The Role of Agriculture in Reducing Poverty in Tanzania: A Household Perspective from Rural Kilimanjaro and Ruvuma

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Abstract

This paper explores how farm productivity affects poverty, and how various factor market constraints affect farm productivity. The empirical analysis draws on representative surveys of farm households in Kilimanjaro and Ruvuma, two cash crop growing regions in Tanzania. We find that poorer households do not only possess fewer assets, but are also much less productive. We find that agricultural productivity directly affects household consumption and hence overall poverty and welfare. Stochastic production frontier analysis indicates that many farmers are farming well below best practice in the region. Analysis of allocative efficiency suggests that family labour is substantially over utilized, a sign of considerable excess labour supply. Use of intermediate inputs on the other hand is well below what is commensurate with the estimated value of their marginal productivities. An important reason for low input use is lack of credit to purchase inputs, but difficult access to the inputs themselves, being connected to the economy, and food security and self insurance considerations are also important impediments. Easy access to credit is positively associated with being a member of a savings association or being in a contractual arrangement with a cooperative or firm. The findings support a continuing emphasis on increasing agricultural productivity in designing poverty reduction policies. Better agronomic practices and increased input use will be crucial in this strategy. Financial constraints might be relieved through fostering institutional arrangements facilitating contract enforcement and institutions that facilitate saving by the households themselves. They may also be relieved by the provision of more adequate consumption safety nets.

Keywords: Agricultural development. Factor markets. Rural poverty. Farm productivity

JEL Codes. O13, O120, Q120

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1. Introduction and background

Agricultural and food policies, have a crucial role in reducing rural as well as aggregate poverty in Africa, given that the bulk of the poor are in rural areas, and are employed in agriculture. Crucial among these policies are those that help increase incomes of the rural poor. The purpose of this study is to explore some of the determinants of agricultural development in rural Africa, by exploring the factors which have the most poverty reducing effect with a particular emphasis on the role of agricultural productivity, technology, and factor market constraints, and to provide a robust empirical basis for the design of agricultural and rural development strategies effective in reducing poverty in the context of rural Tanzania.

Tanzania is among the world's poorest countries with a per-capita income of about US$280. From a macroeconomic perspective, agriculture plays a dominant role in the economy, accounting for nearly 45% of GDP, in 2003 and employing around 70% of labor force. Agriculture accounts for three quarters of merchandise exports and represents a source of livelihood to about 80% of the population. Agricultural income is the main source of income for the poor, especially in rural areas. But households that rely heavily on such income tend to be extremely poor. The poor are more likely to grow and sell crops than the non-poor, but the majority of production is not sold but consumed by the households.

Smallholder farmers characterize Tanzanian agriculture. The average size of land cultivated varies between less than 1 ha to 3 ha of land. The large majority of the crop area is cultivated by hand, while for the remaining, farmers use ploughs and tractors. The main food crops are maize, rice, wheat, sorghum/millet, cassava and beans and they represent nearly 85% of the area cultