo R-squared	0.42	0.35	0.41

Robust z statistics in parentheses
* significant at 5%; ** significant at 1%

Proportion of correct predictions Tsh 400 contract	82.68
Proportion of correct predictions Tsh 600 contract	82.5
Proportion of correct predictions Tsh 800 contract	90.26

Table 6.8: WTP regressions for cashew nut producers in Ruvuma from round 1 (all coefficients shown are the marginal effects)

	Tsh 300 min price	Tsh 450 min price	Tsh 600 min price
Bid values	-0.0090467	-0.0076630	-0.0010566
	(4.38)**	(5.49)**	(5.29)**
Past year's price over 300	-0.0011836		
	(0.74)		
Past year's price over 450		0.0001488	
		(0.07)	
Past year's price over 600			-0.0000784
			(0.17)
Per capita income (Tsh)	0.0000008	0.0000005	0.0000001
	(1.40)	(0.93)	(2.24)*
Share of cash to total income	-0.0017829	-0.0014658	-0.0003859
	(0.90)	(0.75)	(1.05)
Share of cashew income in hh income	0.0003915	-0.0012232	0.0000373
	(0.19)	(0.63)	(0.14)
Per capita wealth (Tsh)	-0.0000009	-0.0000007	-0.0000000
	(1.75)	(1.46)	(0.00)
No of cashew nut trees	-0.0001245	-0.0000084	0.0000582
	(1.52)	(0.10)	(2.40)*
Education level in years	0.0041433	0.0087631	-0.0027313
	(0.25)	(0.54)	(0.87)
Price variability index	-0.0002580	-0.0008179	0.0000719
	(0.23)	(0.77)	(0.53)
Price variability control dummy	0.0117027	0.0991875	0.0107670
	(0.12)	(1.15)	(0.89)
Dum=1 cash income from cashew least reliable	-0.0848829	-0.0589842	-0.0297028
	(0.84)	(0.61)	(1.47)
Dum=1 cash income from cashew nuts is important	0.3081411	0.2497730	0.0407519
	(3.30)**	(2.76)**	(2.14)*
Dum=1 easy access to sort term credit	-0.0926290	-0.1847276	-0.0690627
	(0.75)	(1.62)	(2.36)*
Dum=1 if in shock use savings	0.0717601	0.0767879	-0.0234855
	(0.78)	(0.90)	(1.40)
Dum=1 if in shock use family assistance	-0.1549754	-0.0371895	-0.0161111
	(1.53)	(0.39)	(0.91)
Dum=1 if in shock use other assistance	0.0512585	0.1031238	0.0126341
	(0.38)	(0.76)	(1.04)
Dum=1 if in shock use new ways	-0.2694285	-0.2601832	0.0066565
	(2.25)*	(2.25)*	(0.51)
Dum=1 hh income declined considerably previous years	0.2634780	-0.0255109	0.0280563
	(2.31)*	(0.25)	(1.48)
Banana production dummy	0.0701050	0.0795912	
	(0.41)	(0.49)	
Herfindhal index (cash income)	-0.0001822	0.0010713	-0.0004128
	(0.10)	(0.65)	(1.94)
Share of cashew nut input costs to cashew nuts production value	-0.0001374	0.0002152	-0.0000506
	(0.22)	(0.39)	(0.54)
Observations	222	222	196
Pseudo R-squared	0.26	0.24	0.50

Robust z statistics in parentheses
* significant at 5%; ** significant at 1%

Proportion of correct predictions Tsh 300 contract	76.00
Proportion of correct predictions Tsh 450 contract	74.05
Proportion of correct predictions Tsh 600 contract	89.65

Source: Authors' computations

Table.6.9: Summary statistics of the predicted value of WTP for coffee minimum price insurance in Kilimanjaro from Round 1

Tsh 400 Minimum price contract			
	No of hh's	Average WTP	St. Dev.
WTP (Tsh)	63,803	92.06	77.82
WTP (Share of Tsh 400 min. price)	63,803	23.01	19.46
Tsh 600 minimum price contract			
	No of hh's	Average WTP	St. Dev.
WTP (Tsh)	58,619	140.96	100.94
WTP (Share of Tsh 600 min. price)	58,619	23.49	16.82
Tsh 800 minimum price contract			
	No of hh's	Average WTP	St. Dev.
WTP (Tsh)	60,116	233.67	85.46
WTP (Share of Tsh 800 min. price)	60,116	29.21	10.68

Source: Authors'computations

Table 6.10: Summary statistics of the predicted value of WTP for coffee minimum price insurance in Ruvuma from Round 1

Tsh 400 inimum price contract			
	No of hh's	Average WTP	St. Dev.
WTP (Tsh)	46,002	52.79	47.30
WTP (Share of Tsh 400 min. price)	46,002	13.20	11.82
Tsh 600 minimum price contract			
	No of hh's	Average WTP	St.Dev.
WTP (Tsh)	45,759	110.68	66.96
WTP (Share of Tsh 600 min. price)	45,759	18.44	11.16
Tsh 800 minimum price contract			
	No of hh's	Average WTP	St. Dev.
WTP (Tsh)	45,563	243.88	102.77
WTP (Share of Tsh 800 min. price)	45,563	30.48	12.84

Source: Authors'computations

Table 6.11: Summary statistics of the predicted value of WTP for cashew nut minimum price Insurance in Ruvuma from Round 1

Tsh 300 minimum price contract			
	No of hh's	Average WTP	St. Dev.
WTP (Tsh)	30,348	37.12	30.02
WTP (Share of Tsh 300 min. price)	30,348	12.37	10.01
Tsh 450 minimum price contract			
	No of hh's	Average WTP	St.Dev.
WTP (Tsh)	30,348	59.68	31.45
WTP (Share of Tsh 450 min. price)	30,348	13.26	6.99
Tsh 600 minimum price contract			
	No of hh's	Average WTP	St. Dev.
WTP (Tsh)	26,794	121.57	42.56
WTP (Share oTsh 600 min. price)	26,794	20.26	7.09

Source: Authors' computations

Table 6.12: Summary statistics of the predicted value of WTP for coffee and cashew nut minimum price Insurance in Kilimanjaro and Ruvuma from Round 2

	No of hh's	Average WTP	St. Dev.
WTP (Tsh)	58,211	338.06	183.43
WTP (Share of Tsh 800 min. price)	58,211	42.26	22.92
Ruvuma coffee Tsh 600 minimum price contract			
	No of hh's	**Average**	**St.Dev.**
WTP (Tsh)	49,597	27.67	70.93
WTP (Share of Tsh 600 min. price)	49,597	4.613	11.82
Ruvuma coffeeTsh 800 minimum price contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	52,236	132.01	96.39
WTP (Share of Tsh 800 min. price)	52,236	16.50	12.04
Ruvuma cashew Tsh 450 minimum price contract			
	No of hh's	**Average**	**St.Dev.**
WTP (Tsh)	39,507	36.56	26.17
WTP (Share of Tsh 450 min. price)	39,507	8.12	5.81
Ruvuma cashew Tsh 600 minimum price contract			
	No of hh's	**Average**	**St. Dev.**
WTP (Tsh)	38,691	83.04	67.64
WTP (Share of Tsh 600 min. price)	38,691	13.84	11.27

Source: Authors' computations

Table 6.13: Kilimanjaro coffee: welfare benefit and cost for minimum price insurance

Premium rule	Premium value (Tsh/kg)	Quantity insured (tonnes)	Number of households	Total premium (Tsh million)	Premium as share of coffee sales (percent)	Consumer surplus (Tsh million)	Consumer surplus as share of coffee sales (percent)
Tsh 400 minimum price							
Mean WTP	92.1	1202.6	30,700	110.7	23.2	77.7	16.3
Mean WTP + 1 SD	169.9	408.0	9,322	69.3	49.3	19.9	14.1
Mean WTP - 1 SD	14.2	2511.7	48,937	35.8	3.1	219.0	19.3
Tsh 600 minimum price							
Mean WTP	141.0	1407.3	28,705	198.4	33.0	127.8	21.3
Mean WTP + 1 SD	241.9	485.4	10,492	117.4	62.5	34.5	18.4
Mean WTP - 1 SD	40.0	2566.7	48,064	102.7	9.2	307.0	27.5
Tsh 800 minimum price							
Mean WTP	233.7	1692.2	36,305	395.4	53.1	183.5	24.7
Mean WTP + 1 SD	319.1	898.9	21,270	286.9	79.9	78.2	21.8
Mean WTP - 1 SD	148.2	2439.3	46,617	361.5	34.3	371.6	35.2
Mean WTP - 2 SD	62.8	2963.2	54,551	185.9	14.3	653.0	50.3

Source. Authors' calculations

Table 6.14: Ruvuma coffee: Welfare benefit and cost for minimum price insurance

Premium rule	Premium value (Tsh/kg)	Quantity insured (tonnes)	Number of households	Total premium (Tsh million)	Premium as share of coffee sales (percent)	Consumer surplus (Tsh million)	Consumer surplus as share of coffee sales (percent)
Tsh 400 minimum price							
Mean WTP	52	7001.0	20,235	364.1	6.2	320.5	5.4
Mean WTP + 1 SD	99	2324.7	7,966	230.2	3.9	94.1	1.6
Mean WTP - 1 SD	5	11200.0	36,315	56.0	0.9	713.9	12.1
Tsh 600 minimum price							
Mean WTP	110	6691.5	20,552	736.1	12.5	492.0	8.3
Mean WTP + 1 SD	176	3608.9	9,988	635.2	10.7	118.8	2.0
Mean WTP - 1 SD	44	12400.0	38,425	545.6	9.2	1048.3	17.7
Tsh 800 minimum price							
Mean WTP	243	7514.8	21,870	1826.1	30.9	696.6	11.8
Mean WTP + 1 SD	345	2447.1	6,397	844.2	14.3	209.8	3.5
Mean WTP - 1 SD	141	11500.0	38,696	1621.5	27.4	1592.6	26.9
Mean WTP - 2 SD	39	13600.0	45,135	530.4	9.0	2926.4	49.5

Source. Authors' calculations

Table 6.15: Ruvuma cashew nuts: Welfare benefit and cost for minimum price insurance

Premium rule	Premium value (Tsh/kg)	Quantity insured (tonnes)	Number of households	Total premium (Tsh million)	Premium as share of cashew nut sales (percent)	Consumer surplus (Tsh million	Consumer surplus as share of cashew nut sales (percent)
300 Tsh minimum price							
Mean WTP	37	4132.1	14,903	152.9	3.9	114.5	3.0
Mean WTP + 1 SD	67	1767.0	5,312	118.4	3.1	29.0	0.7
Mean WTP - 1 SD	7	6469.0	23,789	45.3	1.2	276.4	7.1
450 Tsh minimum price							
Mean WTP	59	4332.9	15,720	255.6	6.6	106.1	2.7
Mean WTP + 1 SD	90	1461.9	4,473	131.6	3.4	22.3	0.6
Mean WTP - 1 SD	28	6537.7	25,026	183.1	4.7	289.2	7.5
600 Tsh minimum price							
Mean WTP	121	3470.9	12,903	420.0	10.8	147.1	3.8
Mean WTP + 1 SD	163	1001.4	3,552	163.2	4.2	55.6	1.4
Mean WTP - 1 SD	79	6073.0	22,773	479.8	12.4	380.1	9.8
Mean WTP - 2 SD	37	6740.5	26,641	249.4	6.4	612.4	15.8

Source: Authors' calculations

Table 6.16: Percentage of households who report a given number of years out of the last ten, when rainfall was in the indicated subjective range

			Kilimanjaro		
Number of years	Much below	Somewhat below	Normal	Somewhat above	Much above
0	3.6	12.6	1.8	32.0	11.8
1	22.6	20.6	5.9	37.9	81.1
2	32.0	32.9	21.0	25.7	6.4
3	20.0	24.4	27.5	4.0	0.6
4	13.4	7.5	21.2	0.3	0.1
5	5.2	1.2	9.8	0.1	0.0
6	2.0	0.7	6.3	0.0	0.0
7	0.6	0.1	3.1	0.0	0.0
8	0.4	0.0	2.0	0.0	0.0
9	0.1	0.0	0.6	0.0	0.0
10	0.0	0.0	0.8	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0
			Ruvuma		
Number of years	Much below	Somewhat below	Normal	Somewhat above	Much above
0	60.7	25.5	0.3	30.9	31.2
1	23.2	27.1	3.1	32.3	55.9
2	10.9	28.7	4.1	24.5	10.4
3	4.3	11.3	7.1	8.6	2.1
4	0.5	6.1	14.1	2.8	0.1
5	0.2	1.0	14.5	0.3	0.1
6	0.2	0.3	18.8	0.1	0.0
7	0.0	0.0	14.7	0.4	0.1
8	0.0	0.0	10.9	0.1	0.0
9	0.0	0.0	8.2	0.0	0.0
10	0.0	0.0	4.2	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

Source: Authors' calculations

Table 6.17: Average number of years in past 10 that households and village officials report rainfall as being in different ranges

Rainfall incidence past decade (number of years)				
	Household responses		Chairman responses	
	Mean	StDev	Mean	StDev
Kilimanjaro				
Much below	2.47	1.42	2.38	1.12
Somewhat below	2.01	1.23	2.68	1.68
Normal	3.53	1.77	3.19	2.05
Somewhat above	1.03	0.88	0.74	0.87
Much above	0.96	0.47	1.02	0.60
Ruvuma				
Much below	0.63	0.94	0.64	0.95
Somewhat below	1.50	1.24	0.87	1.41
Normal	5.78	2.21	7.05	1.96
Somewhat above	1.24	1.15	0.43	0.93
Much above	0.85	0.74	1.01	0.69

Source: Authors' calculations

Table 6.18: Similarity between farmers' perceptions concerning rainfall (Index 1)

Similarity index of rainfall incidence assessment between households from village average (number of years) (1)						
Kilimanjaro	**Rombo**	**Mwanga**	**Same**	**Moshi**	**Hai**	**Overall**
Much below	0.23	0.23	0.25	0.21	0.20	0.22
Somewhat below	0.23	0.26	0.27	0.24	0.22	0.24
Normal	0.18	0.22	0.23	0.18	0.16	0.18
Somewhat above	0.37	0.35	0.35	0.37	0.29	0.35
Much above	0.15	0.20	0.12	0.14	0.11	0.14
Ruvuma	**Songea**	**Tunduru**	**Mbinga**	**Namtumbo**		**Overall**
Much below	0.51	0.52	0.74	0.47		0.61
Somewhat below	0.26	0.27	0.40	0.36		0.34
Normal	0.18	0.16	0.14	0.14		0.15
Somewhat above	0.36	0.39	0.34	0.36		0.36
Much above	0.21	0.35	0.35	0.31		0.32

Source: Authors' calculations

(1) The similarity index is estimated from the proportions p=x/10 and q=1/N*Σ(p), where p are the number of years out of the previous 10 a household declares that rainfall was in one of the ranges above, and N is the total number of households reporting in a village. The index is calculated as D= Σ(|p-q|) / (2Σp). D ranges from perfect similarity (0) to perfect dissimilarity (1).

Table 6.19: Similarity between farmers' perceptions concerning rainfall (Index 2)

Similarity index of rainfall incidence assessment between households from village average (number of years) (1)						
Kilimanjaro	**Rombo**	**Mwanga**	**Same**	**Moshi**	**Hai**	**Overall**
Much below	0.77	0.77	0.75	0.79	0.80	0.78
Somewhat below	0.77	0.74	0.73	0.76	0.78	0.76
Normal	0.82	0.78	0.77	0.82	0.84	0.82
Somewhat above	0.63	0.65	0.65	0.63	0.71	0.65
Much above	0.85	0.80	0.88	0.86	0.89	0.86
Ruvuma	**Songea**	**Tunduru**	**Mbinga**	**Namtumbo**		**Overall**
Much below	0.49	0.48	0.26	0.53		0.39
Somewhat below	0.74	0.73	0.60	0.64		0.66
Normal	0.82	0.84	0.86	0.86		0.85
Somewhat above	0.64	0.61	0.66	0.64		0.64
Much above	0.79	0.65	0.65	0.69		0.68

Source: Authors' calculations

(1) The similarity index is estimated from the proportions p=x/10 and q=1/N*Σ(p), where p are the number of years out of the previous 10 a household declares that rainfall was in one of the ranges above, and N is the total number of households reporting in a village. The index is calculated as D= D= 2 Σ min(p ,q) / (Σp + Σq). It ranges from perfect similarity (1) to perfect dissimilarity (0).

Table: 6.20 Perceptions of households concerning rainfall

If rainfall was 1/10, ¼, ⅓ or ½ below normal you would say that it was (% of household responses):	**Normal**	**Somewhat below**	**A lot below**	**NA**	**Total**
Kilimanjaro					
1/10 below normal	19.9	52.34	25.85	1.91	100
1/4 below normal	1.69	32.41	63.99	1.91	100
1/3 below normal	2.63	8.49	86.86	2.02	100
1/2 below normal	0.21	1.46	96.42	1.91	100
Number of households	**182,775**				
Ruvuma					
1/10 below normal	28.28	53.55	15.71	2.46	100
1/4 below normal	2.55	37.17	57.96	2.32	100
1/3 below normal	0.87	12.22	84.6	2.32	100
1/2 below normal	0.08	1.59	96.01	2.32	100
Number of households	**161,619**				

Source: Authors' calculations

Table 6.21: Reasons for which households indicated they were not interested in rainfall (or drought) insurance

Why not interested in drought insurance? (% out of total households in the region)	
Kilimanjaro	
I cannot pay any amount for rainfall	29.28
I am short of funds in the period before planting	1.98
I have other pressing cash needs in the period before planting	1.15
Declines in rainfall do not hurt me too much	4.70
I have other means of covering losses due to bad rainfall	0.82
Major declines in rainfall do not occur too often	0.94
Other	14.32
% of households not interested	53.19
Total number of households	**182,775**
Ruvuma	
I cannot afford to pay any amount	20.71
I am short of funds in the period before planting	0.78
I have other pressing cash needs in the period before planting	0.46
Declines in rainfall do not hurt me too much	17.32
I have other means of recovering losses due to bad rainfall	0.21
Major droughts do not occur too often	20.20
Other	3.48
NA	2.44
% of households not interested	65.60
Total number of households	**161,619**

Source: Authors' calculations

Table 6.22: Determinants of interest in drought insurance

Interest in drought insurance participation	Kilimanjaro (1)	Ruvuma (2)
	Interested in rainfall insurance	Interested in rainfall insurance
Education of head of hhlds (years)	0.0078351	0.0199430
	(0.92)	(2.26)*
Education control dummy	-0.1233392	-0.1007000
	(1.89)	(1.54)
Household size (number of adult equivalents)	0.0123204	-0.0043820
	(1.27)	(0.40)
Per capita hh income (Tsh 000)	0.0005553	0.0001916
	(4.26)**	(1.10)
Share of cash to total gros income	0.0014562	0.0001747
	(1.51)	(0.17)
Per capita wealth (Tsh)	-0.0000000	-0.0000001
	(1.06)	(1.05)
Number of all kinds of trees	0.0000306	0.0000145
	(1.02)	(0.51)
Land cultivated (acres)	-0.0067593	0.0031886
	(0.65)	(1.07)
Number of animals (cattle equivalent)	0.0027093	-0.0014309
	(0.63)	(0.11)
Herfindhal Index of total gross income diversification	-0.0018540	0.0005755
	(1.66)	(0.44)
Proportion of irrigated land	0.0010499	0.0005606
	(1.27)	(0.17)
Dummy: 1=drought since 1998 affected living conditions	0.0198140	
	(0.41)	
Number of yrs in past 10, when total hhld income declined a lot below average	-0.0109973	
	(0.86)	
Number of yrs in past 10, when cash income from coffee production and sales was much average	0.0041335	
	(0.35)	
Dummy: 1=easy access to short term credit	-0.0192579	0.1436749
	(0.29)	(2.26)*
Dum=1 if when shock occurred used own savings	0.1673770	-0.0281507
	(3.72)**	(0.54)
Dum=1 if when shock occurred used family assistance	-0.0926325	0.0477785
	(1.77)	(0.65)
Dum=1 if when shock occurred used other assistance	0.0287514	-0.1953010
	(0.30)	(2.12)*
Dum=1 if when shock occurred used new ways of generating income	0.0231376	0.1837596
	(0.43)	(2.47)*
Coffee production dummy	0.0596198	-0.0970719
	(0.96)	(1.00)
Banana production dummy	0.0154995	0.0835044
	(0.24)	(1.79)
Rainfall on farm last year below average		0.0418547
		(0.71)
Number of years in past 10 when revenue per acre was less than half of nornal		0.0062711
		(0.45)
Dum=1 hh income declined considerably in previous years		-0.0822377
		(1.60)
Dum=1 cash income from cash crop production and sales is most or second most unreliable		-0.0252610
		(0.54)
Cashew production dummy		0.1976408
		(2.29)*
Tobacco production dummy		-0.0222234
		(0.14)
Observations	914	833
Pseudo R-squared	0.14	0.10
Wald chi2	164.03	95.67
Proportion of correct predictions	68.4	69.7

Source. Authors' calculations
Robust z statistics in parentheses:* significant at 5%; ** significant at 1%.

Table 6.23: WTP for weather insurance in Kilimanjaro under a hypothetical 10 % decline in rainfall below normal

	(1)	(2)	(3)
	Indemnity Tsh 22,000/acre	Indemnity Tsh 38,000/acre	Indemnity Tsh 61,000/acre
Bid for type A contracts	-0.0000315		
	(5.08)**		
Bid for type B contracts		-0.0000172	
		(5.32)**	
Bid for type C contracts			-0.0000107
			(5.61)**
Education of head (years)	0.0031947	-0.0036556	0.0029070
	(0.38)	(0.48)	(0.39)
Education control dummy	-0.1561989	-0.0904394	-0.1428214
	(2.48)*	(1.61)	(2.72)**
Househodl size (number of adult equivalent)	0.0143268	0.0187827	0.0137327
	(1.51)	(2.22)*	(1.65)
Per capita hhld income (Tsh)	0.0000003	0.0000004	0.0000005
	(2.55)*	(3.22)**	(4.02)**
Share of cash to total gros income	0.0027130	0.0034428	0.0027574
	(2.79)**	(3.70)**	(3.09)**
Per capita hhld wealth	-0.0000000	0.0000000	0.0000000
	(0.10)	(0.56)	(0.49)
Number of all kinds of trees	0.0000380	0.0000187	-0.0000037
	(1.28)	(0.70)	(0.14)
Cultivated land (acres)	-0.0086896	-0.0093607	-0.0050140
	(0.85)	(1.03)	(0.57)
Number of animals (cattle equivalent)	0.0048587	0.0047200	0.0050213
	(1.14)	(1.35)	(1.38)
Herfindhal Index of total gross income diversification	-0.0023396	-0.0014617	-0.0004046
	(2.17)*	(1.48)	(0.42)
Proportion of irrigated land	0.0001179	0.0003894	-0.0005272
	(0.15)	(0.52)	(0.74)
Dummy: 1=drought since 1998 affected living conditions	0.0279978	0.0583691	0.0724507
	(0.59)	(1.35)	(1.71)
Number of years in past 10, when total hhld income declined a lot below normal	-0.0101021	-0.0099038	-0.0081291
	(0.83)	(0.87)	(0.73)
Number of yrs in past 10, when cash income from cash crop production and sales declined a lot below normal	0.0023509	0.0050296	0.0051951
	(0.21)	(0.49)	(0.51)
Dummy: 1= easy access to short term credit	0.0348105	0.0859783	0.0782608
	(0.54)	(1.39)	(1.30)
Dum=1 if when shock occurred used own savings	0.2026496	0.2794222	0.2419975
	(4.58)**	(6.62)**	(5.91)**
Dum=1 if when shock occurred used family assistance	-0.1211117	-0.1351296	-0.0845148
	(2.41)*	(3.14)**	(1.98)*
Dum=1 if when shock occurred used other assistance	0.0414985	0.0841996	0.1905354
	(0.45)	(0.98)	(2.14)*
Dum=1 if when shock occurred used new ways to earn income	-0.0178091	-0.0619279	-0.0573487
	(0.34)	(1.33)	(1.24)
Coffee production dummy	0.0407135	0.0891714	0.0984441
	(0.68)	(1.64)	(1.85)
Banana production dummy	-0.0027592	-0.0229183	-0.0190289
	(0.04)	(0.39)	(0.33)
Observations	914	914	914
Pseudo R-squared	0.15	0.18	0.18
Proportion of correct predictions	70.72	74.29	75.95

Source: Authors' calculations
Robust z statistics in parentheses.* significant at 5%; ** significant at 1%

Table 6.24: WTP for weather Insurance in Ruvuma under a hypothetical 10 % decline in rainfall below normal

Ruvuma WTP for –10% drought insurance			
	(1)	(2)	(3)
	Insured for Tsh 2,000/acre	Insured for Tsh 21,000/acre	Insured for Tsh 35,000/acre
Bid for type A contracts	-0.0000201		
	(1.42)		
Bid for type B contracts		-0.0000131	
		(1.81)	
Bid for type C contracts			-0.0000108
			(2.39)*
Education of head (years)	0.0199428	0.0222907	0.0231836
	(2.61)**	(3.62)**	(4.06)**
Education control dummy	-0.0797984	-0.0366186	-0.0275677
	(1.42)	(0.86)	(0.78)
Household size (number of adult equivalent)	-0.0102901	0.0013952	0.0084963
	(1.05)	(0.18)	(1.34)
Per capita hhld income (Tsh)	0.0000001	0.0000001	0.0000002
	(0.67)	(1.24)	(2.42)*
Share of cash to total gros income	0.0006158	0.0002535	-0.0004480
	(0.65)	(0.35)	(0.72)
Per capita hhld wealth	-0.0000001	-0.0000000	-0.0000000
	(1.18)	(0.05)	(0.50)
Number of all kinds of trees	0.0000023	0.0000268	0.0000020
	(0.09)	(1.36)	(0.13)
Cultivated land (acres)	0.0044995	0.0027647	0.0010803
	(1.61)	(1.28)	(0.59)
Number of animals (cattle equivalent)	-0.0020542	0.0004405	0.0040489
	(0.18)	(0.05)	(0.57)
Herfindhal Index of total gross income diversification	0.0015841	0.0001133	0.0003609
	(1.39)	(0.13)	(0.49)
Proportion of irrigated land	0.0024497	-0.0010135	-0.0006673
	(0.86)	(0.51)	(0.42)
Rainfall last year was below normal	-0.0025291	0.0373883	0.0230414
	(0.05)	(0.89)	(0.67)
Number of years in past 10 when revenue per acre was less than half of nornal	-0.0006033	-0.0087851	0.0028336
	(0.05)	(0.94)	(0.36)
Dum=1 hh income declined considerably in previous years	-0.0046807	-0.0020361	-0.0078805
	(0.10)	(0.06)	(0.26)
Dum=1 cash income from cash crop production and sales is most or second most unreliable	-0.0335038	-0.0006277	0.0322233
	(0.80)	(0.02)	(1.11)
Dummy: 1=easy access to short term credit	0.0672123	-0.0735353	-0.0509876
	(1.21)	(1.93)	(1.64)
Dum=1 if when shock occurred used own savings	0.0629001	0.1291919	0.1265810
	(1.30)	(3.14)**	(3.52)**
Dum=1 if when shock occurred used family assistance	-0.0735346	-0.0958323	-0.0590380
	(1.19)	(2.41)*	(1.76)
Dum=1 if when shock occurred used other assistance	-0.0876488	-0.0369287	-0.0440579
	(1.03)	(0.53)	(0.81)
Dum=1 if when shock occurred used new ways to earn income	0.1987073	0.1166692	0.1605734
	(2.92)**	(2.17)*	(3.13)**
Coffee production dummy	-0.1043865	-0.0171953	-0.0662357
	(1.19)	(0.24)	(1.39)
Cashew production dummy	0.1117819	-0.0261707	0.0065172
	(1.41)	(0.45)	(0.13)
Tobacco production dummy	0.0374690	0.2270147	0.2607588
	(0.25)	(1.57)	(2.07)*
Banana production dummy	0.0567938	-0.0012286	-0.0078831
	(1.36)	(0.04)	(0.31)
Observations	833	810	812
Pseudo R-squared	0.10	0.15	0.18
Proportion of correct predictions	75.6	82.39	85.82

Source: Authors' calculations
Robust z statistics in parentheses. * significant at 5%; ** significant at 1%

Table 6.25: WTP for weather insurance in Kilimanjaro under a hypothetical ⅓ decline in rainfall below normal

Kilimanjaro WTP for –30% drought insurance			
	(1)	(2)	(3)
	Indemnity Tsh 24,000/acre	Indemnity Tsh 4,1000/acre insurance	Indemnity Tsh 66000/acre
Bid for type A contracts	-0.0000300		
	(5.00)**		
Bid for type B contracts		-0.0000177	
		(5.04)**	
Bid for type C contracts			-0.0000110
			(5.02)**
Education of head (years)	0.0091647	0.0060331	0.0072183
	(1.15)	(0.79)	(0.97)
Education control dummy	-0.0985363	-0.1041472	-0.1001461
	(1.60)	(1.86)	(1.86)
Household size (number of adult equivalent)	0.0170123	0.0229299	0.0272600
	(1.87)	(2.67)**	(3.26)**
Per capita hhld income (Tsh)	0.0000004	0.0000004	0.0000005
	(3.57)**	(3.69)**	(4.24)**
Share of cash to total gross income	0.0035510	0.0037464	0.0036529
	(3.45)**	(3.90)**	(3.83)**
Per capita hhld wealth	0.0000000	0.0000000	0.0000000
	(0.55)	(0.93)	(1.22)
Number of all kinds of trees	0.0000263	0.0000212	0.0000202
	(0.96)	(0.81)	(0.80)
Cultivated land (acres)	-0.0135037	-0.0098023	-0.0090659
	(1.34)	(1.03)	(0.98)
Number of animals (cattle equivalent)	0.0079945	0.0054865	0.0036573
	(1.86)	(1.47)	(1.08)
Herfindhal Index of total gross income diversification	-0.0003668	-0.0006151	-0.0003552
	(0.34)	(0.61)	(0.36)
Proportion of irrigated land	0.0003012	0.0002210	-0.0000090
	(0.38)	(0.29)	(0.01)
Dummy: 1=drought since 1998 affected living conditions	0.0841162	0.0627385	0.0622337
	(1.85)	(1.44)	(1.48)
Number of years in past 10, when total hhld income declined a lot below normal	-0.0006705	-0.0048672	-0.0082863
	(0.06)	(0.43)	(0.75)
Number of yrs in past 10, when cash income from cash crop production and sales declined a lot below normal	0.0023762	0.0049419	0.0017756
	(0.22)	(0.48)	(0.17)
Dummy: 1= easy access to short term credit	0.0312531	0.0215146	0.0359027
	(0.49)	(0.35)	(0.59)
Dum=1 if when shock occurred used own savings	0.2214839	0.2256798	0.2092927
	(5.13)**	(5.38)**	(5.08)**
Dum=1 if when shock occurred used family assistance	-0.1099834	-0.0715529	-0.0648006
	(2.34)*	(1.58)	(1.45)
Dum=1 if when shock occurred used other assistance	0.0804023	0.0953053	0.1028760
	(0.88)	(1.11)	(1.24)
Dum=1 if when shock occurred used new ways to earn income	-0.0644691	-0.0617310	-0.0632049
	(1.31)	(1.31)	(1.37)
Coffee production dummy	0.1073478	0.1124155	0.1139989
	(1.89)	(2.05)*	(2.14)*
Banana production dummy	-0.0024261	-0.0200338	-0.0052259
	(0.04)	(0.34)	(0.09)
Observations	914	914	914
Pseudo R-squared	0.18	0.17	0.17
Proportion of correct predictions	71.69	73.21	73.79

Source: Authors' calculations

Robust z statistics in parentheses * significant at 5%; ** significant at 1%

Table 6.26: WTP for weather insurance in Ruvuma under a hypothetical ⅓ decline in rainfall below normal

Ruvuma WTP for –30% drought insurance			
	(1)	(2)	(3)
	Insured for Tsh 20,000Tsh/acre	Minimum price Tsh 35,000/acre insurance	Insured for Tsh 58,000/acre
Bid for type A contracts	-0.0000195		
	(1.57)		
Bid for type B contracts		-0.0000112	
		(1.29)	
Bid for type C contracts			-0.0000082
			(1.48)
Education of head (years)	0.0156553	0.0180050	0.0125218
	(2.28)*	(3.15)**	(2.41)*
Education control dummy	-0.0636741	-0.0849125	-0.0666985
	(1.32)	(2.62)**	(2.14)*
Household size (number of adult equivalent)	-0.0124502	-0.0055754	-0.0116430
	(1.46)	(0.75)	(1.78)
Per capita hhld income (Tsh)	0.0000002	0.0000002	0.0000002
	(1.61)	(2.16)*	(2.28)*
Share of cash to total gros income	-0.0011136	0.0000158	0.0001109
	(1.35)	(0.02)	(0.17)
Per capita hhld wealth	-0.0000000	-0.0000000	-0.0000000
	(0.82)	(0.69)	(0.80)
Number of all kinds of trees	0.0000292	0.0000523	0.0000305
	(1.34)	(2.93)**	(1.91)
Cultivated land (acres)	0.0033710	-0.0005541	0.0000757
	(1.46)	(0.28)	(0.04)
Number of animals (cattle equivalent)	-0.0018995	0.0020131	0.0011521
	(0.18)	(0.24)	(0.14)
Herfindhal Index of total gross income diversification	-0.0004036	-0.0007188	-0.0010151
	(0.38)	(0.81)	(1.25)
Proportion of irrigated land	0.0002726	0.0012906	0.0003175
	(0.13)	(0.78)	(0.21)
Rainfall last year was below normal	0.0540662	0.0689318	0.0838694
	(1.16)	(1.75)	(2.23)*
Number of years in past 10 when revenue per acre was less than half of normal	0.0058144	-0.0013220	0.0040106
	(0.59)	(0.16)	(0.51)
Dum=1 hh income declined considerably in previous years	-0.0453940	-0.0456861	0.0139311
	(1.10)	(1.31)	(0.46)
Dum=1 cash income from cash crop production and sales is most or second most unreliable	-0.0226970	-0.0132588	0.0113432
	(0.64)	(0.43)	(0.38)
Dummy: 1=easy access to short term credit	0.0688008	0.0053823	-0.0087103
	(1.35)	(0.14)	(0.25)
Dum=1 if when shock occurred used own savings	-0.0226302	0.0417450	0.0897612
	(0.54)	(1.11)	(2.54)*
Dum=1 if when shock occurred used family assistance	0.0298734	-0.0191174	-0.0206631
	(0.52)	(0.43)	(0.54)
Dum=1 if when shock occurred used other assistance	-0.0405295	0.0367069	0.0284975
	(0.55)	(0.52)	(0.45)
Dum=1 if when shock occurred used new ways to earn income	0.1121665	0.0877135	0.0528945
	(1.98)*	(1.79)	(1.23)
Coffee production dummy	-0.0452696	-0.0807284	-0.0790873
	(0.55)	(1.25)	(1.30)
Cashew production dummy	0.0123894	0.0478020	-0.0282782
	(0.20)	(0.84)	(0.57)
Tobacco production dummy	0.0912742	0.0874516	0.1329693
	(0.78)	(0.77)	(1.26)
Banana production dummy	0.0478922	0.0331855	0.0568675
	(1.29)	(1.12)	(2.14)*
Observations	833	806	833
Pseudo R-squared	0.11	0.16	0.14
Proportion of correct predictions	80.25	83.97	86.14

Source: Authors' calculations
Robust z statistics in parentheses. * significant at 5%; ** significant at 1%

Table 6.27: Summary statistics of the WTP for rainfall insurance in Kilimanjaro

Drought WTP Kilimanjaro –10% rainfall decline below normal			
Tsh 22,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	182539	4997.7	5491.4
WTP (Share on Tsh 22,000)	182539	22.7	25.0
Tsh 38,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	182539	5082.3	7747.4
WTP (Share of Tsh 38,000)	182539	13.4	20.4
Tsh 61,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	182539	7591.3	12536.7
WTP (Share of Tsh 61,000)	182539	12.4	20.6
Drought WTP Kilimanjaro –1/3 rainfall decline below normal			
Tsh 24,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	182539	3417.7	4995.7
WTP (Share Tsh 24,000)	182539	14.2	20.8
Tsh 41,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	182539	4404.4	7141.7
WTP (Share Tsh 41,000)	182539	10.7	17.4
Tsh 66,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	182539	6408.0	10884.8
WTP (Share Tsh 66,000)	182539	9.7	16.5

Source: Authors' calculations

Table 6.28: Summary statistics of the WTP for rainfall insurance in Ruvuma

Drought WTP Ruvuma –10% Rainfall decline below normal			
Tsh 12,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	161530	741.3	2393.8
WTP (Share on Tsh 12000)	161530	6.2	19.9
Tsh 21,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	159736	620.0	2423.4
WTP (Share on Tsh 21000)	159736	3.0	11.5
Tsh 35,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	158317	990.2	3246.8
WTP (Share onTsh 35000)	158317	2.8	9.3
Drought WTP Ruvuma –⅓ rainfall decline below normal			
Tsh 20,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	161530	219.3	1142.1
WTP (Share on Tsh 20000)	161530	1.1	5.7
Tsh 35,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	156346	407.7	1978.4
WTP (Share of Tsh 35000)	156346	1.2	5.7
Tsh 58,000 Contract			
	No of hh's	**Average WTP**	**St. Dev.**
WTP (Tsh)	161530	413.0	2248.4
WTP (Share of Tsh 58000)	161530	0.7	3.9

Source: Authors' calculations

Table 6.29: Kilimanjaro welfare benefits and cost of rainfall insurance

	Premium value (Tsh000/ acre)	Acres insured	Number of households	Total premium (Tsh million)	Premium as share of crop sales	Consumer surplus (Tsh million)	Consumer surplus as share of crop sales	Acres cultivated
Kilimanjaro surplus estimation from insurance against 10% rainfall reduction								
Tsh 22,000 Contact								
At mean WTP	5.0	118,434.6	77,061.4	591.9	3.3	829.8	4.7	241,611
At +1 Sdev WTP	10.5	66,715.2	32,504.1	699.8	7.6	320.5	3.5	117,800
Tsh 38,000 Contract								
At mean WTP	5.1	86,208.6	61,570.6	438.1	2.8	1,017.8	6.5	204,385
At +1 Sdev WTP	12.8	45,581.9	27,589.5	584.8	6.8	481.2	5.6	108,665
Tsh 61,000 Contract								
At mean WTP	7.6	86,180.1	61,098.4	654.2	4.1	1,633.0	10.1	202,950
At +1 Sdev WTP	20.1	47,389.1	27,018.2	953.8	10.9	765.9	8.7	100,551
Total number of households/acres			182,834					504,152

	Premium value (Tsh000/ acre)	Acres insured	Number of households	Total premium (Tsh million)	Premium as share of crop sales	Consumer surplus (Tsh million)	Consumer surplus as share of crop sales	Acres cultivated
Kilimanjaro surplus estimation from insurance against ⅓ rainfall reduction								
Tsh 24,000 Contact								
At mean WTP	3.4	109,298.2	64,430.4	373.5	2.3	794.2	4.9	211,256
At +1 Sdev WTP	8.4	61,629.1	28,708.7	518.5	6.3	340.6	4.2	102,873
Tsh 41,000 Contract								
At mean WTP	4.4	94,289.6	59,689.5	415.3	2.6	1,033.2	6.5	208,050
At +1 Sdev WTP	11.5	50,843.9	28,165.2	587.0	6.6	492.0	5.5	106,507
Tsh 66,000 Contract								
At mean WTP	6.4	88,234.4	57,586.1	565.4	3.6	1,477.6	9.3	197,650
At +1 Sdev WTP	17.3	51,161.1	27,323.6	884.7	8.9	723.4	7.3	105,086
Total number of households			182,834					504,152

Source.: Authors' calculations

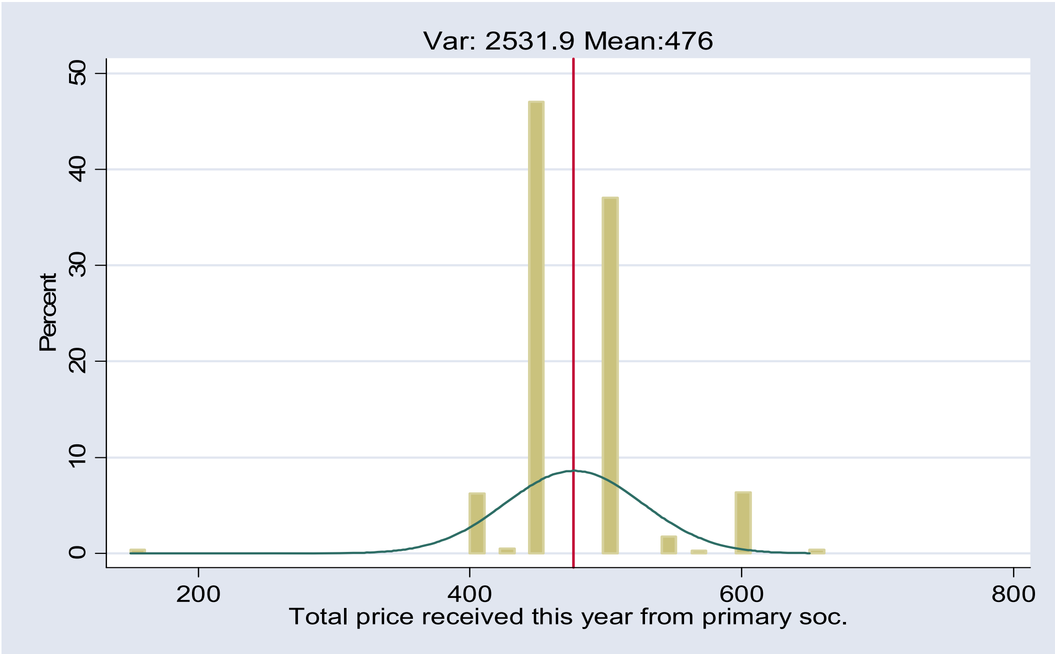
Table 6.30: Ruvuma welfare benefits and cost of rainfall insurance

Ruvuma surplus estimation from insurance against 10 percent rainfall reduction								
	Premium value (Tsh000/ acre)	Acres insured	Number of households	Total premium (Tsh million)	Premium as share of crop sales	Consumer surplus (Tsh million)	Consumer surplus as share of crop sales	Acres cultivated
Tsh 12,000 Contact								
At mean WTP	0.7	51,380.0	21,671.6	38.1	0.4	336.4	3.9	194,069
At +1 Sdev WTP	3.1	37,567.7	13,979.2	117.8	1.9	224.1	3.7	130,920
Tsh 21,000 Contract								
At mean WTP	0.6	38,848.3	16,219.2	24.1	0.3	271.4	3.6	164,927
At +1 Sdev WTP	3.0	32,408.6	11,608.0	98.6	1.7	186.9	3.3	115,648
Tsh 35,000 Contract								
At mean WTP	1.0	39,085.6	21,761.9	38.7	0.4	285.4	3.0	211,464
At +1 Sdev WTP	4.2	20,199.1	13,295.0	85.6	1.3	188.8	2.8	138,996
Total number of households			162,722					1,216,465
Ruvuma surplus estimation from insurance against ⅓ rainfall reduction								
	Premium value (000Tsh/ acre)	Acres insured	Number of households	Total premium (Tsh million)	Premium as shareof crop sales	Consumer surplus (Tsh million)	Consumer surplus as share of crop sales	Acres cultivated
Tsh 20,000 Contact								
At mean WTP	0.2	22,599.0	9,845.8	5.0	0.1	85.0	1.8	99,095
At +1 Sdev WTP	1.4	16,967.0	7,013.9	23.1	0.6	65.8	1.6	65,343
Tsh 35,000 Contract								
At mean WTP	0.4	23,506.3	9,934.5	9.6	0.2	133.0	2.5	80,088
At +1 Sdev WTP	2.4	15,461.9	7,772.3	36.9	0.9	101.0	2.4	53,928
Tsh 58,000 Contract								
At mean WTP	0.4	24,918.8	9,571.2	10.3	0.2	168.1	3.6	77,978
At +1 Sdev WTP	2.7	14,421.9	6,277.4	38.4	1.0	130.2	3.5	44,749
Total number of households			162,722					1,216,465

Source: Authors' calculations

Figure 6.1: Frequency distribution of prices received for coffee by coffee producers selling to primary societies or private buyers in Kilimanjaro in 2003

1A: Selling only to Primary Societies



1B: Selling only to Private

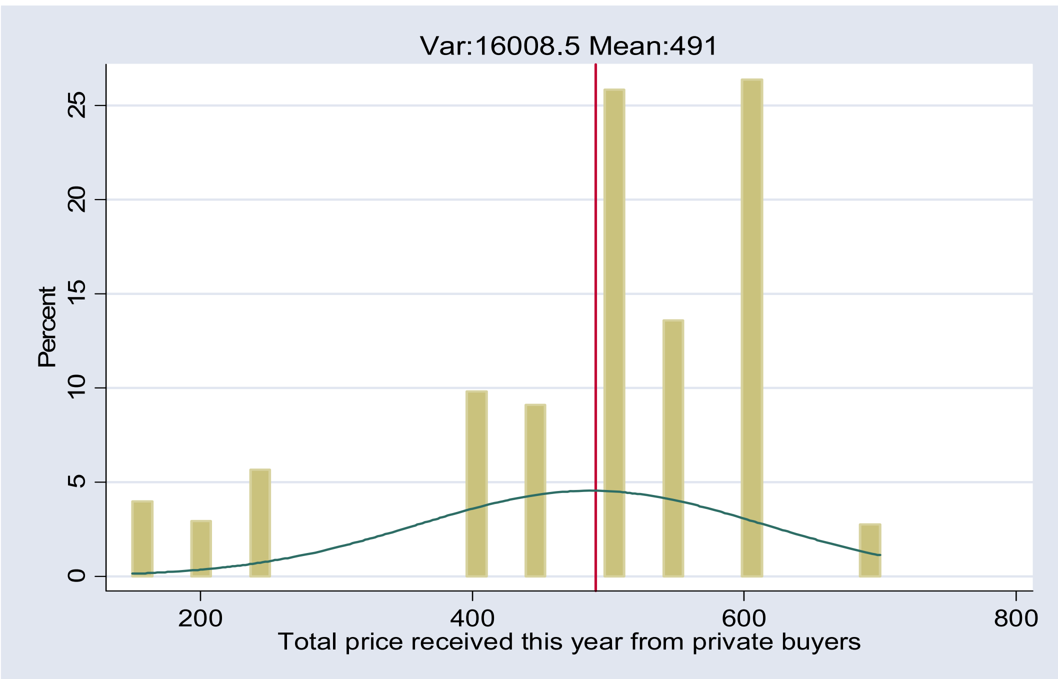
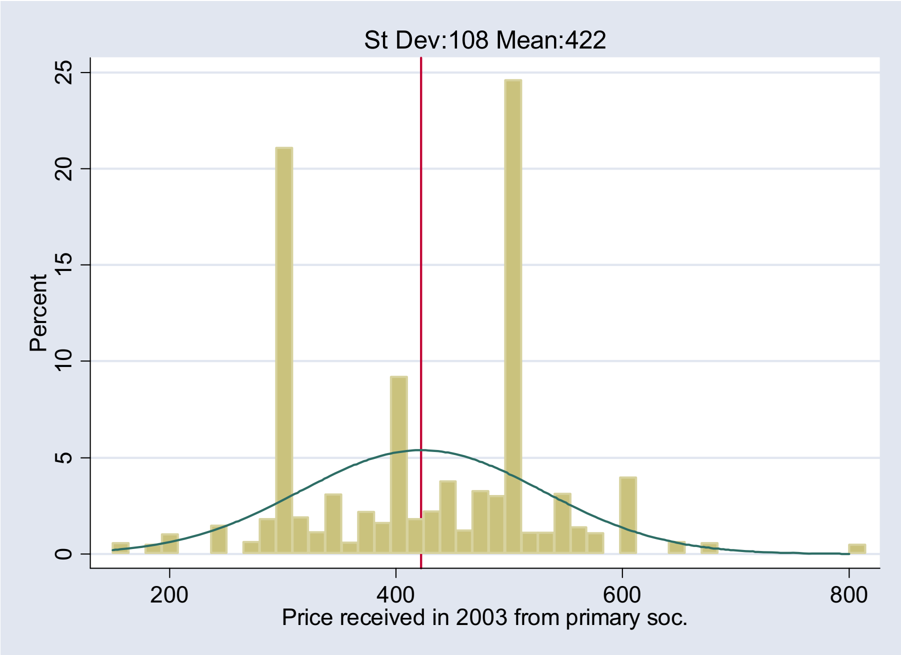


Figure 6.2: Frequency distribution of prices received for coffee by coffee producers selling to primary societies or private buyers in Ruvuma in 2003

2A: Selling only to Primary Societies



2B: Selling only to Private Buyers

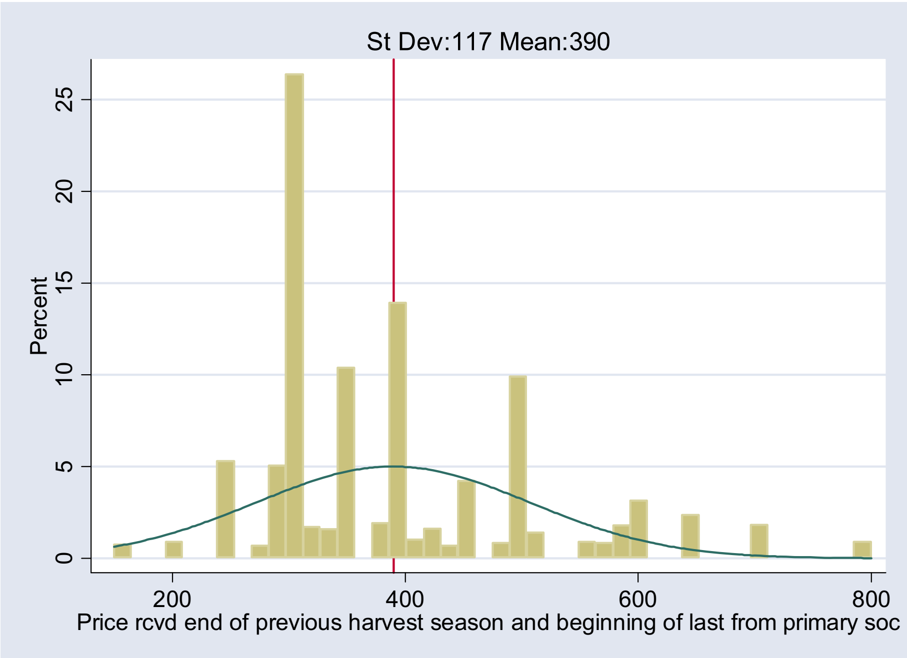
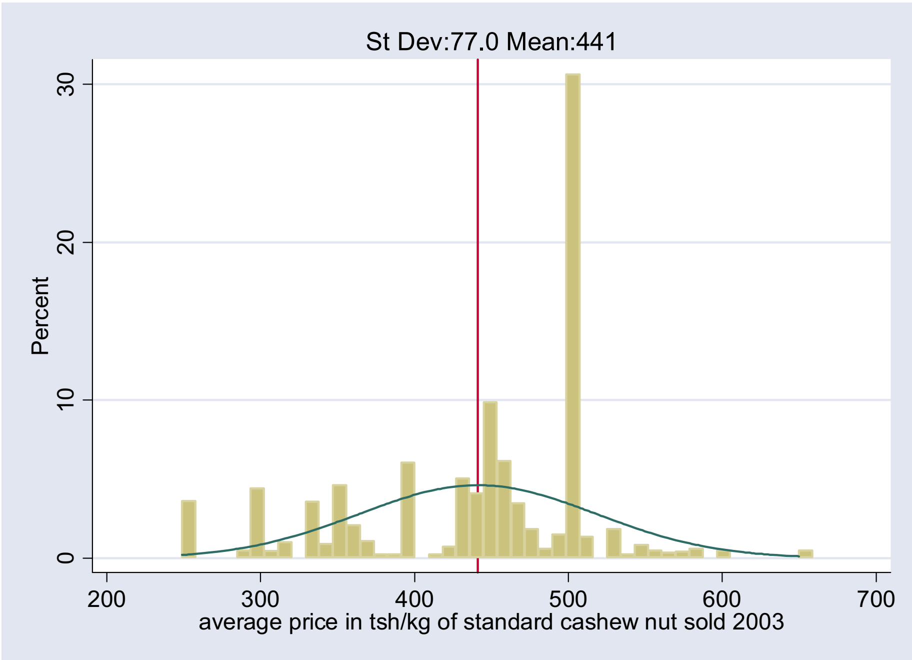


Figure 6.3: Average price received by cashew nut producers in Ruvuma for standard grade cashews

3A: Received in 2003



3B: Received in 2004

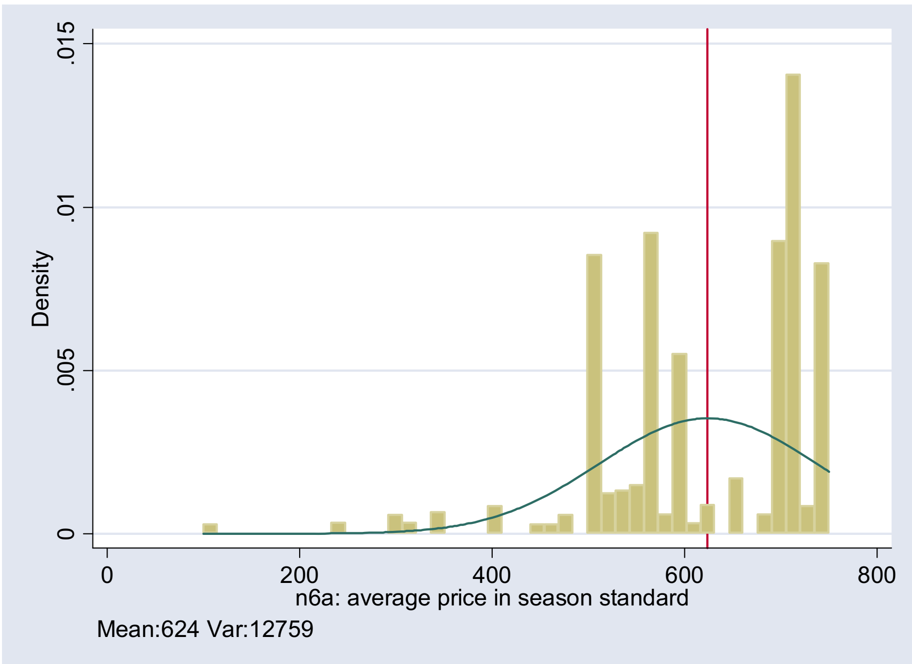
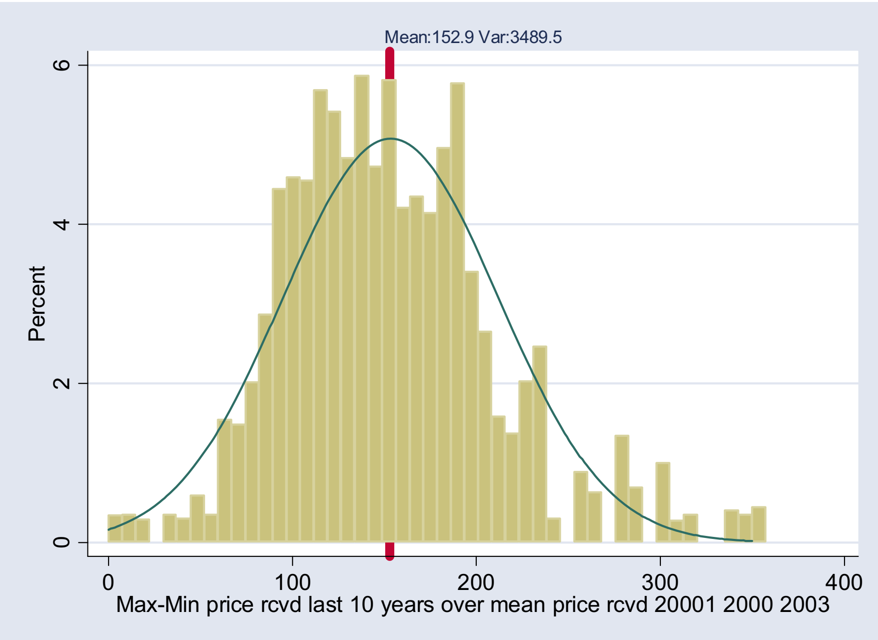


Figure 6.4: Variabilitiy of nominal prices received for coffee in Kilimanjaro and Ruvuma over the previous 10 years

4A: Kilimanjaro



4B: Ruvuma

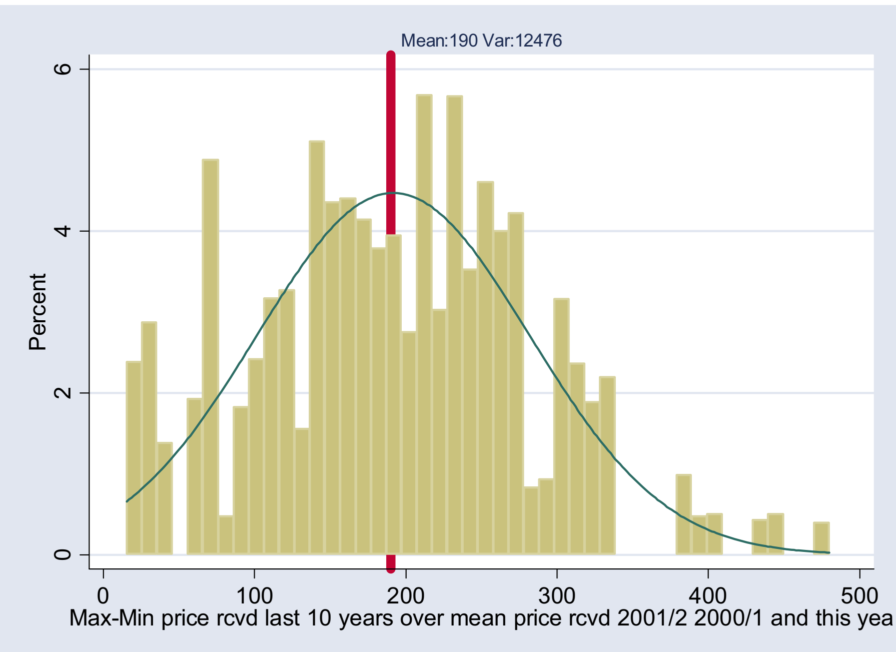


Figure 6.5: Variability of nominal prices received for cashew nuts in Ruvuma over the previous 10 years

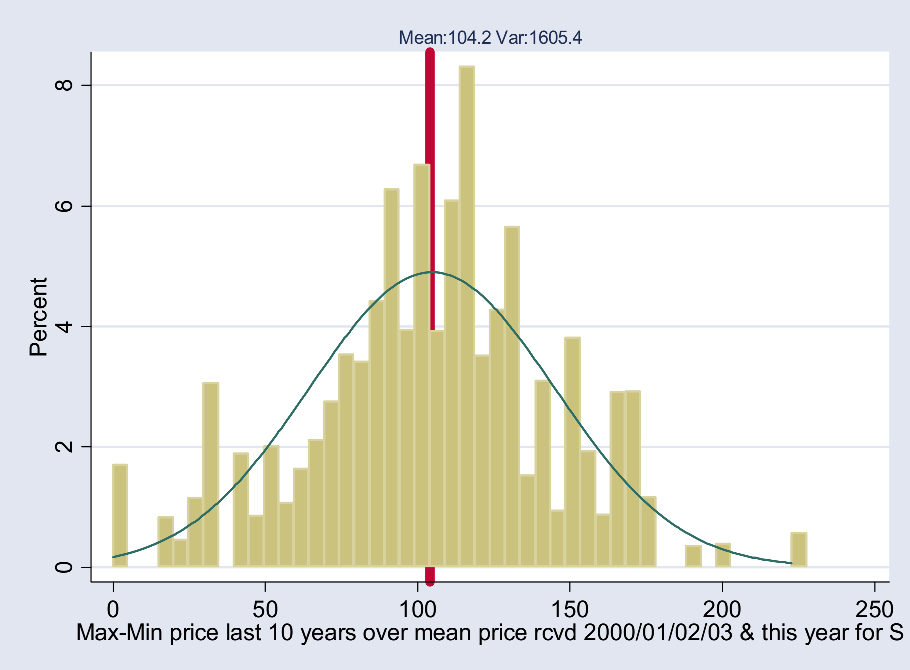


Figure 6.6: Demand for Tsh 400 minimum price insurance in Kilimanjaro by coffee producers

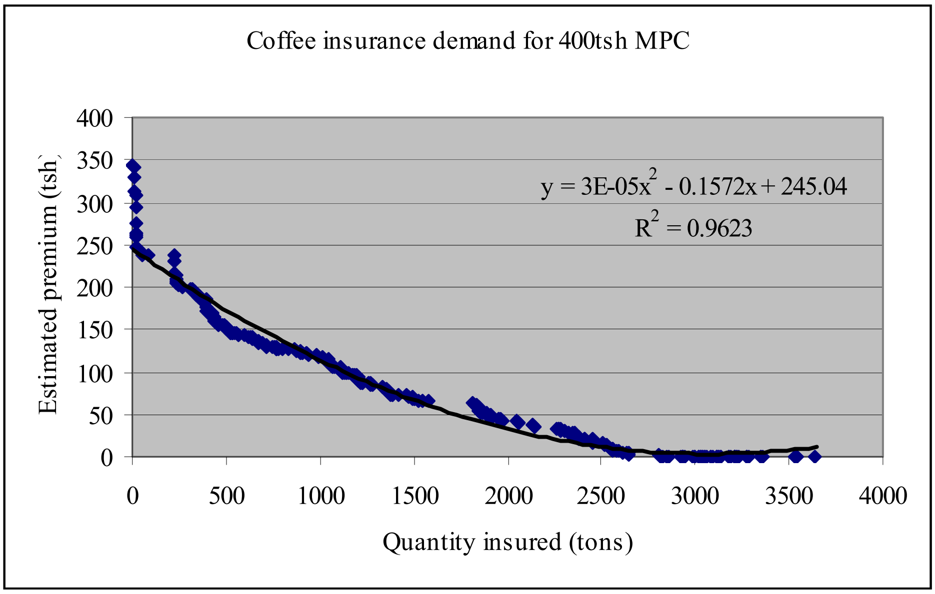


Figure 6.7: Demand for Tsh 600 minimum price insurance in Kilimanjaro by coffee producers

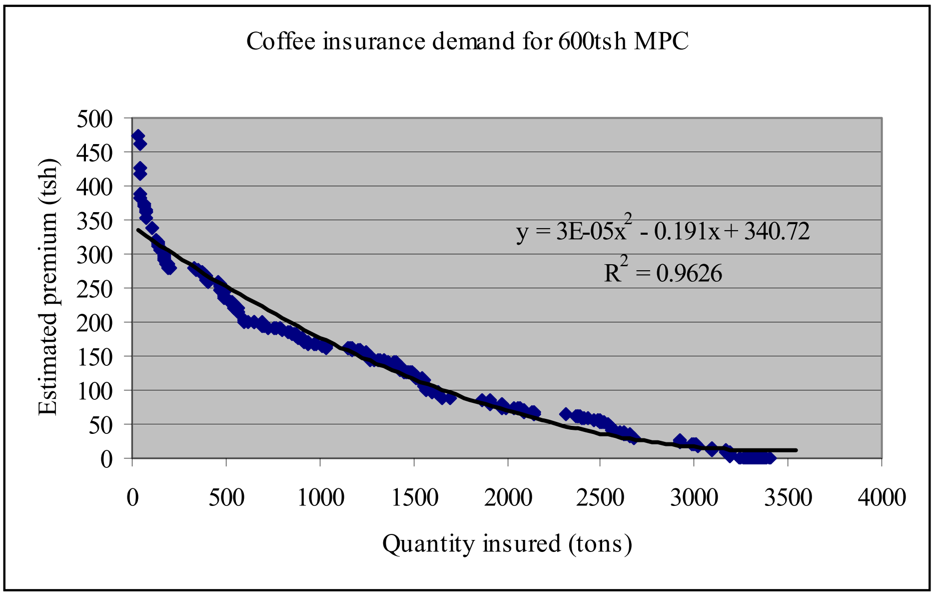


Figure 6.8: Demand for Tsh 800 minimum price insurance in Kilimanjaro by coffee producers

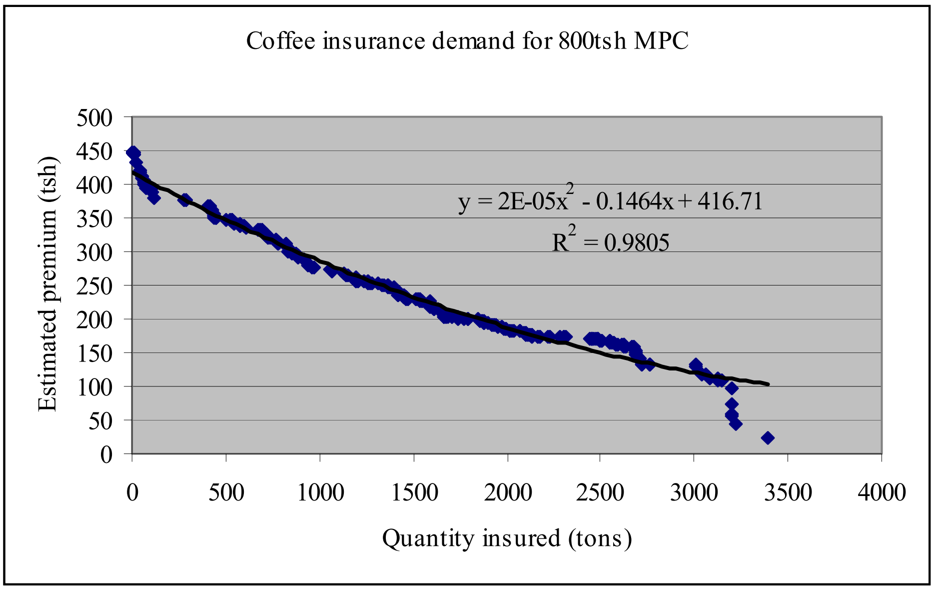


Figure 6.9: Demand for Tsh 400 minimum price insurance in Ruvuma by coffee producers

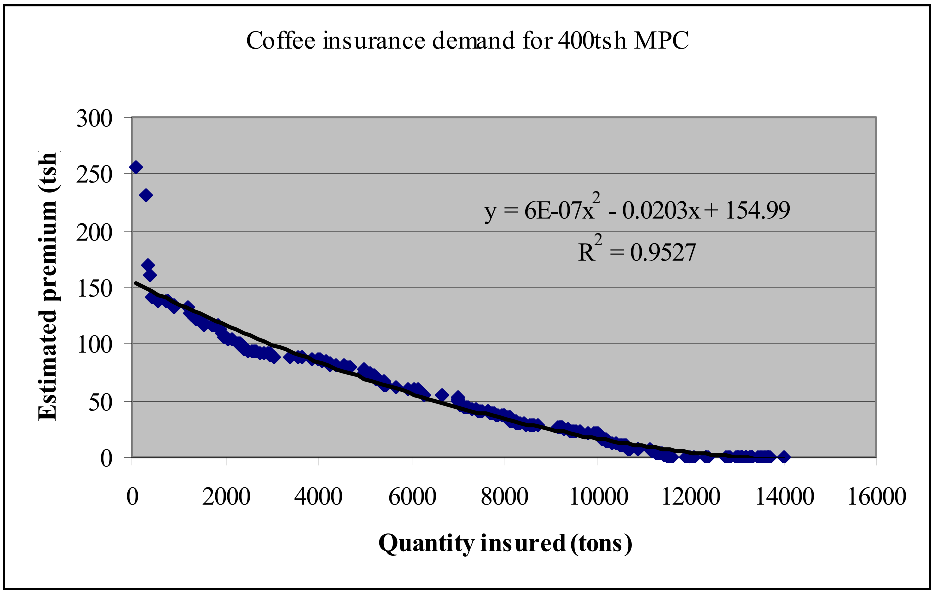


Figure 6.10: Demand for Tsh 600 minimum price insurance in Ruvuma by coffee producers

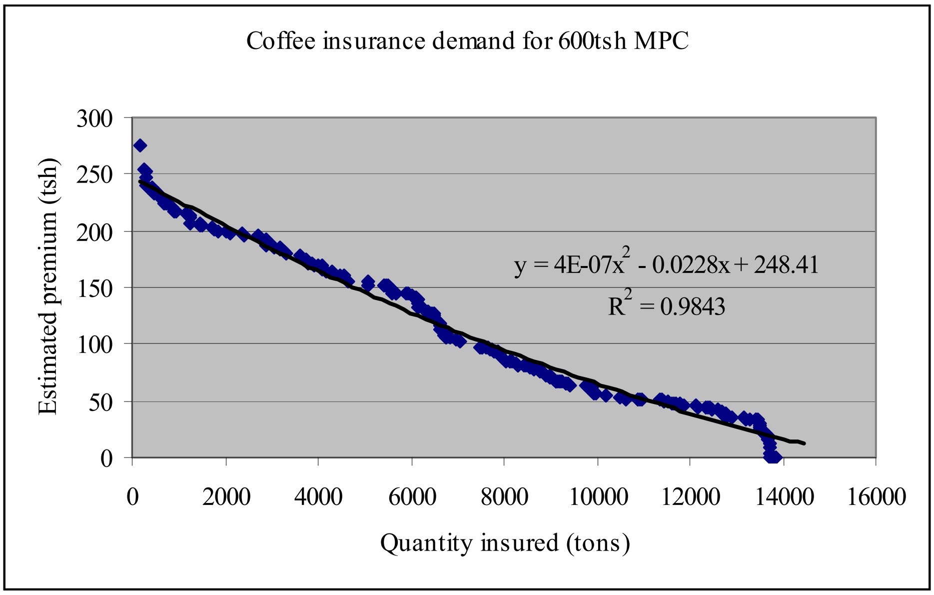


Figure 6.11: Demand for Tsh 800 minimum price insurance in Ruvuma by coffee producers

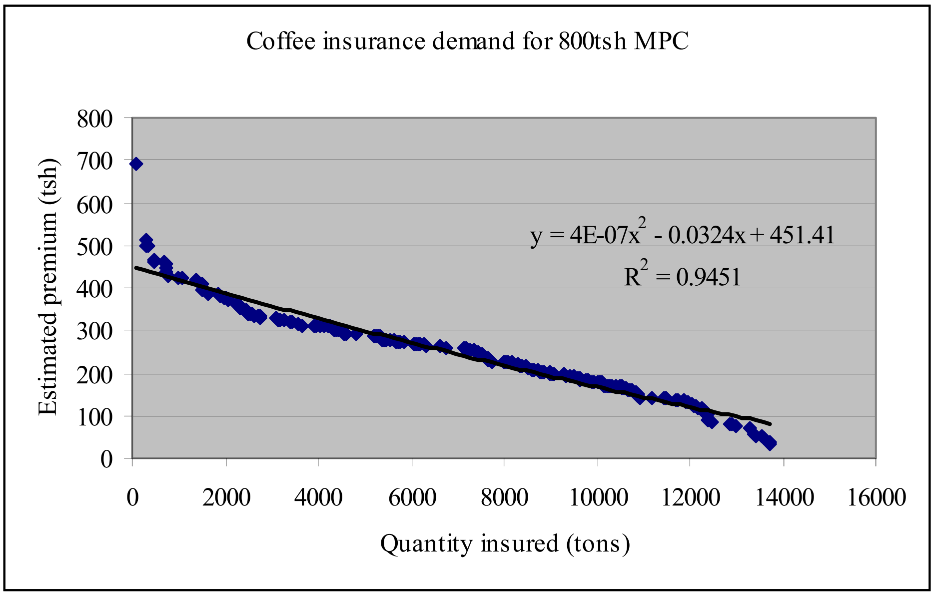


Figure 6.12: Demand for Tsh 300 minimum price insurance in Ruvuma by cashew nut producers

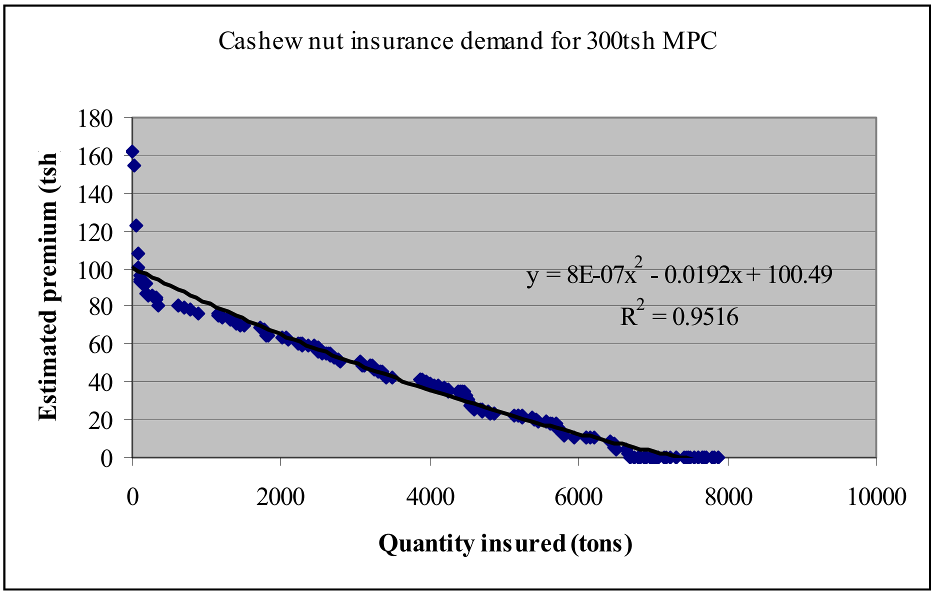


Figure 6.13: Demand for Tsh 450 minimum price insurance in Ruvuma by cashew nut producers

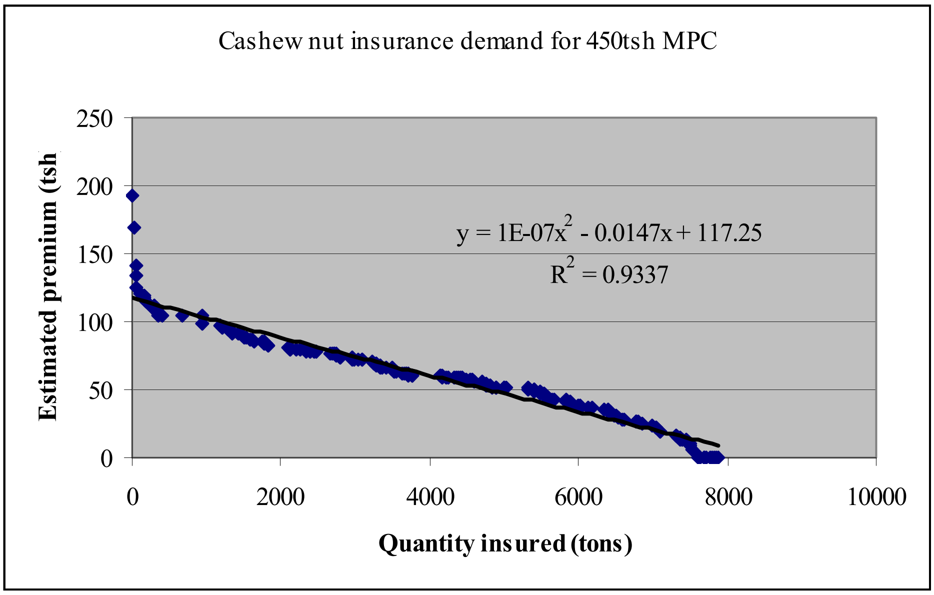


Figure 6.14: Demand for Tsh 600 minimum price insurance in Ruvuma by cashew nut producers

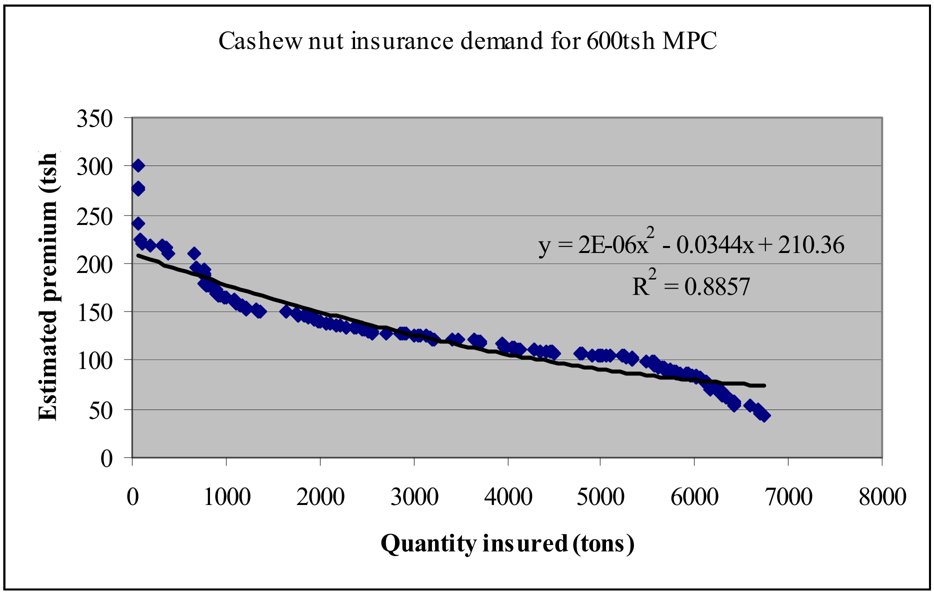
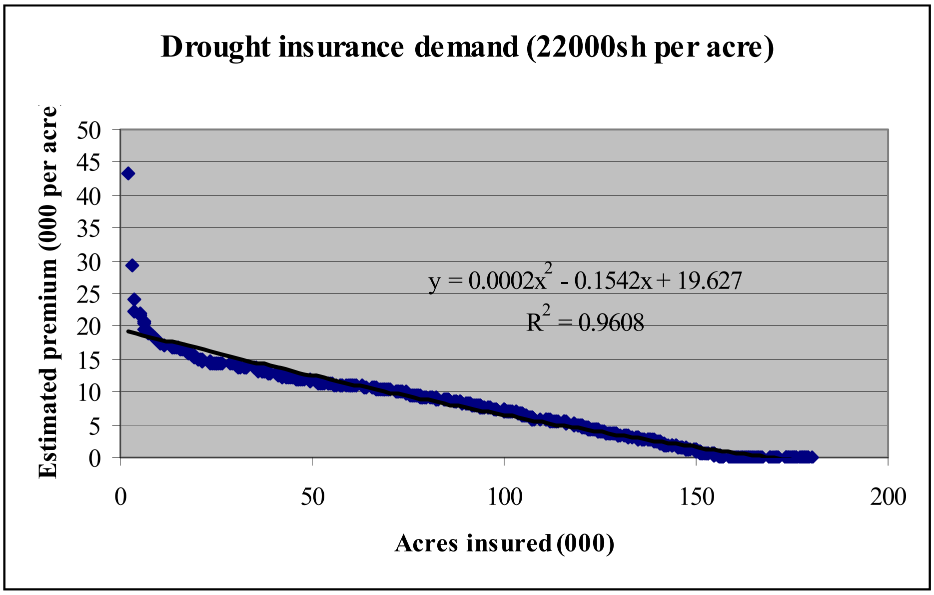
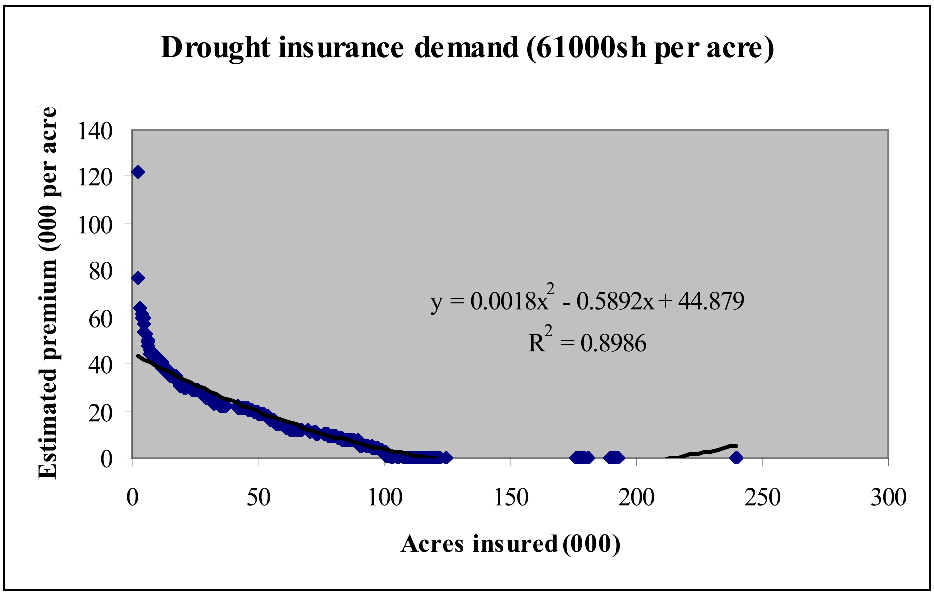


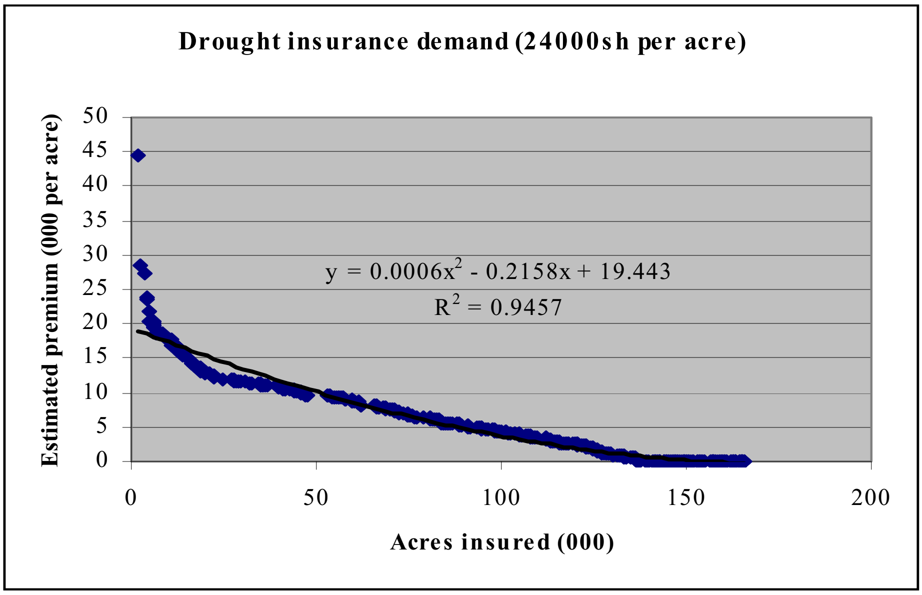
Figure 6.15: Kilimanjaro. Demand for insurance against a 10% rainfall decline

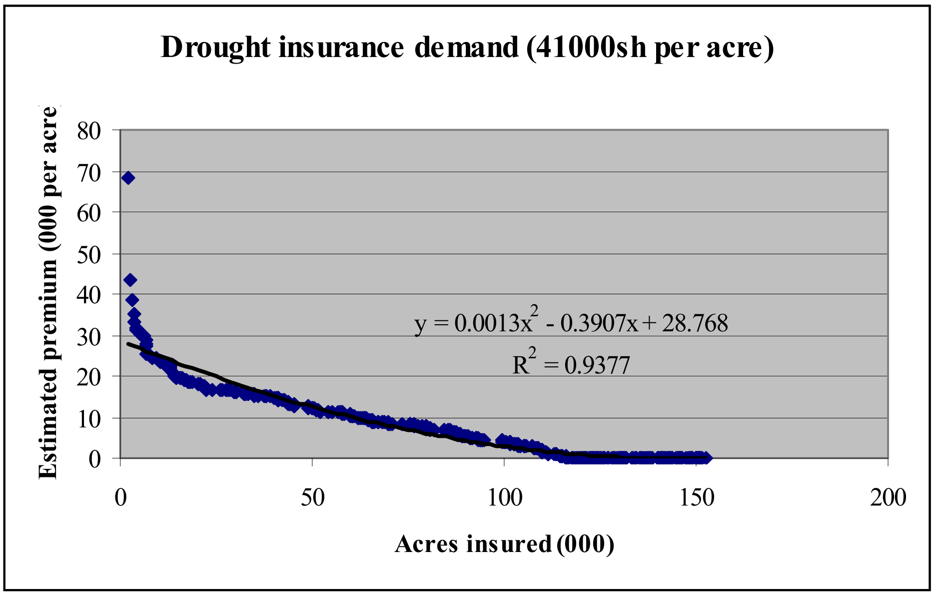


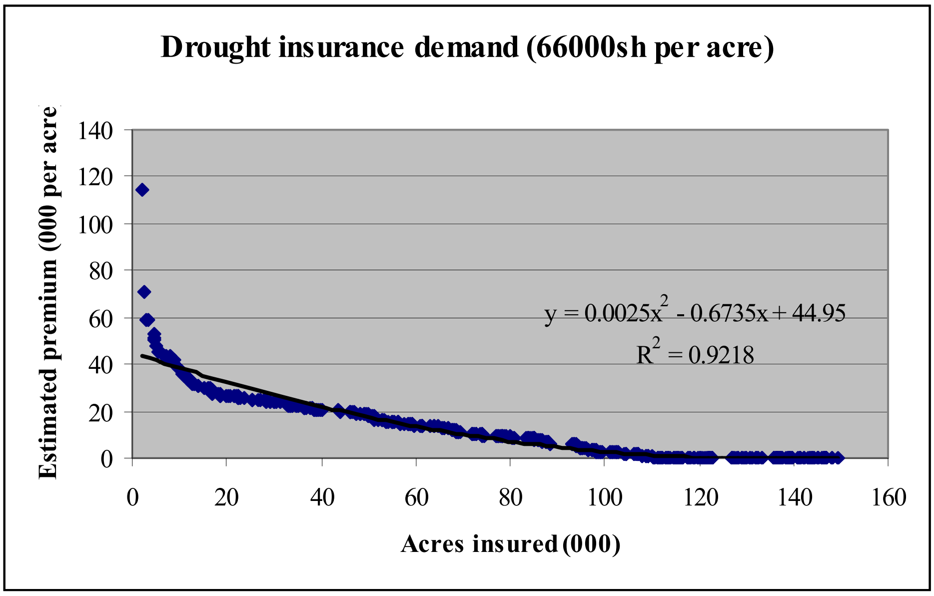


Source: Authors' calculations

Figure 6.16: Kilimanjaro. Demand for insurance against a 30% rainfall decline

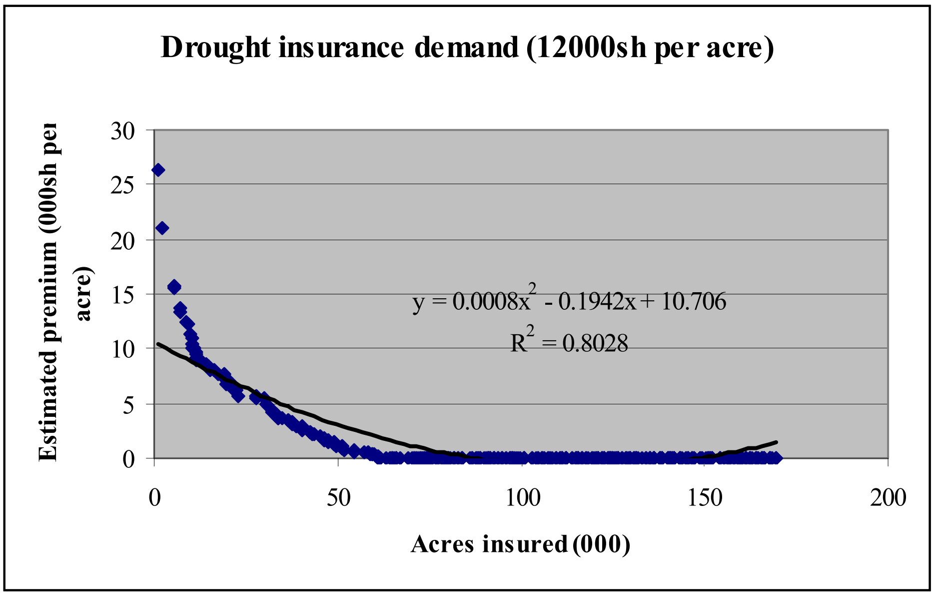


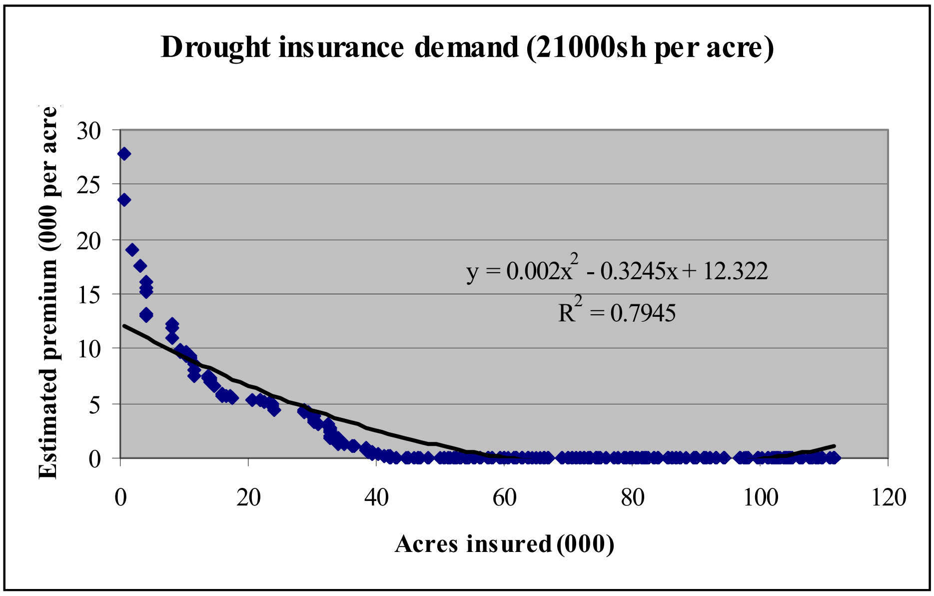


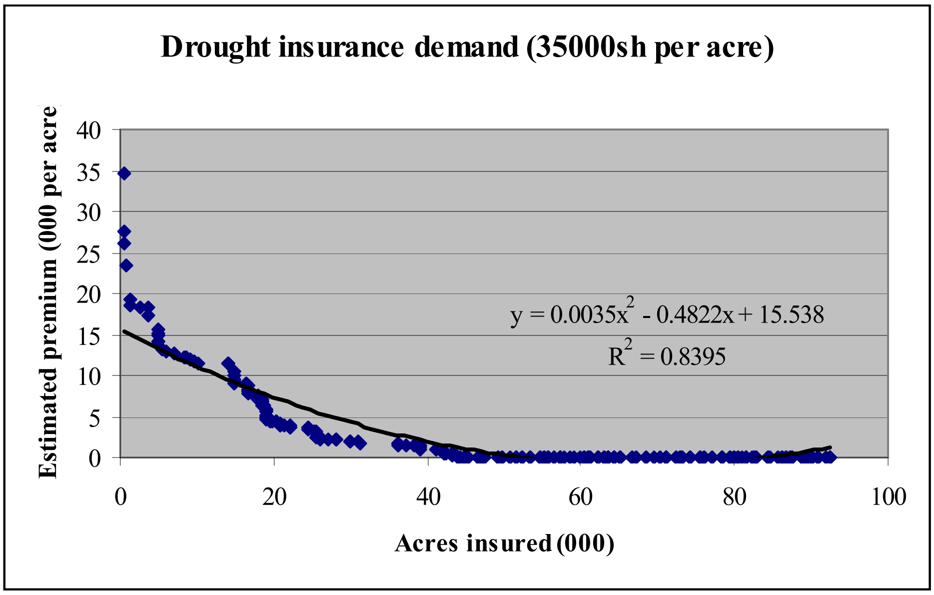


Source: Authors' calculations

Figure 6.17: Ruvuma. Demand for insurance against a 10% rainfall decline

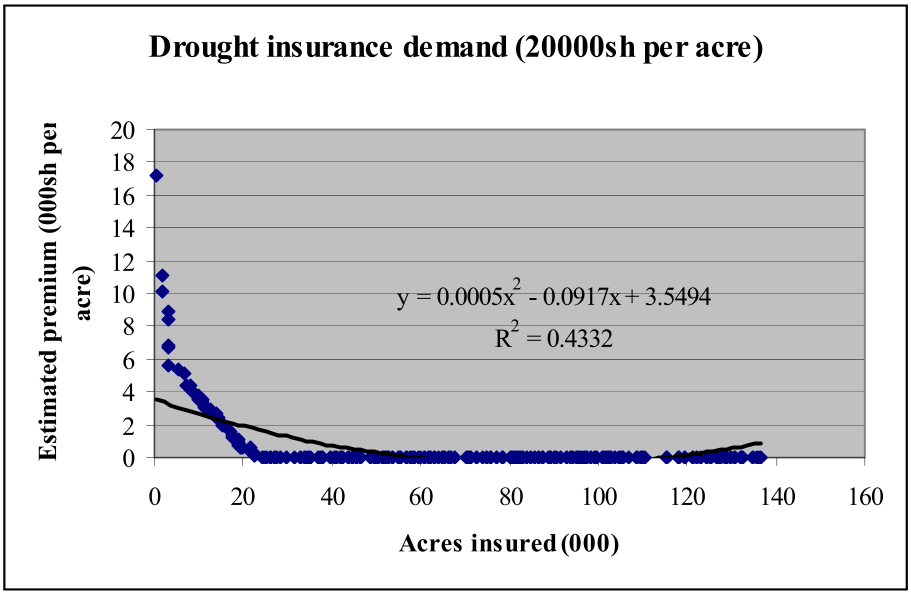




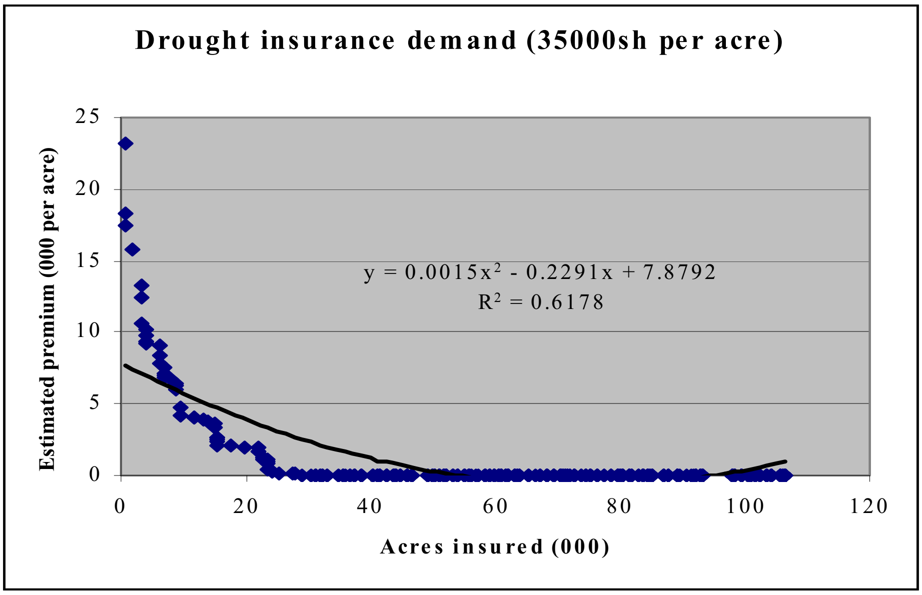


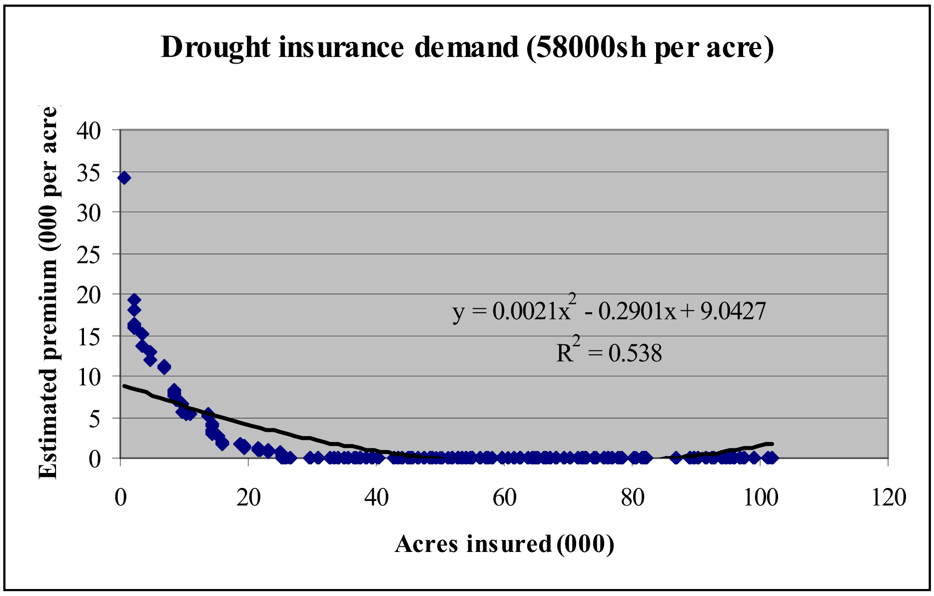
Source: Authors' calculations

Figure 6.18: Ruvuma. Demand for insurance against a 30% rainfall decline



Rainfall decline





Source: Authors' calculations

Appendix 1: Survey and sampling design[1]

The purpose of this note is to describe the procedure for the selection of a sample of villages and rural agricultural households that can be utilised for the survey of both coffee producing and non-coffee producing agricultural households.

The list of villages must be such that it can be utilised to draw a random sample of agricultural households, in the sense that it will be representative of all agricultural households in the Kilimanjaro Region. The sampling frame for the analysis is a list of the number of households and population in all villages in Kilimanjaro,[2] provided by the National Bureau of Statistics (NBS), and based on the most recent population census of 2002. The villages are grouped by wards and districts. There are six districts in Kilimanjaro, of which one (Moshi urban) is the capital of the region, and is an urban district.

The first step in the methodology is to define the frame more precisely. We are interested in agricultural households (equivalently we shall refer to these as farm households) as well as coffee producing households among them. The most recent District Integrated Agricultural Survey (DIAS) for Kilimanjaro, namely the one for the 1998/99 year, defines an agricultural household as one in which one or more members are holders. A holder in turn is a person that exercises management control over an agricultural household operation and who takes major decisions regarding resource utilization and disbursement. An agricultural household is defined as an economic unit of agricultural production under single management. It consists of all livestock and all land used for agricultural production without regard to title. In the 1998/99 DIAS the agricultural households were restricted to those that met the following conditions:

- Having or operating at least 25 m^2 of arable land
- Own or keep at least one head of cattle or five goats/sheep/pigs or fifty chicken/ducks/turkeys during the relevant (for the survey) October to September agricultural year.

For the current survey this definition will also be followed to distinguish farm households from non-agricultural households.

The list of wards and villages that is available from the National Bureau of Statistics (NBS) classifies wards as rural, urban and mixed urban/rural. We shall consider as the frame for the survey as the one consisting of villages in wards classified as rural. This is not strictly speaking a frame of agricultural households, as will be seen below, but is the best we can have with the available information

To explore the frame issue deeper, the following calculations were done. First in the 2002 census, the various villages were classified according to whether the ward in which they belong is rural. This classification is available from the NBS website. The number of all such households in the Kilimanjaro Region was thus estimated for 2002 to be equal to 199391. By utilizing the 1988 to 2002 rate of growth of population in Kilimanjaro (estimated to be equal

[1] A similar procedure has been followed for selecting households in Ruvuma. Details available upon request from the authors.
[2] In the frame provided by the NBS the smallest enumeration area (EA) or primary sampling unit (PSU) is either a village or a street when the location is a city or town. For the remainder of this note we shall refer to these PSUs as “villages”, although they may actually be streets in small towns.

to 1.608 percent annually) the 2002 rural population and number of households was projected back to 1998. The estimated number of rural households thus estimated for 1998 is 187064.

In the 1998/99 DIAS the number of agricultural households in Kilimanjaro was estimated to be equal to 223930, which appears to be much larger than the above projected number of 187064. However, there is a serious problem with the 1998/99 numbers of agricultural households. This concerns the reported number of agricultural households in the Same district. In the 1998/99 DIAS this is reported to be equal to 114295 or more than half of the total number of agricultural households in Kilimanjaro, according to the 1998/99 DIAS. This number, however, must be grossly overstated. The reason is that the number of total (not just rural) households reported in the 2002 census for Same is only 44272, and the number of households in 2002 living in rural wards in Same in 2002, is reported to be only 23429. When this last number is projected back to 1998 it results in a number of rural households in Same in 1998 equal to 21980. This is less than 20 percent of what is reported in the DIAS, and raises serious issues about the method utilised to compute these aggregates in Same. The problem does not appear to be the same in the other districts.

To deal with this problem the following method was used. By comparing the 1998/99 DIAS reported numbers of agricultural households in all other districts except Same, and comparing them with the 1998 backward projections of rural households resulting from the 2002 census, it appears that the number of agricultural households in the 1998/99 DIAS is on average 66.4 percent of the number of rural households in 1998 as projected back from the 2002 census. This percentage was then used to estimate the number of agricultural households in Same in 1998, from the backward projection of the 1998 estimated number of all rural households there. The estimated number of agricultural households in Same with this method is 14598. Thus the adjusted total number of agricultural households in the Kilimanjaro Region in the 1998 DIAS is equal to 124233, which is much lower than the originally reported figure of 223930. This number is still smaller than the number of rural based households projected back to 1998, which is, as reported above, 187064 households. This implies that even if we consider the frame to consist of all rural based households, based on the 2002 census, it will overstate the number of agricultural households. In fact we expect that only about 66.4 percent of the selected households from this frame will be agricultural ones. Hence if we wish to sample M agricultural households from this frame, we should select a sample equal to M/0.664, and reject the households that in the actual visit are found not to be agricultural by the above definition of an agricultural household, in order to make sure we get an expected number of M agricultural households.

The 1998/99 DIAS also reports the number of coffee producing households among the agricultural households. As will be seen below the share of coffee producing households in all farm households is utilised in the sample selection method. For Same, given the adjustment above, it was assumed that the share of coffee producing households in the new number of rural households is the same as the share of coffee producing households reported in the 1998/99 DIAS. The resulting total number of coffee producing farm households in Kilimanjaro in 1998 is equal to 79598 or 64.1 percent of all reported agricultural households in the adjusted 1998/99 DIAS.

From now on then the frame that will be considered is the list of all villages in Kilimanjaro that are in wards which are classified as rural by the NBS according to the 2002 census. The total number of such villages is 369, located in 82 rural wards. The corresponding number of households in this set as reported in the 2002 census is equal to 199391 and the corresponding population is 941262.

Consider now the problem of selecting among these villages and households a set of 900 farm households at random for sampling. Ideally we would like to have about 600 of these households to be coffee producers, and the rest non-coffee producers. This presents a problem for the sampling design because according to the 1998/99 DIAS only 64.1 percent of all agricultural households in the Kilimanjaro Region are coffee producers. This implies that if we select 900 households at random (namely with equal selection probabilities) from the population, we expect that only 900x0.641=577 will be coffee producing. This is smaller than the number we actually want. The problem, however, can be solved by adjusting the district-wide selection probabilities as will be shown below.

In the problem at hand, the following list or frame is available. There is a complete list of the numbers (in other words there is no need for the names of farmers or household heads) of all rural households in each village, ward and district. In Kilimanjaro there are five rural districts (Rombo, Mwanga, Same, Moshi rural, and Hai), within each district there are between nine (in Hai) and 29 (in Moshi rural) rural wards. Within each ward there are several villages, with a minimum of two villages and a maximum of ten villages per ward. The typical number of villages per ward is three-five. From preliminary discussions in the field during a visit in some of the relevant areas in May 2003, it appears that there is considerable household homogeneity within each village and, possibly ward, but considerable heterogeneity between wards. This implies that we should sample fewer households in each village or ward and larger numbers of villages or wards, to obtain better precision in the survey variables. However, this must be balanced against the cost of travelling from village to village. Nevertheless, the number of households per village, as seen in the available frame, is considerable, hence we need to select a significant number of households per village to capture the village population characteristics. This involves compromises between the number of households per village and the number of villages to visit.

Given the structure of the frame, there will be three levels of stratification. At the first level all districts will be chosen, so that the whole region will be represented. At the second level a certain number of wards will be chosen and within each ward a certain number of villages will be chosen. Finally, within each village a given number of households will be chosen. Given that all villages in a given ward are geographically close together and hence will necessitate small travel cost among them and given that villages in a given ward are most likely more homogeneous than villages from different wards possibly situated far apart, the idea is to select a small number of villages per ward, but as large a number of wards as possible, within the overall budget.

Assume that the total number of rural households in the frame is N. This is the total number of households in the rural or rural/mixed wards in Kilimanjaro. As the selection of the villages must be done so as to eventually provide the basis for the larger survey, it will be assumed that a survey will involve a sample of m farm households. This notation is utilised as illustrative to indicate the way the villages are selected. In the actual choice of households for the study m is set equal to 900/0.664=1355. This is done in order to make sure that there will be an expected number of farm households, namely households with some minimum farm output, equal to 900. Since some non-response is expected, the actual number of households selected will be larger than 1355 so as to have readily available substitutes, in case of non-response. It will be assumed that the non-response rate is equal to 30 percent. Hence the actual number of households selected will be about 1355X1.25=1762. This basically means that the selected number of households in each village will be 30 percent larger than what would have been selected in the absence of non-response. Otherwise, the number of wards and villages selected will be the same, as if non-response is zero. The choice of wards, villages and number of households per village will be made on the basis of m=1350 (the slight adjustment from the above number of 1355 is done to preserve the integer number of villages selected as will be seen below), while in each village visited the actual number of households selected will be 1.30*(number of households to sample per village).

The following description concerns the selection of wards and villages to visit. The selection of rural households is mentioned as well. The sampling design will consist of a multistage stratified design. In other words the population of farms will be divided into strata, and a sample will be drawn from each stratum. In the case of the Kilimanjaro Region in Tanzania the strata are already defined, namely the rural districts (Moshi urban will be excluded, as by definition it is not a rural area). Hence, the sample for the survey will be drawn from each district, and from selected rural wards and villages in each district. The whole idea of sample design in a survey is how to select the number of households to sample from each stratum (district), and then how to allocate this number within each district to the individual ward and villages.

Given that we know the number of households for all strata (districts) and substrata (wards, and villages), the next step in the design of any sample is to apportion the desired sample among the first level strata (districts), and then the subsequent substrata (namely wards, and villages). In the sequel the size of the sample, namely the number of desired farm households to sample will be denoted by m, while the desired number of coffee producing households to sample will be denoted by c.

Assume that S denotes the number of strata, which in Kilimanjaro is equal to the number of districts (The number of districts in Kilimanjaro that will be sampled is 5). The next step is to partition or apportion the total number of the desired sample m to the S different strata. At this point the only number that is needed, is the total number of households in each district. Denote the total number of households in stratum s as N_s (s=1, … S, where S is the total number of districts to be sampled, namely 5), and the total number of households in all districts in which there will be a survey as N. Then by definition

$$N = \sum_{s=1}^{S} N_s \qquad (1)$$

For the survey at hand, N will be equal to the total number of rural households estimated for 2002, namely 199391. For some of the calculations below N_s and N are projected back to 1998, in order to compute relevant factors. Since all these backward projections are done with the same growth rate, the allocation of rural households in 1998 among districts is the same as in 2002.

Furthermore, denote the total number of coffee producing households in the region by C and the number of coffee producing households in each district by C_s . Clearly a relationship such as (1) also holds between C and the C_s . While we know reasonably well the total number of rural households in each district, ward, etc., as they were derived from a recent census, we do not know exactly the number of farm households and coffee producing households, as their number was inferred by the 1998/99 DIAS, which is a sample survey and not a census. Nevertheless, this is the best source for the number of coffee producers. Given that 1998/99 is a year not too far in the past, that coffee production is based on coffee trees that are perennial and hence stay on farm for a long time and that the rate of population growth is small, it can be taken with reasonable degree of confidence that the distribution of coffee producers in Kilimanjaro is as indicated in DIAS. It is difficult to speculate whether the total number of coffee producers in 2002 should be equal to the total absolute number of coffee producers in 1998, or it should be correspond to the same share of all rural households as in 1998. It is probably safer to assume that their share in all rural households and their geographical distribution in 2002 is the same as in 1998 and this will be assumed here.

Since we are interested in coffee producing households and their comparison with non-coffee producing ones, we need a good (namely one with small sampling variance) representation of coffee producing households. This could be ensured by a proportional sampling design[1]. In other words the desired allocation of our required sample of coffee producing households among the districts should be according to their shares in total coffee producers in the 1998 DIAS. Hence if c is the desired total number of coffee producing households in our survey and c_s is the number of coffee producing households in the survey that will be sampled from district s, the desired allocation of c among districts could be done as follows.

$$c_s = c \cdot \frac{C_s}{C} \qquad (2)$$

Since, however, the share of coffee producers in each district is different, as indicated in the DIAS of 1998/99, we need to sample a different number of households at random from each district, in order to be sure that our expected sample number of coffee producers is equal to c_s in each district s. If the 1998/99 share of coffee producers in all rural households in district s is denoted as α_s ($=C_s/N_s$), and we assume that this share is unchanged in 2002, and if the number of rural households sampled in each district is equal to m_s, where the sum of m_s is equal to the total number of sampled households m, then the expected number of coffee producing households in the sample for the district will be equal to.

$$c_s = \alpha_s \cdot m_s \qquad (3)$$

If we equate (2) and (3) we find that under this design the desired number of sampled households in each district to ensure (2) is equal to.

$$m_s = c \cdot \frac{N_s}{C} \qquad (4)$$

While this allocation of the sample among district is proportional to the number of all rural households in the district, it nevertheless, implies a total number of sampled households (namely the sum of the district samples in (4)), that is equal to c(N/C) which is larger than m (=1350), which is what we desire. This is because the ratio of C/N in the population (=0.426) is smaller than the desired ratio of c/m (=600/1350=0.444). Hence the above design albeit producing the minimum variance estimated statistics among coffee producing farm households is uneconomical from our perspective. While the discrepancy is not large, and one could in fact utilize this design and the expected number of coffee producing households would be 577, this is only because by chance the share of coffee producers in all households happens to be close to our desired share of coffee producers in the sample. In fact, we must adjust the allocation of the desired sample in (4) among the districts if we wish to have a sample of coffee producing households as originally desired.

Clearly if we want the farm households to be chosen at random, while at the same time ensuring that the expected number of coffee households among those sampled will be 600,

[1] See for instance G. Kalton. Introduction to Survey Sampling. Sage Publications, University Paper Series Number 07-035, Newbury Park London, 1983, or L. Kish. Survey Sampling. New York, John Wiley, 1965.

we must oversample the districts with higher share of coffee producers and undersample the districts where coffee producers constitute a smaller share of farm households. A natural number to utilise in adjusting the number of households to sample is the share of coffee producing households in all rural households in the district, relative to the similar share in the whole region, namely the following unitless number.

$$\beta_s = \frac{C_s / N_s}{C / N} \tag{5}$$

Clearly the above parameter is larger than 1 in districts where the share of coffee producers in the population is larger than the same share for the whole region, and smaller than 1 otherwise. The allocation of the sample then will be done in a way similar to a formula like (4), which allocates samples in proportion to the district population, but with the following nonlinear adjustment.

$$m_s = \lambda\left(c \cdot \frac{N_s}{C}\right) \cdot (\beta_s)^{\alpha} \tag{6}$$

where α and λ are parameters to ensure that the two adding up conditions are satisfied. These two conditions are first that the sum of m_s over all districts should be equal to m, and second that the sum of the expected coffee producers among those sampled will be equal to c. These two conditions can be written as follows (Exp(.) denotes the expected value of a statistic).

$$m = \sum_s m_s = \lambda \cdot \sum_s \left(c \cdot \frac{N_s}{C}\right) \cdot \beta_s^{\alpha} \tag{7}$$

$$c = \sum_s Exp(c_s) = \sum_s m_s \cdot \frac{C_s}{N_s} \tag{8}$$

From (7), and for any value of α, the parameter λ can be derived directly by simple division. By adjusting the parameter α then one can make sure that (8) is satisfied as well. 2

In the case in hand, it was found that for a value of α equal to 0.35, and a consequent value of λ equal to 0.972, the two adding up conditions are satisfied exactly (after rounding up to the nearest integer). The following table shows the population figures in 2002 and 1998 (projected backwards from 2002), and the allocation of our sample of 1350 rural households among the five districts in the Kilimanjaro Region, as well as the expected number of farm and coffee producing households in each district. It can be seen that while the sample that will be chosen will be equal to 1350, the actual expected number of interviews and questionnaires to be filled is 891, as this is the expected number of farm households among the rural ones. The expected number of agricultural households in the actual sample is not exactly equal to 900 but instead 891 because of rounding errors. The error, however, is less than one percent.

Table 1. Allocation of the sample for the 2003 vulnerability survey among districts in the Kilimanjaro Region

District	No rural hhlds 2002 (census) (1)	No rural hhlds 1998 (projected from 2002 census) (2)	No farm hhlds 1998 (DIAS adjusted for Same) (3)	No coffee hhlds 1998 (DIAS adjusted for Same) (4)	No of hhlds to sample. Vuln. survey 2003 (5)	Expected no of farm hhlds. Vuln. survey 2003 (6)	Expected number of coffee producing hhlds. Vuln. survey 2003 (7)	No of wards to visit in each district (8)	Final adjusted number of hhlds to sample in each village in given district (9)	Final no of hhlds that will be sampled. Vuln. Survey 2003 =(9)*(8) (10)
Rombo	44608	41850	29111	24394	343	238	200	11	31	341
Mwanga	14268	13386	10628	3323	81	65	20	3	27	81
Same	23429	21980	14598	3609	115	77	19	4	29	116
Moshi rural	82154	77075	45186	37984	595	349	293	20	30	600
Hai	34932	32772	24710	10288	216	163	68	7	31	217
Total	199391	187064	124233	79598	1350	891	600	45		1355

Source: Computed by author

Once the m_s are chosen for all s (s=1,…, S), the next step is to decide which wards within each district to visit. The way this can be done is the following. First, given that the heterogeneity among rural households in Kilimanjaro is presumably among wards, the choice is made to visit only one village per ward. This implies that the number of wards to visit will be the same as the number of villages.

Second, the initial number of households to sample in each village will be set at 30. This implies a number of wards and villages to visit will equal to R=1350/30=45. Table 1, column (8) indicates what this implies about the number of wards to visit in each district, given the sample that is to be selected from each district. Since the number of wards to visit must be integer, and the number obtained by dividing the desired sample in each district by the number of households to sample (30) is normally a fraction, the nearest integer of wards is chosen and this is the number indicated in column (8) for wards to visit. However, once this is done, and we maintain the number 30 for the number of households to sample in each ward, the selection probabilities of each household sampled in a given district and ward will be slightly different. To keep the selection probabilities as equal as possible, the desired number of sampled households in each district (indicated in column 5) is divided by the integer number of wards, and the nearest integer of this division is chosen. This is indicated in column (9) in Table 1, and is the number of households to sample in each village visited in a given district. By multiplying these numbers by the number of wards in column 9, one obtains the number of households to sample in each district in the actual survey, and this is indicated in column (10) in Table 1. It can be seen that these numbers are very close but not exactly equal to the theoretically desired sample numbers in column (5), but this is the best that can be done, and the error is quite small.

Clearly not all 30 (or the corresponding close number in column 9 of the table above) of the selected households will be interviewed in each village visited, as the idea is that only the farm households among them will be interviewed. In other words, once a household is chosen the first questions will have to do with whether they have some minimum agricultural production. If the household passes this test, then it will be interviewed. If not, then the enumerator should move to the next household chosen in the village. If the survey is further restricted to coffee producing households, the relevant first question should be whether the household cultivates any coffee. If the answer is yes, then the enumerator should proceed with the interview. If not, then the next household in the list should be visited. The exact questions to ask at the beginning of an encounter with a household, in order to decide whether to interview a household, are indicated in Appendix 2.

Given the number of wards to visit, the next issue is how to select the wards to visit in each district, from the list of all rural wards in the district. The way this should be done is by a method known in statistics as Probability Proportional to Size (PPS). Size in this survey will refer to the total number of rural households in a ward. The PPS method ensures that a ward with many rural households is more likely to be selected than a small one (always on the basis of the number of rural households). This is different than a Simple Random Sampling (SRS) design, where each ward would have exactly the same probability of being selected for a visit. The PPS procedure is fairly standard in sample surveys, and is explained in detail in Appendix 1 to this note.

Once the wards have been selected, the next step concerns the selection of the village to visit within each ward that is indexed by sr (namely in district s, ward r). The way to do this is to first specify the number of samples (namely rural households) per village for this ward. The number of rural households (called primary sampling units in sampling theory) per village, is denoted by H. As indicated above this may be different than 30 depending on the district where the relevant ward is located.

The number of villages to visit in a ward indexed by s and r, denoted as nv_{sr} , was already specified to be equal to 1. This was done on the basis of *a-priori* information concerning the homogeneity pattern of villages in the districts. Once the numbers H and nv_{sr} are chosen, the actual village to visit in each ward must be chosen. The procedure again will be to utilise PPS to choose the village to visit in each ward indexed by sr. In other words a large village will be more likely to be selected than a small one (on the basis of the number of farms) according to this method. This is different than a Simple Random Sampling (SRS) design, where each village would have exactly the same probability of being selected for a visit. The PPS procedure is explained in detail in Appendix 1.

Consider a village among the ones selected to be visited (we will use the index v to denote the v'th village in ward r in district s). Denote the number of individual rural households in this village by N_{srv} =M (we use the symbol M instead of the more complicated symbol N_{srv}). Then, if the PPS method of choosing villages is followed, the probability of choosing a particular village v among all the villages in any given ward sr, will be proportional to M (exactly as the name denotes).

Once the exact location of the village to visit in each ward sr is chosen by PPS, then for each village, one could obtain the detailed list of individual households from the village record of the chairman, or other similar list in the village. From that list one will select a random number of H*1.25 households to visit. As discussed earlier, the reason for the multiplication of the number of intended households to visit by 1.25 is to account for non-response. In other words the random list of households selected will be 38 (or even 40 if this is more convenient). The enumerator will start visiting these households. If they cannot be interviewed because of absence of the head, or unwillingness or inability to talk to the enumerators (this is considered a non-response), then the next household in the list will be visited. Once the household agrees to talk, the first question that will be asked is whether they have agricultural production. If not then this household will not be sampled, and so on down the list. The actual number of households that is expected to be interviewed if this procedure is followed, is 891, as indicated earlier, of which 600 will be expected to be coffee producers.

A further problem that will arise in the actual survey, is that despite the fact that the available census is recent (namely from 2002), there may be differences between the number of households indicated as residing in a given village, and the actual number residing there when the enumerators visit the village sometime in 2003. In this case, in order to keep the selection probabilities equal and the same for all households in the district, the survey team will need to adjust the actual number of households selected for interview by the fraction (M_{2003} /M_{2002}) where M_n is the number of households[1] in year n. In other words if there has been a growth of the actual number of households of the order of four percent, as revealed by the new village household listing, then the actual number of households to select to visit should be not H, as indicated above, but an integer number closest to H_1= H*(1.04). Of course the adjustment for non-response will now apply to the new number H_1 . Given that the census on the basis of which this survey is designed is quite recent, the adjustments expected from this correction should not be too large.

For each village the selection of households will be done by a Simple Random Sampling (SRS) method. A simple way to operationalize this method in the field is indicated in annex C. If the wards and villages are chosen in the way outlined above, and H farm households within each selected village are chosen randomly, then the selection probabilities of all the chosen rural households can be found as follows:

The selection probability of a rural household can be written by the fundamental law of conditional probabilities as follows:

Prob(Selection of a household in a district in the region)=Prob(Selection of a household/Given selection of a village, and ward in a given district) Prob(Selection of village/Given selection of a ward in a given district) Prob(Selection of ward/Given selection of a given district) Prob(Selection of a district) (9)

The probabilities in equation (9) can be written as follows using the notation utilised earlier:

Prob(Selection of a household/Given selection of a village, and ward, in a given district)= H/N_{srv} (10)

Prob(Selection of village/Given selection of a ward in a given district)

$$= n_{srv} \cdot \frac{N_{srv}}{N_{sr}}$$ (here of course the number of villages n_{srv} is equal to 1) (11)

Prob (Selection of a ward/Selection of a given district) =

Number of wards chosen times $\frac{N_{sr}}{N_s} = \frac{m_s}{H} \cdot \frac{N_{sr}}{N_s}$ (12)

Prob(Selection of a given district)= 1 (since all district are to be included) (13)

If we use the formulas (10)-(13) in equation (9) we obtain that.

Prob(Selection of a household/Given the choice of district s in the region)= $\frac{m_s}{N_s}$ (14)

With the method outlined above, then, all household living in rural wards within a given district will have the same probability of being selected. However, because of the way the sample was allocated among the districts (re. equation (6)), these selection probabilities will not be the same in the different districts. This implies that, to compute any statistic for the whole region, the data from any given household must be weighted with weights that are equal to the inverse of the selection probabilities.

[1] See Kalton, op. cit. p. 42-43.

The statistics that will be computed from a sample of this form will weigh each farm household's data equally in each district but unequally between districts. For instance, if the value for an agricultural household h in district s for a given variable (say area planted in coffee) is x_{hs} then the average value for the whole sample will be equal to

$$\bar{x} = \sum_{s=1}^{S} \left(\frac{1}{\sum_{h=1}^{m_s} w_{hs}} \sum_{h=1}^{m_s} w_{hs} x_{hs} \right) \tag{15}$$

In the above equation the weights w_{hs} will be the following.

$$w_{hs} = \frac{N_s}{m_s} \tag{16}$$

Notice that these weights, which equal the inverse of the overall selection probability in the district, depend only on s, namely the 0district where the household is located, and will be different for different values of s. Table 2 gives these weights, along with the numbers that are used to estimate them.

Table 2. Selection probabilities and weights by district

District	No rural hhlds 2002 (census)	No of actual households to sample in survey	Selection probabilities based on 2002 figures	Weights (inverse of select. Probs)
Rombo	44608	341	0.007644	130.815
Mwanga	14268	81	0.005677	176.148
Same	23429	116	0.004951	201.974
Moshi rural	82154	600	0.007303	136.923
Hai	34932	217	0.006212	160.977
Total	199391	1355		

Based on the methodology outlined above, a selection of wards and villages was done to satisfy all the above criteria. The list of selected wards and villages, as well as their population statistics and the number of households to sample in each village, are indicated in Table 3. This is then the actual places that the survey teams should visit. As discussed above, in each identified village the number of households to select by SRS will not be what is indicated in the 9^{th} column of Table 1 in Appendix 1, but in fact 30 percent larger. In Rombo, for instance, in all villages the number of households selected from the village lists (assuming that the updating fraction discussed above due to the change in population is equal to 1) will be equal to 31*1.3=40. This, in order to account for non-response. Once the desired number of households are interviewed (namely 31), the ones remaining in the list of 40 selected households will be omitted.

Table 3: Wards and villages to visit in the Kilimanjaro vulnerability survey.

Ward sequential number (1)	District name (2)	Ward name (3)	Village or Street name (4)	Total Pop. Census 2002 (5)	Number of households in 2002 (6)	Number of agric. households to sample per village (7)	Weights[1] for computing survey statistics (8)
1	Rombo	Mamsera	Mamsera Juu	2131	498	31	130.815
2	Rombo	Mengwe/Manda	Mengwe Chini	2555	565	31	130.815
3	Rombo	Keni/Aleni	Aleni - Chini	6031	1226	31	130.815
4	Rombo	Shimbi	Shimbi Mashami	2648	590	31	130.815
5	Rombo	Mrao/Keryo	Mrao	2793	567	31	130.815
6	Rombo	Katangara/Mrere	Mrere	6202	1194	31	130.815
7	Rombo	Olele	Kiooti	3174	658	31	130.815
8	Rombo	Kirongo/Samanga	Samanga	5368	995	31	130.815
9	Rombo	Kitirima/Kingachi	Leto	4679	912	31	130.815
10	Rombo	Nanjala/Reha	Nayeme	5788	1111	31	130.815
11	Rombo	Motamburu kitendeni	Nalemuru	2800	611	31	130.815
12	Mwanga	Msangeni	Mamba	1033	228	27	176.148
13	Mwanga	Jipe	Jipe	963	208	27	176.148
14	Mwanga	Kilomeni	Sofe	1808	347	27	176.148
15	Same	Ruvu	Ruvu Jiungeni	3183	761	29	201.974
16	Same	Mhezi	Mtunguja	2574	495	29	201.974
17	Same	Mtii	Lugulu	1847	382	29	201.974
18	Same	Bwambo	Vugwama	2334	458	29	201.974
19	Moshi Rural	Mwika Kusini	Kimangaro	4462	920	30	136.923
20	Moshi Rural	Mwika kaskazini	Mrimbo Uuwo	4445	967	30	136.923
21	Moshi Rural	Mamba kusini	Kimbogho	1529	368	30	136.923
22	Moshi Rural	Marangu Mashariki	Rauya	4080	652	30	136.923
23	Moshi Rural	Marangu Magharibi	Nduweni	1641	377	30	136.923
24	Moshi Rural	Kilema Kusini	Kilema chini	2858	476	30	136.923
25	Moshi Rural	Kirua Vunjo Mashariki	Mero	2546	552	30	136.923
26	Moshi Rural	Kahe	Ngasinyi	2433	563	30	136.923
27	Moshi Rural	Old Moshi East	Tsuduni	1922	326	30	136.923
28	Moshi Rural	Mbokomu	Korini Juu	2143	483	30	136.923
29	Moshi Rural	Uru Mashariki	Mnini	2334	483	30	136.923
30	Moshi Rural	Uru South (Mawela)	Kariwa	3135	700	30	136.923
31	Moshi Rural	Mabogini	Mtakuja	4486	1124	30	136.923
32	Moshi Rural	Arusha Chini	Uhuru	1858	448	30	136.923
33	Moshi Rural	Kibosho Mashariki	Sungu	2141	435	30	136.923
34	Moshi Rural	Kibosho Magharibi	Manushi Ndoo	3330	664	30	136.923
35	Moshi Rural	Kindi	Kindi kati 1	7026	1474	30	136.923
36	Moshi Rural	Kirua Vunjo Kusini	Uchira	5603	1201	30	136.923
37	Moshi Rural	Okaoni Kibosho	Omarini	2141	511	30	136.923
38	Moshi Rural	Kimochi	Sango	3815	834	30	136.923
39	Hai	Machame Mashariki	Nkuu - Ndoo	2659	628	31	160.977
40	Hai	Machame Kusini	Kikavu Chini	3752	920	31	160.977
41	Hai	Machame Kaskazini	Nshara "A"	2329	488	31	160.977
42	Hai	Masama Mashariki	Mbweera	4166	996	31	160.977
43	Hai	Masama Magharibi	Mbosho	1966	479	31	160.977
44	Hai	Siha Mashariki	Kishisha	1283	282	31	160.977
45	Hai	Siha Kaskazini	Nrao Kisangara	1888	458	31	160.977

[1] Final weights have been adapted to reflect actual response rate.

Appendix 2: Household and community questionnaires[1]

TANZANIA VULNERABILITY SURVEY 2005
Research on Poverty Alleviation, FAO and World Bank
SET 1: PRICE CONTRACT: 10/20/50
WTP RAINFALL CONTRACT: 2000/4000/7500/1000/3000/5000
Ruvuma Household Questionnaire Round 2 (February 2005)
(To be answered by household head or most knowledgeable household member)

Date of interview: _____________day _________________ month__________ year

	Region	District	Ward	Village	Name of household head	Name of respondent if different from household head
Name						
Code						

Region Code	**Village code**	10=Angalia1	20=Mkwaya	30=Kipololo
1=Kilimanjaro	1=Mlete	11=Mchesi	21=Ndondo	31=Mpepai
2= Ruvuma	2=Muhukuru_Barabarani	12=Wenje	22=Chiulu/Chiula	32=Kitura
	3=Morogoro	13=Mchoteka	23=Kingerikiti	33=Ligera
District Code	4=Madaba	14=Mbesa	24=Kibandai 'A'	34=Mlilayoyo
1=Songea rural	5=Sisi kwa sisi	15=Kitanda	25=Mango	35=Naikesi
2=Tunduru	6=Namiungo	16=Nampungu	26=Langiro Asili	36=Likuyu/ Seka manga
3=Mbingao	7=Namakambale	17=Namakungwa	27=Mahenge	
4=Nambumbo	8=Tuwemacho	18=Litorongi	28=Tukuzi	
5=Songea urban	9=Chiungo	19=Lipumba	29=Ulolela	

Note: To identify the household name use the name of the respondent (household head or most knowledgeable person in the household), and for the household code use the corresponding code from the household list.

	Name	Code/id number
Respondent		
Is respondent different from last time? (1=yes, 2=no). ______		
If yes, then who was the respondent last time? Use code from household roster (99 if respondent does not remember		
Enumerator		
Supervisor		
Data enterer		

Note to Enumerator – please use following codes throughout the questionnaire

- **99 if the respondent does not know, does not remember or refuses to answer (in other words answer is not necessarily zero)**
- **88=Not Applicable (question irrelevant for the respondent)**
- **In all other cases blanks or empty spaces will be interpreted as zeros**

LOCAL UNIT CONVERSION CHART

Whenever during the interview the respondent refers to local units (bags, tins, debe, pishi, etc., make sure to return to this page and record or estimate in kilograms the weight, or in litres the content of the local units used by this particular respondent for this particular product. Remember **1Ha=2.47 acres**

Product	Local unit	Weight in kgs	Content in litres

[1] Questionnaires for the other rounds are similar. All questionnaires are also available in Swahili and are available upon request from the authors

A. Household roster –demographic characteristics, education and health

Please enumerate all household members of the household, i.e. members who usually live and eat in the household, including those who were members of the household last year. Please start with the household head, his/her spouse, other adults and then children (ranked from oldest to youngest). First list all the persons who are household members now, and then add those who were members last year but have left at the bottom.

(A1) **ID**	(A2) Name	(A3) Gender 1=Male 2=Female	(A4) Enter Age (yrs) at last birth day.	(A5) Relationship to head of the household 1=Head 2=Spouse 3=Child of both parents 4=child of head only 5=child of spouse only 6=grandchild 7= Niece, nephew 8=Parent or parent in law 9= brother/sister or brother/sister in law 10=daughter or son in law 11=adopted child 12=Other	(A6) Marital status (if ≥ 15 years old) 1=unmarried 2=married 3=separated/ divorced 4=widowed 5=other 88=N/A	(A7) Highest grade completed 0=pre-school 1=Standard 1 2=Standard 2 … 8=Standard 8 9=course after primary educ. 10=Form I 11=Form II 12=Form III 13=Form IV 14=course after second. educ. 15=Form V 16=Form VI 17=Course after Form VI 18=Diploma course 19=Other certificate 20=Some but not finished university 21=Completed University Degree 22=Adult education only 23=No education	(A8) Was [NAME] a member of the household 1 year ago (1=yes, 2=no)	(A9) Is [NAME] still a member of the household (1=yes, 2=no) If A9= 1 go to A11, if A9=2, go to A10	(A10) If [NAME] is no longer a member of the household, what has happened 1=died 2=married and moved within the village 3=married and left the village 4=moved to live on his own in the village or with another family 5=left the village to live on his/her own or with another family 6=other (explain)______________ ______________	(A11) For how many months has [NAME] been absent during the past year? (Zero if less than 1 month)	(A12) If absent, what was the main reason for his absence? 1=looking for work; 2=business 3=medical treatment 4=education 5=social event 6=started own household 7=others	(A13) Did [NAME] fall sick or get injured during the past 4 weeks? 1=yes 2=no (if A13=2 go to A15)	(A14) If yes, what sort of illness/injury did [NAME] suffer from? 1.Malaria 2. Respiratory 3.Measles 4.Diarrhoea 5.Cholera 6.TB 7.AIDS 8.Pregnancy related 9.Malnutrition 10.Accident 11.Intestinal infections 12.Skin infections 13.Mental illness 14. Others	(A15) Does [NAME] usually sleep under a mosquito net? 1=yes 2=no
1														
2														
3														
…														
12														

B. Activities of household members aged 5 years or above

ID (from A1)	Household member Name [repeat all names from Section A except children 5 or below] be sure that ID numbers correspond with those in section A.	Main activity (time spent)	If codes 1-5 in col (B3)		Last year, [NAME's] spent second most of his/her time while a member of the household as? Activity code	If codes 1-5 in col (B6)		If none of the two main activities mentioned in the previous two questions involved work on own farm, then how many months last year did {NAME} spend on the family farm last year (Answer only if main or secondary activity is NOT self employment in agriculture or livestock)	Did household member have any other jobs last year? 1=yes 2=no	If yes, state the number of jobs	Is household member 1= village chairman, 2=Kitongoji chair 3=10 cell leader 4=member of village council 5=village execution officer 6=relative to one of the above 7=none of the above
		In the past year (since last survey) or during the time he/she was a member of this household if not member for the whole year, [NAME] spent most of his/her time as (see code below)?	What is sector of employment? (see code below)	How many months were spent in the past year (since the last survey) doing this activity? (Use months if needed)		What is sector of employment?	How many months were spent **last year (since the last survey)** doing this activity? (Use fraction of months if needed))				
(B1)	(B2)	(B3)	(B4)	(B5)	(B6)	(B7)	(B8)	(B9)	(B10)	(B11)	(B12)

Activity code
1=regular wage earner in private sector
2=regular wage earner in public sector
3=irregular wage earner
4=self employed
5=unpaid family worker
6=student
7=looking for work
8=not working and not looking for work
9=household work
10=retired, pensioner
11=too old, too young
12=disabled
13=other

Sector of employment
Primary sector
1=agriculture
2=fishing
3=livestock
4=mining and quarrying
5=other primary
Industrial sector
6=manufacturing/production/crafts
7=construction
8=other industry
Service sector and government
9=wholesale/retail/shop
10=restaurant/food preparation
11=repair work
12=transport, storage and communication
13=banking, finance, real estate and business
14=public service, army, education, health
15=other service and government

C. Cash Income

What were the main sources of the total <u>cash</u> income of all household members over the past year (since the last survey)? Please indicate the five most important sources (1=most important, 2=second most important, … Up to 5th most important). Note to enumerators: please read each response.

Sources of income	Degree of Importance	Sources of income	Degree of Importance
C1. cash income from sale of food crops		C10. cash income from own non-agricultural enterprise	
C2. cash income from sale of coffee		C11. cash from pensions	
C3. cash income from sale of other cash crops		C12. cash from land rents	
C4. cash income from sale of vegetables		C13. cash from dividends, interest on bank deposits etc.	
C5. cash income from sale of livestock		C14. cash income from state and NGO assistance	
C6. cash income from sale of livestock products (milk, eggs, meat…….)		C15. cash gifts from friends, neighbours & relatives,	
C7. cash income from regular wage jobs		C16. cash from remittances from household members living elsewhere	
C8. cash income from irregular agricultural wage jobs		C.17. Other cash (explain)…..	
C9. cash income from irregular non-agricultural wage jobs			

C18. What share of the total cash income of the household (i.e. of all household members) last year was obtained?
(Code 88=0%, 1=1-25%, 2=26-50%, 3=51-75%, 4≥75%)

From regular wages ______________
From all irregular wages___________
From pensions___________________
From remittances_________________

D. Non-farm income

How much *income (cash and in kind)* have the different household members (≥ 5 years old) received from non-farm activities over the past year (since last survey)? If the individual was not a member of the household for the full year, list only their income during the time they were a member.

D1. Household member ID (from A1)	D2. Household member Name [repeat all names of household members listed in Section B]	D3. Total wages (in cash and in kind) received in all regular wage jobs (Tsh000)		D4. Total wages received (in cash and in kind) in occasional wage jobs (Tsh000)		D5. Total net income from non-farm business (Tsh000)	D6. Total amount of pensions received (Tsh000)	D7. Total amount received from all kinds of State and other institutional assistance (e.g.NGO), except pensions (Tsh000)		D8. Total amount received as gifts from neighbours, relatives, family, etc (Tsh000)		D9. Total amount received or brought back as remittances (Tsh000)	
		In cash	Value in kind	In cash	Value in kind			In cash	Value in kind	In cash	Value in kind	In cash	Value in kind
(D1)	(D2)	(A)	(B)	(A)	(B)	(D5)	(D6)	(A)	(B)	(A)	(B)	(A)	(B)

E. Total and food consumption expenditures

E1. Is your current household income adequate to meet your needs? __________ 1= not enough even for food; 2=enough for food but nothing left for other necessities; 3=enough for food and necessities, but not much left for other expenses; 4=enough to meet most of our needs) Note to enumerators – read the different possible answers.

For the questions below ask the respondent to fill in the answers for **all** the following periods	A. one day	B. one week	C. one month
E2. What is the total amount in cash your household spent for **all** expenditures in the last (Tsh000):			
E3. What is the amount in cash your household spent for food in the last (Tsh000):			

E4. What is the **average** cash amount spent **per month** for all **consumption** expenditures **during last year**? (Tsh000)	
E5. What is the **average** cash amount spent **per month** for all **food** expenditures **during last year?** (000 Tsh)	

How do you judge the stability of your total household...	1=very unstable 2=somewhat unstable 3=stable	How do you judge the stability of your total household ...	1=very unstable 2=somewhat unstable 3=stable
E6. **Total cash** expenditures from year to year?		E8. Cash **non-food** expenditures from year to year?	
E7. Household **non-cash** consumption from year to year?		E9. Cash **food** expenditures from year to year?	

Was your household income adequate to meet your needs … year(s) ago?	(1= not enough even for food; 2=enough for food but nothing left for other necessities; 3=enough for food and necessities, but not much left for other expenses; 4=enough to meet most of our needs)
E10. 1 year ago	
E11. 2 years ago	
E12. 3 years ago	
E13. 4 years ago	
E14. 5 years ago	
E15. 6 years ago	

F. Household assets

Housing condition

Do you live in the same house as last year? (1=yes, 2=no) _______
If yes, skip to question F8

F1. What is the type of house you live in? ________
(1=detached house; 2=semi-detached house; 3=flat; 4=hut in compound; 5=others)

F2. Is the house you live in ________
(1=owner occupied; 2=free public; 3=free private; 4=subsidized public; 5=subsidized private; 6=rented; 7=others)

F3. When was the house built? ________

F4. Does the house you live in have baked brick or concrete/stone walls (1=yes, 2=no) ? ________

F5. How large is the compound of the house (in acres)? _______

F6. Number of rooms used for living & sleeping ____ (exclude kitchen, bathroom, toilet)

F7. Does the house you live in have a metal, stone or concrete roof? (1=yes, 2=no) _____

F8. If you rent the house you live in, what is monthly rent paid (Tsh000)? ______

F9.A. Did you make any renovations to the house over the past year? (1=yes, 2=no) _______
F9.B. If yes, how much did you spend (Tsh000) __________

F13. Do you boil the water before drinking it? __________
(1=yes; 2=no)

F15. If you were to sell house and compound today, how much do you think you would make (Tsh000)________

F16.A. Does the household own another house than the one discussed (1=yes; 2=no) _________
B. Did you acquire this during the past year? (1=yes; 2=no) _________

F17. If yes in F16A, how much do you think you would make if you were to sell the house and compound today (Tsh000)? __________

	A. Did your household buy/receive or sell/give away any of the following items over the past year? (1=yes, 2=No)	**B.** If it bought or received any of these items		**C.** If it sold or gave away any of these items	
		B1 How many?	**B2.** What was the total value (Tsh000)?	**C1** How many	**C2** What was the total value (Tsh000)?
Consumer durables					
F18. Radio/cassette player/stereo equipment					
F19. TV set/video					
F20. Dish antenna/decoder					
F21. Telephone fixed					
F22. Cell phone					
F23. Computer/printer					
F24. Refrigerator/freezer					
F25. Sewing machine					
F26. Chairs					
F27. Sofas					
F28. Tables					
F29. Beds					
F30. Cupboards, chest of drawers, boxers, wardrobes, bookcases					

	A. Did your household buy/receive or sell/give away any of the following items over the past year? (1=yes, 2=No)	B. If it bought or received any of these items		C. If it sold or gave away any of these items	
		B1.How many?	B2. What was the total value (Tsh 000)?	C1.How many?	C2. What was the total value (Tsh 000)?
F31. Electric gas/stove					
F32. Other stove					
F33. Water heater					
F34 Books (not school books)					
F35. Watch					
F36. Motor vehicle					
F37. Motor cycle					
F38. Bicycle					
F39. Boat/canoe					
F40. Mosquito net					
Production tools					
F41. Wheel barrow					
F42. Plough for animal traction					
F43. Tractor					
F44. Trailer for tractor, harvester/reaper, plough for tractor, harrow					
F45. Sprayer and/or fogger					
F46. Water pumping set					
F47. Milking machine					
F48. Milling machine					
F49. Coffee pulping machine					
F50. Tobacco curing machine					
F51. Cashew machines					
F52. Incubator					
F53. Fishing net and other fishing equipment					
F54. Beehives					
F55. Sugar cane processing machine					
F56. Irrigation pump*[1]					
Buildings					
F57. Storage building for agric. products					
F58. Tobacco curing hut					
F59. Animal shed					

F60 Did you buy or obtain as a gift/inheritance any non-farm enterprise assets (not your house, land, consumer durables or farm equipment)? (1=yes, 2=no) (A)________ If yes, how? (1=bought; 2=obtained by gift/inheritance) (B)_______ What was the total value (price if bought)? (Tsh000) (C) ___________

F61 Did you sell or give away any non-farm enterprise assets (not your house, land, consumer durables or farm equipment)? (1=yes, 2=no) (A) ________ If yes, how? (1=sold; 2=gave away) (B)_______ What was the total value (price if sold)? (Tsh000) (C) ________

[1] * indicates that the item was not included in the first round.

G. Agricultural land ownership and use (crop production)

	A. Amount	B. Unit (1=ha; 2=acre)
G1. What is the total amount of land your household **owns now**? (in acres)		
G2. What is the total amount of land your household **cultivated** (both owned & rented) (in acres) this **year?**		

During the past year (since the last survey):			A. Amount	B. Unit (1=ha; 2=acre)	C. Value (Tsh000)
G3. Did you buy/receive any agricultural land? 1=yes, bought 2=yes received; 3=not bought or received		G4. If bought or received, state amount and value			
G5. Did you sell/give away any agricultural land? 1=yes, bought 2=yes received; 3=not bought or received		G6. If sold/given away, state amount and value			
			A. Amount	B. Unit (1=ha; 2=acre)	C. Rent (Tsh000)
G7. Did you rent in any land for agriculture? 1=yes, 2=no		G8. If rented, state amount and rent			
G9. Did you rent out any land for agriculture? 1=yes, 2=no		G10. If rented, state amount and rent			

I would now like to ask you some questions about your tree crops.

	Do you currently own any of the following tree crops?		Did you change the number of trees you own during the past year?		
	A 1=yes 2=no	B If yes, how many?	C 1=yes 2=no	D If yes, how many did you plant?	E If yes, how many did you uproot?
G11. Coffee, arabica					
G12. Banana					
G13. Cashew nut trees					
G14. Other fruit trees					
G15. Trees for timber or firewood					
G16. Other trees					

G17. How many parcels of land did you operate (includes rented land) this past year?	

For each land parcel answer the following questions starting with the largest parcel. Start with the largest and continue to the smallest.

Parcel number	G18. Size		G19.Distance from household compound (km) (0 if next to compound)	G20.Altitude compared to village centre 1=much above 2=somewhat above 3=about the same 4=somewhat below 5=much below	G21.What is the general slope of the parcel 1=very steep 2=gentle slope 3=mostly flat	G22. Irrigated? 1=yes; 2=no	G23. If yes, state type of irrigation 1=flooding 2=sprinkler 3=drip irrigation	G24. Is land parcel: 1=fully owned by household 2=partly owned by household 3=under long term leasehold 4=Rented 5= other	G25. Soil quality 1=Good 2=Medium 3=Poor	G26. Distance from nearest all weather road	G27. What kind of improvements does this plot have such as bunding, terracing, or mulching 1=rock bunds 2=soil bunds 3=mulching 4=terraces 5=grass lines 6=other 7=none		G28. How was the land cultivated last year 1=by hand 2=by animal traction 3=by tractor 4=was not cultivated (fallow) 5=other
	(A) Amount	(B) Unit 1=ha 2=acres									(1)	(2)	
P1													
P2													
P3													
P4													
P5													
P6													
P7													
P8													
P9													
P10													

For each of the largest 5 parcels (fewer if household does not operate 5 or more) answer the following questions regarding the crops cultivated this year in each parcel (follow sequence of plots indicated above).

G29. Parcel No	G30. Type of cultivation 1=mono-crop 2=mixed crop	G31. Crop code (if mixed, repeat parcel number and list different crops	G32. Number of trees if applicable	G33. Production last year		G34. Rainfall received in parcel last year compared to normal in past (code below)	G35. Onset of rainfall last year compared to normal 1=normal; 2=little bit late 3=much too late 4=early	G36. crop damage due to pest/insect attacks? 1=none 2=little 3=somewhat 4=a lot
				A. Units (use same units along the same rows)	B. Amount			

Crop code
1=maize
2=beans
3=coffee
4=banana
5=millet
6=sorghum
7=wheat
8=rice
9=cassava
10=yams
11=sweet potato
12=Irish potato
13=groundnuts
14=onions
15=tomatoes
16=pumpkin
17=carrots
18=sweet pepper
19=cabbage
20=other vegetables
21=simsim (sesame)
22=peas
23=castor oil
24=sugar cane
25=papaya
26=other fruit
27=others, specify
28=tobacco
29=cashew
30=sunflower
31=avocado

Units
1=kg
2=litre
3=100kg bags
4=20kg tins/debe
5=5kg tins
6=bunch (specify weight in front)
7=root bag (specify weight in front)
8=cups (specify weight in front)
9=pieces

Normality code
1=much above normal
2=somewhat above normal
3=around normal/average
4= somewhat below normal
5=much below normal

G37. What was the production and sales of main annual crops in the past year? (state units and conversion rates to kg in the local unit conversion table). If some products haven't been completely harvested, give estimated total production.

	A. Produced this year? 1=yes 2=no	D. Total production	E. Units for production and sales (apply to all cols)	F. Amount sold	G. Total value of sales (Tsh. 000)	H. Amount used for household consumption	I. Amount still stored	J. Chemical Fertiliser used? 1=Yes 2=no	K. Organic fertilizer used? 1=yes 2=no	L. Chemicals/ pesticides used 1=Yes 2=no	M. Improved seeds used? 1=yes 2=no
Maize											
Beans											
Coffee Arabica											
Banana											
Millet											
Sorghum											
Wheat											
Rice											
Cassava											
Yams											
sweet potatoes											
Irish potatoes											
Groundnuts											
Onions											
Tomatoes											
other Vegetables											
Sunflower											
Peas											
Castor oil											
Sugar cane											
trees for timber or firewood											
Papaya											
Other fruit											
Tobacco											
Cashew											
Simsim											

	A. Produced this year? 1=yes 2=no	D. Total production	E. Units for production and sales (apply to all cols)	F. Amount sold	G. Total value of sales (Tsh. 000)	H. Amount used for household consumption	I. Amount still stored	J. Chemical Fertiliser used? 1=Yes 2=no	K. Organic fertilizer used? 1=yes 2=no	L. Chemicals/ pesticides used 1=Yes 2=no	M. Improved seeds used? 1=yes 2=no
Other product (code from prev. page) G38 ________											
Other product (code from prev. page) G39________											
Other product (code from prev. page) G40________											

Unit code

1=kg
2=litre
3=100kg bags
4=20kg tins
5=5kg tins
6=bunch (specify weight in front)
7=root bag (specify weight in front)
8=cups (specify weight in front)
9=pieces
10-other (explain)________

A. In how many years out of the last ten have you grown this crop?		In how many years out of the last ten, has production per acre of these two crops been in the following categories: (total number of years should be equal to number in column A)				
		B1. Normal or above normal	B2. Less than normal and at least 9/10 of normal	B3. Less than 9/10 of normal and at least ¾ of normal	B4. Less than three quarters of normal and at least ½ of normal	B5. Less than half the normal production
G41. Maize						
G42. Cassava						

H. Livestock production and sales

H1. Did your household have any livestock during any period last year?	1= yes	2=no

If NO, go to animal product section. IF YES, how many animals does your household own now and last year?

	A. Number 1 year ago (i.e. at the time of last survey)	B. Acquisitions since February last year				C. Diminishments since February last year					D. Number now
		(1) # bought	(2) Total spent (Tsh000)	(3) # born	(4) # obtained as gift or by exchange of labour or other goods or services	(1) # sold.	(2) Total payment received (Tsh000)	(3) # killed for cons.	(4) # given as gift or in exchange of labour or other goods or services	(5) # died /stolen	
H2. Draft bullocks or oxen											
H3. Cows and male cattle											
H4. Goats/sheep											
H5. Pigs											
H6. Horses mules donkeys											
H7. Poultry (chicken, ducks, turkeys, guinea fowl)											

Animal products last year (i.e. since last survey):

H9. Did your household produce any animal or bee products last year? ________ (1=yes, 2=no). If NO, go to the FARM INPUT section. If YES, we would like to ask you some questions about the type of products produced and the amount sold.

	A. Did your household produce any of the following animal products 1=yes; 0=no	B. Total production last year	C. Unit	D. Quantity sold last year	E. Value of sales (Tsh000)
H10. milk					
H11. Cheese, butter, yoghurt					
H12. Honey					
H13. Meat (Beef, goat/sheep, pork) (from animals slaughtered)					
H14. Eggs					

Unit code

1=kg
2=litre
3=100kg bags
4=20kg tins
5=5kg tins
6=bunch (specify weight in front)
7=root bag (specify weight in front)
8=cups (specify weight in front)
9=piece

I. Farm inputs

How much of various inputs did you use and buy this past year (including inputs for coffee, tobacco and cashew production)?

	A. Used this year 1=yes 2=no; if no, go to F for non blocked items.	B. Total used		C. Quantity purchased	D. Value spent Tsh000 for quantity purchased	E. What was the main source of your input last year? 1=Private market/shop 2=Cooperative 3=Government project 4=Other	F. Was it easy to get assuming you had financing (1=yes, 2=no)	G. Was it available when you needed it? 1=yes 2=no
		B1. Amount	B2. Unit 1=kg 2=litre					
I1. Traditional seeds								
I2. Improved seeds								
I3. Organic fertiliser								
I4. Inorganic fertiliser								
I5. Chemicals (insecticides herbicides)								
I6. Veterinary services								
I7. Other livestock related services and inputs (feed, transport, etc. except labour)								
I8. Animal or machinery hire for ploughing etc.								
I9. Transport of farm products								
I10. Other production expenses								

I11. Did you obtain any inputs on credit (1=yes; 2=no)? _______

I12.A If yes, whom did you get credit from? ______
(1=food crop buyer; 2=primary society; 3=private cash crop trader; 4=cash crop company;
5=relatives/friends; 6=bank; 7=sacco or other credit association; 8=rosca; 9=private input trader; 10=other (explain)___________________

I13. How did you eventually pay back?_____
(1=In cash after sale of product; 2=By deduction from sale price when lender bought my products; 3=In kind with other products; 4=through working for the person who lent me; 5=I have not repaid yet ; 6=other way (specify)………………………...)

J. Hired farm labour

J1. Did you hire workers for the farm last year (inclusive for coffee, tobacco, and cashew production)?	1=yes	2=no

J2. How many days of hired labour did you use last year for all your crops (i.e. since last November)	J3. Total amount spent for this type of labour last year in cash and estimated value of non-cash payments	
	A. Cash (Tsh000)	B. Value in kind (Tsh 000)

K. Processing of farm products

K1. Have you processed any farm products from crops/other plants **during the past year (i.e., since the last survey)** (beer, butter, vegetable oil, …(1=yes; 2=no)? _____
If no, go to next section.

	A0. During the past twelve months list all products made from crops and other plants by household members (beer, shea butter , vegetable oil, etc) (see codes in last column)	A. Total production last year		B. Total amount sold	C. Total sales last year Tsh000	D. Total cash production expenses during last year (tools, containers, labour, etc.) Tsh000
		A1. unit	A2. amount			
K2.						
K3.						
K4.						
K5.						
K6.						
K7.						

Production unit code
1=kg
2=litre
3=100kg bags
4=20kg tins
5=5kg tins
6=bunch (specify weight in front)
7=other (specify weight in front)

Product codes
1=beer/wine/strong drink
2=maize or rice flour
3=yam or cassava flour
4=oil
5=prepared/cooked food
6=other, specify

L. Marketing of crops

L1. Did you sell any of the products you produced last year ? (1=yes, 2=no) _____ If no, go to the next section. If yes, could tell us during which period of the year you sold your harvest. For the **main** marketed products **except coffee and cashew nuts** (not more than 4 products). **Note to enumerator: if any crops were sold, this section should be filled out (cross-check with G37F)**

	A0. Use crop codes from page 11	What percentage of your sales of the major products did you sell in each of the following periods (% of total sold; columns should add to 100%)				
		A. Right after harvest	B. 1-4 months after harvest	C. 5-8 months after harvest	D. 9-12 months after harvest	E. More than 12 months after harvest
L2.						
L3.						
L4.						
L5.						

L6.Did you encounter any problems in selling farm products last year (except coffee, tobacco, cashew))? (1=yes,2=no)______________________
If answer to above was yes, then what were the most important problems you encountered (list up to three)? (Do not read responses).
If a problem is identified, ask how often it occurs (column B).

Type of problem	A. 1=most important 2=second most important 3=third most important 88=all others	B. Frequency of problem 1=always 2=sometimes 3=rarely a problem 88=not mentioned in A
L7. I could not find buyers when I wanted to sell		
L8. I could not sell in the village and had to transport to nearest market		
L9. Transport to market was not available when I wanted to sell		
L10. It took too long to sell, and product deteriorated in quality		
L11. I had to wait too long for payment		
L12. Prices were low		
L13. Other problems (explain)		

M. Coffee production and sales

M1. Do you have coffee trees? (1=yes, 2=no) _____. If no, go to the next section.

Arabica coffee marketing and sales last year and this year (all units in kg of parchment equivalent). If available and the farmer is willing to share them, please use the receipts. Cross check with coffee production in section G.

	How much coffee did you sell?			
	A. to the primary society	B. Directly to the auction (through farmers' groups)	C. private buyers or others?	D. to Akscg or other NGOs under special contracts
M2. Amount sold since the beginning of the harvest season this year (2004)				
M3. Initial price in Tsh per kg				
M4. Additional payment in Tsh per kg				
M5. Amount sold from the end of last harvest season (2003) till the beginning of this year's harvest season (2004)				
M6. Initial price in Tsh per kg				
M7. Additional payment in Tsh per kg				

Coffee production costs

Last year	A.Cultivation	B.Pruning	C.Weeding	D.Harvesting	E. Washing and processing	F. Transport to collection centre	G. Other	H. Total Days	L. Total amount spent (Tsh) (note: total should be ≤ J3A & J3B	
M8. How many days did you and other household members spend over the past year (2004) on									L1. Cash	L2. In kind
M9. How many days from hired labour (permanent and seasonal) did you utilise over the past year (2004) on										

M10. What was the total cash cost (Tsh 000) of other variable inputs applied to coffee trees:
Fertilizer (A) ____________ Spraying chemicals (B) ____________ Various services (e.g. rental equipment, …) (C) ____________
Credit (interest paid) (D) ____________ Other inputs (E) ____________

In all cases below it concerns the price for coffee in parchment form.

M11. (A) Do you know what is the price of coffee today offered at your village? __________ (1=Yes , 2=no).
(B) If yes, how much is it (Arabica Parchment) __________Tsh/kg

M12. Do current coffee prices cover total cash production costs (namely excluding your household labour and other in kind household inputs) 1=yes, 2=no	
M13. At current prices, is it worth the time of your household members to produce coffee? 1=yes, 2=no	
M14. What is the current or most recent Moshi auction price for arabica coffee? (in Tsh/kg)	

1=highly likely, 2= somewhat likely, 3= somewhat unlikely, 4=highly unlikely, 99=cannot tell or do not know	A. Below 400 Tsh/kg	B. At least 400 and less than 600 Tsh/kg	C. At least 600 and 800 and less than Tsh/kg	D. At least 800 and less than1000 Tsh/kg	E. Above 1000 Tsh/kg
M15. How likely do you think it is that next year's coffee prices (in the village for parchment) will be the in the indicated range					

	(A). January -March	(B). April-June	(C). July-September	(D). October-December	TOTAL
M16. What proportion (percentage) of your total coffee production do you normally harvest in each of the following periods (note answers must add to 100)					
M17. What proportion (percentage) of your total coffee production last year did you harvest in each of the following periods (note answers must add to 100)					

Willingness to pay for coffee price insurance

Suppose it would be possible to buy a contract NOW to ensure yourself a certain minimum coffee price in the future after the next harvest. If the market price is higher than this minimum price at the time your contract expires, you will get the market price. If it is lower than this minimum price, you will get the minimum price stipulated in your contract. While it is not possible to offer such contracts at this time, it may be possible to do so in the future. Obviously, such a contract does not come for free. A premium must be paid NOW, and we would like to know if you would be interested in such contracts and how much you would be willing to pay for such a contract. The coffee you would deliver would be of the same quality as you delivered last year and it would be collected at the same place it is collected now.

M18 Would you be interested in such a contract if it were offered to you? (1=yes; 2=no) __________

While you may not be interested in such a contract, you may become more interested if we make it a bit more concrete, so please bear with us for a moment.

While we fully realize that this is not an easy exercise, we would like to emphasize that it is important that you give us as honest and precise an answer as possible. By overstating the premium you would be willing to pay, you would suggest that the interest in such an insurance scheme is higher than it actually is and vice versa, if you understate the premium, you suggest that you are less interested than you actually are. Note once again that the contract guarantees you a certain minimum price and that if the actual market price in a year turns out to be higher, you get that higher market price.

M19. (A) Would you be willing to pay Tsh10 for a contract which permits you to sell 1 kg of coffee in May-August of 2005 (i.e. 3 to 6 months from now for at least Tsh 400 (1=yes, 2=no) ______
(note you can buy as many of these 1 kg contracts as you wish)

(B). If your answer is YES, then how many contracts would you be willing to buy at this price? ________________

(C). If your answer is no, what is the maximum price you would be willing to pay for such a contract? __________Tsh

M20. (A) Would you be willing to pay Tsh20 for a contract which permits you to sell 1 kg of coffee in May-August 2005 (i.e. 3 to 6 months from now for at least Tsh 600. (1=yes, 2=no) ______ (note you can buy as many of these 1 kg contracts as you wish)

(B). If your answer is YES, then how many contracts would you be willing to buy at this price?________________

(C). If your answer is no, what is the maximum price you would be willing to pay for such a contract? __________Tsh

M21. (A) Would you be willing to pay Tsh 50 for a contract which permits you to sell 1 kg of coffee in May-August 2005 (i.e. 3-6 months from now) for at least Tsh 800. (1=yes, 2=no) ______
(Note you can buy as many of these 1 kg contracts as you wish)

(B) If your answer is YES, then how many contracts would you be willing to buy at this price?________________

(C). If your answer is no, what is the maximum price you would be willing to pay for such a contract? __________Tsh

M22. Would you be able to pay for the premium now? (1=yes, 2=no) ______

N. Cashew nut production and sales

N1. Do you have cashew nut trees? (1=yes, 2=no) _____ *If no, go to the next section.*

N2. Who was the main buyer for your cashew nuts this past year? (1=Primary society, 2=trader, 3=cashew nut private company; 4=other)____________
N3. Did you make a contract for producing and selling cashew nut last year? (1=Yes, 2=No)______________
N4. If yes with whom? (1=primary society, 2= trader, 3=private cashew nut company, 4=other)_____________

Cashew nut marketing and sales last year and this year (all units in kg of raw nuts). If available and the farmer is willing to share them, please use the receipts.

	How much cashew nut did you sell	
	A. Standard	B. Under grade
N5. Amount sold since the beginning of the harvest season this year (2004)		
N6. Average price in Tsh per kg		
N7. Amount sold from the end of last harvest season (2003) till the beginning of this year's harvest season (2003)		
N8. Average price in Tsh per kg		

Last year	A. Land preparation	B. Pruning	C. Weeding	D. Harvesting	E. Processing	F. Transport to collection centre	G. Other	H. Total Days	I. Total amount spent (Tsh) note: should be ≤ to J3 A and B	
N9. How many days did you and other household members spent last year on									L1. Cash	L2. In kind (value)
N10. How many days from hired labour (permanent and seasonal) did you utilise last year on										

N11. What was the total cash cost (Tsh) of other variable inputs applied to cashew nut trees:
Fertilizer (A)…………..…….. Spraying chemicals (B) …..……………….. Various services (e.g. rental equipment, …) (C)………………..Cash Credit (interest paid) (D) ……………………..

N12. (A) Did you receive any of these inputs on credit or as a loan? (1=yes, 2=no)_______________
(B) If yes, from whom?(1=primary society, 2=from buyer of product, 3=from seller of inputs, 4=other)____________
Cashew nut prices (in all cases below the cashew nut for which price is asked is per kg, for standard grade nuts)

N13. Do current cashew prices cover total cash production costs (namely excluding your household labour and other in kind household inputs)	1=yes,	2=no
N14. At current prices, is it worth the time of your household members to produce cashew? 1=yes, 2=no		

1=highly likely, 2= somewhat likely, 3= somewhat unlikely, 4=highly unlikely, 99=cannot tell or do not know	A. Below 300 Tsh/kg	B. At least 300 and below 400 Tsh/kg	C. At least 400 and below 500 Tsh/kg	D. At least 500 and up to 600 Tsh/kg	E. Above 600Tsh/kg
N15. How likely do you think it is that next year's cashew nut prices (in the village) will be the in the indicated range					

Willingness to pay for cashew nut price insurance

Suppose it would be possible to buy a contract NOW to ensure yourself a certain minimum cashew nut price in the future after the next harvest. If the market price is higher than this minimum price at the time your contract expires, you will get the market price. If it is lower than this minimum price, you will get the minimum price stipulated in your contract. While it is not possible to offer such contracts at this time, it may be possible to do so in the future. Obviously, such a contract does not come for free. A premium must be paid NOW, and we would like to know if you would be interested in such contracts and how much you would be willing to pay for such a contract. The cashew you would deliver would be of the same quality as you delivered last year and it would be collected at the same place it is collected now.

N16. Would you be interested in such a contract if it were offered to you? (1=yes; 2=no) __________
While you may not be interested in such a contract, you may become more interested if we make it a bit more concrete, so please bear with us for a moment..

While we fully realize that this is not an easy exercise, we would like to emphasize that it is important that you give us as honest and precise an answer as possible. By overstating the premium you would be willing to pay, you would suggest that the interest in such an insurance scheme is higher than it actually is and vice versa, if you understate the premium, you suggest that you are less interested than you actually are. Note once again that the contract guarantees you a certain minimum price and that if the actual market price in a year turns out to be higher, you get that higher market price.

N17. (A) Would you be willing to pay Tsh10 for a contract which permits you to sell 1 kg of standard grade cashew nut in August-December 2005 (i.e. 6-10 months from now) for at least Tsh300. (1=yes, 2=no)______
(note you can buy as many of these 1 kg contracts as you wish)

(B) If your answer is YES, then how many contracts would you be willing to buy at this price? _______________

(C) If no, what is the maximum price you would be willing to pay (in Tsh)? __________

N18 (A) Would you be willing to pay Tsh20 for a contract which permits you to sell 1 kg of standard grade cashew nut in August-December 2005 (i.e. 6-10 months from now) for at least Tsh450. (1=yes, 2=no)______
(note you can buy as many of these 1 kg contracts as you wish)

(B) If your answer is YES, then how many contracts would you be willing to buy at this price? _______________

(C) If no, what is the maximum price you would be willing to pay (in Tsh)? __________

N19.(A) Would you be willing to pay Tsh 30 for a contract which permits you to sell 1 kg of standard grade cashew nut in August-December 2005 (i.e. 6-10 months from now) for at least Tsh 600. (1=yes, 2=no)______
(note you can buy as many of these 1 kg contracts as you wish)

(B) If your answer is YES, then how many contracts would you be willing to buy at this price? _______________

(C) If no, what is the maximum price you would be willing to pay (in Tsh)? __________

N20. Would you be able to pay for the premium now? (1=yes, 2=no) ______

N21. Are you still sure of your responses? _____________(1=very sure; 2=sure ; 3=have some doubt; 4=still have a lot of doubt;99=really don't know)

O. Willingness to pay for rainfall based insurance

We would like to ask you some questions relating to how weather affects your farm production, and then some questions about whether you would be interested in a particular kind of insurance for losses due to bad weather.

First I would like to ask you some questions concerning rainfall in the location of your farm.

O1 How many years out of the last ten was the rainfall in your farm …. (The sum of all answers must be 10)

A. Much below normal	B. Somewhat below normal	C. Around normal or average	D. Somewhat above normal	E. Much above normal

We would like to ask you if rainfall falls a certain percentage below normal, if you would consider it:

1= normal, 2= somewhat below normal; 3= a lot below normal. (Note to enumerator, as soon as the respondent has indicated that he considers a certain drop in rainfall below normal as 3=a lot below normal, you enter 3 for the subsequent questions till W.6)

O2 In particular, if rainfall in a particular year is around 1/10 below normal, would you say that rainfall is: ________

O3 If rainfall in a particular year is around a quarter (1/4) below normal, would you say that rainfall is: ________

O4 If rainfall in a particular year is around a third (1/3) below normal, would you say that rainfall is: ________

O5 If rainfall in a particular year is half (1/2) or more below normal, would you say that rainfall is: ________

O6 When you consider a period of 10 years, how often (i.e. how many years out of ten) did you obtain:

A. A normal revenue per acre or more (as low as 10% below average is considered normal)	B. Between 10 percent and one quarter below the average revenue per acre	C. More than one quarter, but not less than half the average revenue per acre	D. Less than half of the average revenue per acre

Explanation for the respondent

Some organizations are currently exploring the introduction of a rainfall based insurance contract. The spirit of the contract is that if the amount of rain is below a certain minimum, you would receive a certain payout. The contract will be written per acre and you can buy as many contracts as you want. In other words, if the rainfall falls below a certain level (defined as a fraction below normal rainfall), you would receive a certain amount at the time of harvest. If the rainfall was above that then you would receive nothing. If you had bought two contracts, you would receive two times that amount. If you had bought three contracts, you would receive three times that amount, etc. and you would receive a multiple of that amount depending on the number of contracts you have bought per acre. Obviously, such a contract would not come for free and you would be asked to pay a certain premium for such a contract. The premium would have to be paid at the time of the purchase of the contract, i.e. before the planting season. We would like to know if you would be interested in such contracts and how much you would be willing to pay for such a contract. While we fully realize that this is not an easy exercise, we would like to emphasize that it is important that you give us as honest and precise an answer as possible.

O7 Would you be interested in such a type of contract? (1=yes, 2=no) _____

(To the enumerator) If the answer of the respondent to the previous question is "Yes", then go to Question O9 below. Otherwise continue

O8 If your answer to W7 is No, then why is it so? (Do not read responses; select only one answer from below) ________________

1. I cannot afford to pay any amount for rainfall insurance
2. I am short of funds in the period before planning
3. I have other more pressing cash needs in the period before planting
4. Declines in rainfall do not hurt me too much
5. I have other means of covering my losses due to inadequate rainfall
6. Major declines in rainfall do not occur too often
7. Other (explain)____

Even if you answered that you are not interested in such a contract we would like to ask you some relevant questions to see whether you would be interested when you heard the options.

O9. Consider the following contract. When rainfall in the following year is 1/10 OR MORE below normal, then you will be paid an amount equal to Tsh12000 per acre. Are you willing to pay 2000 Tsh/acre for such a contract (you could buy as many "per acre contracts as you want"? (1=yes, 2=no)?_________

O10. How many acres (one contract per acre) would you insure at that price?

Number of acres	

O11. Consider the following contract. When rainfall in the following year is 1/10 OR MORE below normal, then you will be paid an amount equal to Tsh21000 per acre. Are you willing to pay 4000 Tsh/acre for such a contract (you could buy as many "per acre contracts as you want"? (1=yes, 2=no)?________

O12. How many acres (one contract per acre) would you insure at that price?

Number of acres	

O13. Consider the following contract. When rainfall in the following year is 1/10 OR MORE below normal or more, then you will be paid an amount equal to Tsh 35000 per acre. Are you willing to pay 7500 Tsh/acre for such a contract (you could buy as many "per acre contracts as you want"? (1=yes, 2=no)?

O14 How many acres (one contract per acre) would you insure at that price?

Number of acres	

O15A. How much chemical fertilizer do you normally use on your farm? _____ (in kgs)

O15B. If you were to buy one of the insurance contracts offered above, how much chemical fertilizer would you use?_____ (in kgs)

O16. Consider the following contract. When rainfall in the following year is 1/3 OR MORE below normal, then you will be paid an amount equal to Tsh 20000 per acre. Are you willing to pay 1000 Tsh/acre for such a contract (you could buy as many "per acre contracts as you want"? (1=yes, 2=no)? _____

O17 If you answered yes to any of the above questions, then how many acres (one contract per acre) would you insure at that price?

Number of acres	

O18. Consider the following contract. When rainfall in the following year is 1/3 OR MORE below normal, then you will be paid an amount equal to Tsh 35000 per acre. Are you willing to pay 3000 Tsh/acre for such a contract (you could buy as many "per acre contracts as you want"? (1=yes, 2=no)? _____

O19. If you answered yes to any of the above questions, then how many acres (one contract per acre) would you insure at that price?

Number of acres	

O20. Consider the following contract. When rainfall in the following year is 1/3 OR MORE below normal, then you will be paid an amount equal to Tsh 58000 per acre. Are you willing to pay 5000 Tsh/acre for such a contract (you could buy as many "per acre contracts as you want"? (1=yes, 2=no)? _____

O21. If you answered yes to any of the above questions, then how many acres (one contract per acre) would you insure at that price?

Number of acres	

O22. If you were to buy one of the insurance contracts offered above, how much inorganic fertilizer would you use?_____ (in kgs)

Note for external readers of the questionnaire, the * on the premiums indicates an actuarially fair contract.

P. Access to credit	
P1. Does any member of your household belong to a sacco (1=yes, 2=no)	
P2. Does any member of your household belong to a rosca (1=yes, 2=no)	
P3. Does any member of your household have an individual bank account (1=yes, 2=no)	
P4A. During the last year, have you needed money quickly for an emergency, that you could not cover from your own resources? (1=yes, 2=no) If yes, go to next question; if no, go to P6A.	
P4B. Were you able to obtain money to deal with this emergency? (1=yes, 2=no)_ If yes, go to next question; if no, go to P6A.	
P5. If answer to above is yes how did you cover your needs? (1=gifts from relatives or friends, 2= borrowed from relatives or friends, 3=borrowed from sacco, or other formal credit association; 4=borrowed from rosca; 5=borrowed from cooperative or other primary society; 6=borrowed from local trader, shopkeeper or other person not related to household; 7=borrowed from local or other bank; 8=other (explain)____________________________________)	
P6A. Did you need seasonal credit to buy inputs for the farm this year? (1=yes, 2=no) *If yes, go to next question, if no, go to P8A*	
P6B. Were you able to obtain credit for seasonal inputs? (1=yes, 2=no) *If yes, go to P7; if no, go to P8A.*	
P7. If answer to previous question is yes, then whom did you obtain this credit from? (1=borrowed from relatives or friends, 2=borrowed from sacco or other formal credit association; 3= borrowed from rosca; 4=borrowed from cooperative or other primary society; 5=borrowed from local trader, shopkeeper or other person not related to household; 6=borrowed from local or other bank; 7=other (explain)____________________________________)	
P8A. Did you need credit to buy any of the capital items (farm or non-farm) that you bought this year? (1=yes, 2=no) *If yes, go to P8B, if no, go to P10*	
P8B. Were you able to obtain credit for capital items?	
P9. If answer to previous question is yes, then whom did you obtain this credit from? (1=borrowed from relatives or friends, 2=borrowed from sacco or other formal credit association; 3= borrowed from rosca; 4=borrowed from cooperative or other primary society; 5=borrowed from local trader, shopkeeper or other person not related to household; 6=borrowed from local or other bank; 7=other (explain)____________________________________)	

P10. How many loans do various members of your household have now? (number)	
P11. What is the total amount of loans your household owes now? (Tsh000)	
P12. A. How much (average) interest do you pay per month on these loans (Tsh000)	
P13. Have you given out any loans to other people? (1=yes, 2=no)	
P14. What is the total amount of loans you have given out to other people now? (Tsh000)	
P15. How much (average) interest do you collect on these loans per month? (Tsh000)	
P16. Do you normally in a year spend for consumption less than your income? (1=yes,2=no) Note: income includes all cash and in kind income, as well as home production; consumption includes purchased and non-purchased items	
P17. If the answer to question above is yes, then what portion of your income do you save in a normal year? (1=less than 5%, 2=at least 5 and less than 10%), 3= at least 10 and less than 20%;4= at least 20 and as much as 30%;5=more than 30%	
P18. Do you keep some of your savings in cash? (1=yes, 2=no)	
P19. What proportion of your total savings do you normally keep in cash? (1=up to 10%, 2=more than 10%, but less than a quarter), 3= at least a quarter, but less than half;4=half or more	
P20. Do you keep some cash outside the household? (1=yes, 2=no)	
P21. If you keep cash outside the household, where do you keep it? 1=bank;,2=sacco;3=rosca; 4=other (explain)______	

Q. Real income evolution and instability

Compared with 6 years ago (1999), is income from each of the following sources now a larger share of total income, about the same, or a smaller share of total income?
1=larger share of total now than 6 years ago;
2=about the same share as 6 years ago;
3=smaller share of total now than 6years ago.
88=do not receive any income from this source now and also did not 6 years ago.

Q1. Cash income from own farm staple food crops (cereals/banana /root crops/ etc)		Q6. Wages (cash or goods exchanged) of all types	
Q2. Cash income from sale of own livestock		Q7. Income (cash or goods exchanged) from food and other agricultural processing activities (not coffee)	
Q3. Cash income from coffee production and sales		Q8. Income (cash or goods exchanged) from other non-farm family enterprises	
Q4. Cash income from other cash crops		Q9. Income from pensions	
Q5. Cash income from sale of vegetables / fruits		Q10. Income (cash or goods) from gifts and remittances	

Q11. Has food produced by the household become a larger or smaller share of total food consumption over the past six years? ________
1=larger share of total now than 6 years ago;
2=about the same share as 6 years ago;
3=smaller share of total now than years ago.
88=do not receive any income from this source now and also did not 6 years ago.

R. Constraints to expanding income opportunities

R1. Is your household interested in increasing its agricultural production activities? __________ (1=yes; 2=no)
If yes, go to R2; if no, go to R3.

R2. IF YES, what are the three most important problems/constraints that prevent you to increase your household's agricultural activities?
1=most important, 2=second most important, 3=third most important (DO NOT READ RESPONSES) If no constraints mark 1 for responses option 17 and 88 elsewhere

	1.Cannot obtain more land		7. Prices of products too low		13. Difficulties of dealing with state
	2. Cannot obtain loans, credit for capital purchases		8. Delayed payments from buyers		14. Difficulty in dealing with primary society or cooperative
	3. Cannot obtain credit/loans for seasonal capital needs		9. Not enough family labour		
	4. Cannot find labour to hire		10. Prices of inputs too high		15. Agricultural production less profitable than other activities of household
	5. Cannot sell products		11. Cannot find suppliers of inputs		16. Other (explain)….
	6. Do not have enough own capital		12. High cost of marketing because of bad roads		17. No constraints (if no constraints mark 1 here and 88 elsewhere.)

R3. IF NO, what are the two most important reasons why you are not interested?
→ 1=most important, 2=second most important (DO NOT READ RESPONSES)

	1. Farming is not profitable		3. We can make more money doing other things		5. We cannot sell what we want to sell now
	2. We are too old		4. We do not need the money		6. Other (explain)….

R4. Are some of your household members interested in working more for wages? ___________ (1=yes; 2=no)
If no, go to section S; if yes, continue.

R5. IF YES, what are the two most important problems in finding additional work?
1=most important, 2=second most important (DO NOT READ RESPONSES)

	1. There is no or little work available where we live
	2. There is work available but wages are too low
	3. We do not have any spare time to work more
	4. We make better income in our current activities
	5. Other (explain) …………..

S. Portfolio and growth preferences

S1. Suppose you earned some extra money from your income activities (equal to about half your annual income), what would you use it for?
State the 3 most important purposes (DO NOT READ RESPONSES) (1=most important, 2=second most important, 3= third most important).

	1. Increase agricultural food crop production		5. Increase farm processing activity		9. Buy bicycle, motorcycle, truck, car, etc.		13. Put in savings account in bank
	2. Increase coffee production		6. Increase storage capacity or other farm buildings		10. Buy food or other consumer goods		14. Other..........................
	3. Increase production of non-food cash crops besides coffee		7. Invest in non-farm enterprise		11. Pay for children's education		
	4. Increase livestock production		8. Improve house		12. Buy household appliances		

T. Major shocks and other temporary events that negatively affected household's living conditions in the past year

SHOCKS ARE EVENTS THAT OCCUR SUDDENLY. OFTEN THEY HAVE A CLEAR BEGINNING AND A CLEAR END. THEY GENERALLY DO NOT LAST FOR MORE THAN A FEW DAYS OR WEEKS. SOME MAY EVEN BE VERY BRIEF (E.G. A HAILSTORM). THE CONSEQUENCES OF SHOCKS (E.G. LOSS OF ASSETS, OR LACK OF FOOD) MAY BE FELT FOR A LONG PERIOD OF TIME

In the past year have the living conditions in your household been negatively affected by any of the following [SHOCKS]?

ID		Over the past year, have the living conditions of household members been affected by [SHOCK]? 1= yes 2= no If 2 go to next item		How did [SHOCK] affect the food consumption of the household 1=Very negatively 2=somewhat Negatively 3=not much 4=not at all	How did [shock] affect the total consumption of the household? 1=Very negatively 2=somewhat Negatively 3=not much	How long did it take to get back to the total consumption level attained before the shock? 1. Less 1 month 2. 1-3 months 3. 3-6 months 4. 6 –12 months 5. Have not recovered yet	Who else in the community experienced this [SHOCK]? 1. Only this household was affected 2. Few households 3. Many households 4. Almost everybody
T0		T1		T2	T3	T4	T5
1	Drought						
2	Heavy rainfall, flooding, untimely rains, hailstorm						
3	Unexpected decline in cereal price compared to the previous year						
4	Unexpected decline in cash crop price compared to the previous year						
5	Major harvest losses due to wild animals, birds, livestock, insects, pests						
6	Fire/house burnt down						
7	Theft of household assets						
8	Unemployment from paid job						
9	Loss of livestock (death, theft, illness; NOT SALE)						
10	Eviction, loss of land (NOT SALE)						
11	Substantial post harvest maize loss						
12	Other (specify) _______						

			Age	Sex 1=M, 2=F				
13	Major illness not resulting in death # 1							
14	Major illness not resulting in death # 2							
15	Major illness not resulting in death # 3							
16	Death # 1							
17	Death # 2							
18	Death of person outside of household who provided important financial support							

As a direct consequence of this [SHOCK] …

			If yes in T7		If yes (code 1 in T9)		If yes (code 1) in column T11					If yes to T16		
	Of the shocks identified on the previous page, which three shocks were the most serious ones? **Provide shock ID from T0**	As a result of [SHOCK] did you lose (part of) your harvest 1=Yes 2=no → T9	How much did you lose 1=90-100% 2=1/2-90% 3=1/2 to ¼ 4=less 25%	As a result of [SHOCK] did you incur major expenses (e.g. funeral, medical bills) 1=yes 2=no → T11	How much did you spend in '000 Tsh	Did you lose any livestock? (NOT BY SALE) 1=yes 2=no → T16	How many oxen did you lose?	How many other cattle did you lose?	How many goats, pigs or sheep did you lose?	How many poultry did you lose?	Did [SHOCK] have any non-material consequences? 1=Yes 2=no → T19	What kind of consequences? **Consequence code**		**Consequence code** 1. Social disruption *e.g. immorality, drug, alcohol abuse* 2. Family breakdown *e.g. orphan hood, early marriage, inheritance* 3. Emotional breakdown *e.g. depression, mental illness* 4. Educational breakdown *e.g. interrupted school, lack of concentration* **5.** Other ____(specify)
	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17	T18	
Most Serious														
Second Shock														
Third Shock														

To reduce the consequences of this [SHOCK] (e.g. for the household's food consumption) or to recover from the [SHOCK] (e.g. to rebuild a house) **…**

			If yes to T20			If yes to T23	**If 1-4 in T24**		**If yes to T26**			**If yes to T29**	
	Shock ID **From P6**	Did you use cash savings? Or did you sell, barter or exchange land, animals or other assets? 1=Yes 2=no → T23	What assets did you sell or exchange? **Codes at bottom in column 1**		Did you receive assistance from family or others (friends, NGO, gov't)? 1=Yes 2=no → T26	From whom **Codes at bottom in col 2**	Is the person from whom you received aid:1=better-off than you, 2=about the same, or 3=poorer than you?	Did you engage in new ways of generating income? *e.g. sell food / crafts, work off farm…* 1=Yes 2=no → T29	What did you do? **Codes at bottom in column 3**		Did you take any other actions to deal with [SHOCK] *e.g. Borrow, eat less expensive food…*? 1. Yes 2. No	What did you do? *e.g. borrow money,, migration* **Codes at bottom in column 4**	
	T19	T20	T21	T22	T23	T24	T25	T26	T27	T28	T29	T30	T31
Most Serious													
Second Shock													
Third Shock													

Column 1 Sale or exchange of assets or savings	Column 2 Reliance on assistance and aid	Column 3 Adaptations in income generation	Column 4 Other actions
1. House 2. Land 3. Oxen 4. Other cattle 5. Other livestock 6. Food stock 7. Household appliances 8. Jewellery 9. Cash Savings 10. Other (specify) ________	**from ..** 1. Relative in village 2. Relative outside village 3. Neighbours / friends in village 4. friends outside village 5. Local religious organization, NGO, or village official 6. (inter) national NGO 7. government 8. Other ________(specify)	1. Work harder, longer hours on farm 2. Engage in (more) off farm labour 3. Crafts, carpentry, beer making and other self employment 4. Join food for work program 5. Prostitution 6. Send children to work or beg 7. Other (specify)________________	1. Migrate with household to other area 2. Borrow money or food 3. Send household members away to look for work 4. Postpone purchase of clothing and other durables 5. Eat less expensive food (no meat or fish) 6. Collect and eat wild foods 7. Eat less 8. Other (specify)

U. Household consumption expenditures

A. FOOD, BEVERAGES AND TOBACCO

On average, how many people were present in the household and participated in the meals in the last 7 days? Also indicate the number of visitors who participated in the meals and the number of days they did so.

U1	Household Members		Visitors			
	(1) Adults	(2) Children	(3) Adult	(4) # days	(5) Children	(6) # days
(A) Male						
(B) Female						

How much of each of the following food items has the household (including meals prepared for visitors) consumed over the past 7 days. **Enumerators - let wife assist as she may be more familiar with food consumption than the man.**

Item Description	**Code**	**Total amount consumed**	**Unit of Qty 1=kg 2=litre 3=pieces 4=gram 5=other…**	**Purchased (incl. food bought while temporarily away from home by household members and visitors over past 7 days.**		**Consumption out of home produce**	**Obtained as gift**
				Qty.	**Value (Tsh)**	**Qty**	**Qty**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Banana	101						
Maize (grains)	102						
Maize (cobs)	103						
Maize (flour)	104						
Beans (dry)	105						
Rice	106						
Millet/sorghum	107						
Bread	108						
Sweet Potatoes (Fresh)	109						
Casava(Fresh	110						
Cassava(Dry/Flour)	111						
Irish Potatoes	112						
Beef	113						
Pork	114						
Goat/sheep meat	115						
Other meat	116						
Chicken	117						
Fresh Fish	118						
Dry/Smoked fish	119						
Eggs	120						
Fresh Milk	121						
Cooking oil	122						
Margarine, Butter, etc	123						
Fruits	124						
Onions	125						
Tomatoes	126						
Cabbages	127						
Peas	128						
Other Vegetables	129						
Groundnuts	130						
Sugar	131						
Coffee	132						
Tea	133						
Salt	134						
Soda/soft drinks/ juice	135						
Beer local	136						
Beer commercial	137						
Cigarettes	138						
Other Tobacco	139						
Restaurant exp on food	140						
Restaurant exp on drinks	141						
Spices	142						

B. NON-DURABLE GOODS AND FREQUENTLY PURCHASED SERVICES (during last 30 days)

Item	Code	Unit of Quantity 1=kg 2=litre 3=pieces 4=gram 5=other	Purchases		Home Produced		Obtained as gift	
			Quantity	Value (Tsh000)	Quality	Value (Tsh000	Quality	Value (Tsh000
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Housing expenditures								
Rent of rented house	201							
Maintenance and repair expenses	202							
Water	203							
Electricity	204							
Paraffin (kerosene)	205							
Charcoal	206							
Firewood	207							
Others	208							
Personal care								
Matches	210							
Washing soap	211							
Bath soap	212							
Tooth paste	213							
Cosmetics	214							
Handbags, travel bags etc	215							
Batteries	216							
Newspapers and magazines	217							
Others	218							
Transport& communication								
Tyres, Tubes, spares, etc.	220							
Petrol, diesel etc.	221							
Taxi and/or bus fares	222							
Stamps, envelopes, etc	223							
Air time & service fee for mobile phones	224							
Expenditure on fixed phones	225							
Others	226							
Health expenditures								
Consultation Fees	230							
Medicines etc.	231							
Hospital/Clinic charges	232							
Traditional doctors fees/medicines	233							
Others	234							
Other service								
Sports, theatres etc	240							
Dry Cleaning and Laundry	241							
Houseboys/girls, Shamba boys etc.	242							
Barber and beauty shops	243							
Expenses in hotels, lodging places	244							
Milling expenses	245							

C. SEMI-DURABLE AND DURABLE GOODS AND SERVICES (during last 365 days)

Item Description	Code	Purchases Value (Tsh000)	Free (obtained as gift) Value (Tsh000)
(1)	(2)	(3)	(5)
Clothing			
Men's clothing	301		
Women's clothing	302		
Children's wear	303		
Clothing Material and tailoring	304		
Men's Footwear	305		
Women's Footwear	306		
Children's Footwear	307		
Other Footwear and Repairs	308		
Furniture, Carpet, Furnishings etc			
Furniture Items (chairs, sofas, tables, beds, cupboards, chest of drawers, wardrobes, book cases)	401		
Carpets, Mats, etc.	402		
Curtains	403		
Bedding Mattresses	404		
Blankets and bed sheets, etc.	405		
Mosquito nets	406		
Insecticide for mosquito nets or spraying the compound	407		
Other and Repairs	409		
Household Appliances and Equipment			
Electric iron/Kettles/cooking pots etc.	421		
Charcoal and Kerosene stoves	422		
Electronic Equipment (TV. dish antenna, decoder, etc.)	423		
Radio/cassette player/stereo equipment	424		
Computer/printer	425		
Bicycles	426		
Motorcar, pick-ups, etc.	427		
Motor cycles	428		
Phone Handsets (Both Fixed and Mobile)	429		
Other equipment and repairs	430		
Jewellery, Watches etc.	431		
Glass/Table Ware, Utensils & Electric goods			
Plastic Basins	441		
Plastic plates/tumblers	442		
Jerry cans and Plastic buckets	443		
Enamel and metallic utensils	444		
Switches, plugs, cables, bulbs etc	445		
Others and repairs	449		
Education			
Schools fees including PTA	601		
Boarding and Lodging	602		
School uniform	603		
Books and supplies	604		
Other educational expenses	609		
Other services			
Expenditure on household functions	801		
Insurance Premiums	802		
Other services N.E.S.	809		

D. NON-CONSUMPTION EXPENDITURE

Items Description	Code	Value during 12 months (Tsh000)
(1)	(2)	(3)
Taxes and duties paid	901	
Pension and social security contribution	902	
Remittances, gifts and other transfers including title	903	
Contributions to funerals and other functions	904	
Others (like subscriptions, interest to consumer debts, etc	909	

E. WHAT KIND OF TAXES HAVE YOU PAID THIS YEAR?
(NOTE: the sum of taxes reported below should equal the value in 901)

Type of tax / product	Code	A. Paid any of the following taxes? (1=yes,2=no)	B. If yes, what was the total amount of taxes paid this year (Tsh000)	C. Has amount of tax increased since 5 years ago? 1=yes, 2=the same 3=decreased 4=tax did not exist 5 years ago)
Produce cess				
Coffee	1001			
Maize	1002			
Other crops	1003			
Livestock	1004			
Cashew	1005			
Tobacco	1006			
Education levy				
Coffee	1007			
Maize	1008			
Other crops	1009			
Livestock	10010			
Cashew	10011			
Tobacco	10012			
Village levy				
Coffee	10013			
Cashew	10014			
Tobacco	10015			
Other products	10016			
Development levy	10017			
Other taxes (explain) ……………..	10018			
Other taxes (explain) ……………..	10019			
Other taxes (explain) ……………..	10020			

We would like to thank you for your time and cooperation.

TANZANIA VULNERABILITY SURVEY 2004
Research on Poverty Alleviation World Bank, and FAO

Kilimanjaro Round 2. Village Questionnaire (November 2004)
(to be answered by village committee/council or focus group of knowledgeable villagers)

Date of interview :_____________day _________________ month

	Region	District	Ward	Village	Household Head
Name					
Code					

1= **Region Code** Kilimanjaro
2=Ruvuma

District Code
1=Rombo
2=Mwanga
3=Same
4=Moshi Rural
5=Hai

Village code (same code can be given to the ward of that particular village)
1=Mamsera Juu
2=Mengwe Chini
3=Aleni-Chini
4=Shimbi Mashami
5=Mrao
6=Mrere
7=Kiooti
8=Samanga
9=Leto
10=Nayeme
11=Nalemuru
12=Mamba
13=Jipe
14=Sofe
15=Ruvu Jiungeni
16=Mtunguja
17=Lugulu
18=Vugwama
19=Kimangaro
20=Mrimbo Uuwo
21=Kimbogho
22=Rauya
23=Nduweni
24=Kilema Chini
25=Mero
26=Ngasinyi
27=Tsuduni
28=Korini Juu
29=Mnini
30=Kariwa
31=Mtakuja
32=Uhuru
33=Sungu
34=Manushi Ndoo
35=Kindi kati 1
36=Uchira
37=Omarini
38=Sango
39=Nkuu-Ndoo
40=Kikavu Chini
41=Nshara 'A'
42=Mbweera
43=Mbosho
44=Kishisha
45=Nrao Kisangar

Note – codes for ward and village are the same

Enumerator – please record the various readings of latitude, longitude and altitude of the community. Take the place of interview as point of reference. Readings should be between 2°25' and 4°25' South (of Equator) latitude and 36°25'3'' and 38°18'00''East of Greenwich longitudinally.

	Latitude (xx°xx'xx''S)	Longitude (xx°xx'xx''E)	Altitude (meters)
1st reading			
2nd reading			
3rd reading			

	Name	code
Enumerator		
Supervisor		
Data enterer		

Note to Enumerator – please use following codes throughout the questionnaire
99 if the respondent does not know, does not remember or refuses to answer (in other words answer is not necessarily zero)
88=Not Applicable (question irrelevant for the respondent)

A. Information about Community Respondents

May we please ask you a few questions about yourselves before we start the interview?

A.1 How many men are present at this meeting? ______

A.2 How many women are present? ______

A.3.A. Is the village chairman present? ______ (1=yes; 2=no) B. gender of chair ______ (1=male; 2=female) C. age ______ D.. years served as chair ______

A.4 Is village executive officer present? ______

A.5 Number of other elected officials present ______

A.6 How many people present have completed:

a. no formal schooling _____ b. some primary_____ c. primary_____ d. some secondary_____ e. form IV_____ f. form VI_____

A.7 Number of people present whose main activity in terms of total income is farming _____

A.8 Number of public sector employees present _____

Social and Demographic Information

A.9 How many people live in the village now? _________ (incl. those temporarily away)

A.10 How many households live in the village? _________

A.11 How many new households have **moved into** this village from outside during the past year? _________

A.12 How many households from this village **have left** the village permanently in the last year? _________

A.13 Has this village requested or received financial support from an association of former inhabitants of the village or surrounding area over the past year. (1=Y,2=No) _________

A.14 In how many households do members often migrate temporarily to work elsewhere (1=almost everyone; 2=about three quarters; 3=about half; 4=about a quarter; 5=very few; 6=none)

A.15 Do households generally receive remittances? __________ (1=almost everyone; 2=about three quarters; 3=about half; 4=about a quarter; 5=very few; 6=none)

A.16 Not including the village committee, how many economic or social organizations are there? _______

A.17 How many of these organizations are active? _______

B. Geographical and agro-ecological information about the village

B1. How many months of the year does it normally rain? ________

Which are the months of rains?	1. Jan	2. Feb	3. March	4. Apr	5. May	6. Jun	7. Jul	8. Aug	9. Sept	10. Oct	11. Nov	12. Dec
B2. In which months does it **normally** rain and how much does it rain in each of those months? (0=no rain; 1= little bit of rain; 2=moderate rain; 3= lot of rain)												
B3. How did the rains this **past year** compare to normal in **each** month (1=much above normal; 2=somewhat above normal; 3=around normal; 4=somewhat below normal; 5=much below normal)?												

B4. Indicate for the following crops during which months they are normally **planted (P), weeded (W), harvested (H) and sold (S)** in this village												
B4a.1 Maize Masika (P, W, H)												
B4a.2 Maize Vuli (P,W,H)												
B4b.1 Beans Masika (P, W, H)												
B4b.2 Beans Vuli (P, W, H)												
B4c. Coffee (P, W, H)												
B4d. Banana (P, W, H)												

B5 How much CASH expenditures do households typically have in each month? (0=almost none; 1=a little bit; 2=some; 3=a lot)												

B6 How high is the demand for hired labour during each of the following months? (0=no demand; 1=some demand; 3=high demand)												

B7. Is it difficult for anyone (including residents and non-residents) to obtain a plot of land in this village? (1=yes; 2=no)? ________

B8. If yes, why? (1=too expensive; 2=not many plots available; 3=both; 4=other - explain
B________) A________

B9. Share of all households in community with coffee trees. ________

B10. Share of all households in community who still grow coffee ________

B11. What is the distance to the nearest town (km)? ________

B12. How many hours does a truck take to go to the nearest town

B13. During the rainy season? Hours A________ Minutes B _______

B14. What proportion of households lives within 1 km of centre of village? ______

B15. What proportion of households lives between 2 and 5 km of the centre of the village? ___

C. Socio-economic information about the village

Is there a _________ in the village?	A. Were the following services present last year? (1=yes, 2=no)	B. Are the following services present in the village now? 1=Yes, 2=No	C. If the answers to the previous question is no, has the distance (in km) to the nearest service 1=remained the same 2=changed compared to last year.	D. If the answer to the previous question is 2, at how many kms is the nearest service now?
C1.Elementary school				
C2. Junior secondary school				
C3. Senior secondary school				
C4. Church				
C5. Dispensary				
C6. Health centre				
C7 Hospital				
C8. Bore hole for water				
C9. Community well				
C10. Public water tap				
C11. Market				
C12. All weather road (tarmac)				
C13. All weather road (gravel)				
C14. Electricity				
C15. Public telephone				
C16 Possible to receive cell phone				
C17 Bus service to nearby town?				
C18 Village bank or other formal credit society or association				
C.19 Agricultural Extension agent				
C20. Veterinary service				
C21. Sales point for agricultural inputs (fertilizer, seeds,…)?				
C22. Primary society?				

D. Information on shocks

I would like to ask you about important shocks that have taken place in this community over the past year? Shocks are events which happen unexpectedly and which can cause substantial damage to people's livelihoods.

Event description	A. Has the following shock taken place over the past year?1=Yes; 2=No If "No", go to next event.	B. What proportion of the community has been affected by this shock (%)?
D1. Fire		
D2. Flood		
D3. Drought		
D4. Irregular rainfall pattern (too late, too early, …)		
D5 Unexpected drop in cereal prices from one year to the other		
D6 Unexpected drop in coffee prices from one year to the other		
D9 Epidemic (malaria, cholera, …)		
D11 Animal disease		
D12 Banditry/thefts		
D13 Others (Specify)		

D14 Did the Masika rains come on time this past year? ____________
(1=on time; 2=somewhat late; 3= very late)

D15 Did the Vuli rains come on time this past year? __________
(1=on time; 2=somewhat late; 3= very late)

W1. In how many years out of the last ten was the rainfall in the village (Insert number of years out of last ten. The sum of all answers must be 10)

A. Much below normal	B. Somewhat below normal	C. Around normal or average	D. somewhat above normal	E. much above normal	F. Sum of the years to the left

W2. In how many years out of the last ten was the rainfall in your village (Insert number of years out of last ten. The sum of all answers must be 10)

A. Above or around normal or minimally (5% or less) below normal	B. Around 10% (1/10) below normal	C. Around a quarter (1/4) below normal	D. Around a third (1/3) below normal	E. Around half (1/2) below normal	F. Less than half (1/2) of normal	G. Sum of the years to the left

We would like to ask you if rainfall falls a certain percentage below normal, if you would consider it:
1= normal, 2= somewhat below normal; 3= a lot below normal. _________

Note to enumerator, as soon as the respondent has indicated that he considers a certain drop in rainfall below normal as 3=a lot below normal, you enter 3 for the subsequent related questions)

W.2 In particular, if rainfall in a particular year is around 1/10 below normal, would you say that rainfall is: _______

W.3 If rainfall in a particular year is around a quarter (1/4) below normal, would you say that rainfall is: _______

W.4 If rainfall in a particular year is around a third (1/3) below normal, would you say that rainfall is: _______

W.5 If rainfall in a particular year is half (1/2) or more below normal, would you say that rainfall is: _______

E. Labour market information

We would like to ask you some questions on the daily standard agricultural wage rate for adults. Note that this rate should be the sum of the remunerations received in cash as well as those received in kind, i.e. the cost of non-cash wage items such as meals, part of the harvest, etc.

Activities	(A) Land preparation	(B) Planting	(C) Weeding	(D) Harvesting
E.1 What was the agricultural daily wage rate this past year for the different activities (Tsh/day) for men?				

If daily wage rates are unknown and expressed as a lump sum for a particular task, what was on average:
(if E1 was answered, go directly to E4)

E.2 The total labour cost of preparing 1 acre of land **last year** and how long does it take on average
A______(Tsh) B___ (days)

E.3 The total labour cost of weeding 1 acre of land **last year** and how long does it take on average
A______(Tsh) B___(days)

E.4 During the peak season month for labour demand do some village members go to other villages or town to work? (1=yes, 2=no)______________

E.5 What is the price of 1 bag of Urea and how many kg does it contain?
A.______ price (Tsh) B. ____ kg

E.6 What was the price of 1 bag of Urea **last year** and how many kg does it contain?
A.______ price (Tsh) B. ____ kg

E.7 What is the price of 1 bag of DAP and how many kg does it contain?
A.______ price (Tsh) B. ____ kg

E.8 What was the price of 1 bag of DAP **last year** and how many kg does it contain?
A.______ price (Tsh) B. ____ kg

E.9 At the sales point for agricultural inputs mentioned in C22, is fertilizer typically physically available when needed (1=yes; 2=no)? ______________

F. Information on Marketing

F1. How many different traders/companies visited the village last year to buy **maize**?_____________

F2. How many different traders/companies visited the village last year to buy **coffee**?_____________

G. Information on taxes

What types of taxes are collected in the village?

Type of tax	A. Collected in village? (1=yes; 2=no	B. Who collects it?	C. Amount of tax in this year		D. How does tax compare to that of last year	E. How does tax compare to that of five years ago	F. How many people in the village pay this tax
		1=village authorities 2=district authorities 3=primary societies 4=other	C1. unit on which tax is levied 1=kg of product 2=head of livestock 3=household 4=person, 5=acre of farm 6=other (explain)	C2. amount in Tsh/unit	1=increased 2=decrease d 3=stayed the same 4=tax did not exist last year	1=increased 2=decrease d 3=stayed the same 4=tax did not exist five years ago	1=all 2=some but not all 3=only a few 4=no-one
District produce cess of:							
10. coffee							
11. other crops							
20. education levy							
30. district trading licenses							
40. village levy							
50. tax on livestock							
60. other tax (1) (explain…)							
61. other tax (2) (explain…)							
62. other tax (3) (explain…)							

Appendix 3: Notes on the construction of the income and consumption variables

Income aggregate

The income aggregate is the sum of the individual income flows from all income generating activities of the household during the year prior to the survey. Income is composed of farm and non-farm income. Farm income is composed of income from crop production, livestock income, income from processed farm products and finally income from animal products. A detailed catalogue of more than 20 crops, six types of animals, five animal products and several processed farm products captured the variety of agricultural products produced by the sampled farm households in Kilimanjaro and Ruvuma. For each subcategory of farm activity, income was computed as the sum of the reported values of annual sales plus the value of home consumed annual farm production. The latter flows were valued at median regional unit prices, computed from all the reported sales of all farmers in the regions who sold the product. Livestock income was estimated as income from animal sales plus value of home-consumed slaughtered animals. A detailed farm input module was included in the survey, concerning ten different types of inputs. This allowed the calculation of agricultural net income. Home produced inputs were valued at median regional input prices.

Income from non-farm activities was composed of cash and in kind income from regular and irregular wages, non farm business income, pensions, amounts received from state or other institutions as assistance (e.g. NGO), as well as gifts from neighbours, relatives, family, or others and remittances. The above data were collected using a yearly recall module for each household member above five years old.

Consumption aggregate

The consumption aggregate is the sum of the value of all items consumed. This includes purchased and home produced items, as well as items received as gifts. Data on food consumption expenditures were collected using a seven-day recall module on food, drink, and tobacco; a one-month recall module on frequently purchased non-durable goods and services including cooking fuel, transport, communications, personal effects, and health care; and a one-year recall module on durables, education, and other infrequent expenditures such as expenditures on functions and taxes. A detailed description of all items is in the questionnaire in Appendix 2. The 2000/01 Tanzanian Household Budget Survey consumption aggregate excluded expenditures on health care, education, water, postage, rent, and durables. For the sake of comparability, we also exclude these items from the consumption aggregate.

For all items for which both quantity and expenditure values were collected (this includes all foods, fuel for cooking and lighting, batteries, matches, and soap), we compute unit values for both kilograms and ‘pieces’, and use regional median unit values for each item to impute the value of home-produced and gifted items. For purchased items, we use the actual reported expenditure, both to capture differences in quality among goods within the same category, and because it was thought that expenditures were more accurately reported than were quantities consumed.

Because the value of calculated expenditures using this method was much higher than that reported in the HBS, we adjust our consumption values using the following method:

(1) multiply the nominal regional mean per capita expenditure reported in the HBS final report for rural Kilimanjaro and Ruvuma by the real per capita GDP growth and CPI increase from 2000-2003.
(2) divide the mean expenditure calculated from an HBS-comparable basket (as described above) from the survey by the regional means derived in (1) to compute a "ratio of underestimation" of 1.26 for Kilimanjaro and 1.18 for Ruvuma.
(3) divide all expenditures (HBS-comparable basket) by the regional ratio of underestimation.

Poverty Lines

The poverty lines are constructed according to the cost-of-basic-needs methodology as follows. The food poverty line is taken from the 2000/01 HBS, and reflects the composition of food items consumed by the poorest 50 percent of households, adjusted by a constant to meet the minimum recommended calorie intake of 2,200 calories per adult per day. This amount was adjusted by a regional Fisher index, also taken from the HBS, and multiplied by the change in food CPI since 2000 to calculate the 2003 food poverty line used here. Households with *food* expenditures per adult equivalent below this line are considered *food poor*. Adult equivalent units reflect age and sex specific consumption requirements, and are the same as those used in the HBS, as follows:

Age	Males	Females
0-2	0.4	0.4
3-4	0.4	0.48
5-6	0.56	0.56
7-8	0.64	0.64
9-10	0.76	0.76
11-12	0.8	0.88
13-14	1	1
15-18	1.2	1
19-59	1	0.88
>59	0.88	0.72

The value of total consumption per adult equivalent (per capita) is calculated by dividing total consumption by the value of adult equivalents (number of members) from the household roster. However, for food consumption we divide by the adult equivalent value (number) of those present for meals. Household sizes in the second round were found to be much larger than in the first round. Most of this difference is attributable to children studying away from home, who were counted as household members in the second round, but not in the first. To correct for this spurious difference in household size, and thus per capita and per adult equivalent consumption values, we subtract from the second round adult equivalent value and household size the value of those members who are students and who have spent time away from home during the past year.

To calculate a regional basic needs poverty line, we take the food poverty line as derived above, and following the HBS, divide this by the food share of total consumption expenditures of the poorest 25 percent of households in that region to allow for non-food consumption. Poverty lines and regional poverty rates are reported in Chapter 2, Tables 2.19 and 2.20

Rural household vulnerability and insurance against commodity risks

Evidence from the United Republic of Tanzania

This report has two objectives. It assesses the nature and the extent of vulnerability among rural households in Tanzania with a particular focus on smallholder cash crop growers through exploring all risks, including the decline in commodity prices. It further explores the potential role for market based insurance schemes such as commodity price and weather based insurance to mitigate household vulnerability. The empirical analysis is based on two rounds of specifically designed representative surveys of farm households in Kilimanjaro and Ruvuma, two cash crop growing regions in the United Republic of Tanzania in 2003 and 2004. The contrasting experiences of a richer (Kilimanjaro) and a poorer (Ruvuma) region substantially enriches the policy guidance emerging from the report. The report applies descriptive, econometric and contingent valuation techniques to achieve its objectives. The findings identify drought, health and commodity price shocks as the key risks faced by rural households in Kilimanjaro and Ruvuma. The welfare losses associated with these shocks are substantial. Households extensively use self and mutual insurance to cope with these shocks, but nonetheless, there remains substantial uninsured risks as indicated by the considerable stated demand for coffee and weather based insurance which could have important societal benefits. The "latent" demand for insurance further suggests that current ways of coping may not be efficient and that there may be important economic opportunities which insurance could open up. Liquidity constraints emerge as important impediments in adopting such market based insurance schemes. Great care will need to go into the design and institutional delivery mechanisms of market based insurance. The establishment of interlinked markets such as input, credit and insurance packages deserves special attention in this regard. Finally, other, more traditional, public interventions such as providing public health services, fostering connectivity and access to off-farm employment, and better water management techniques were also identified as promising household vulnerability reducing interventions.

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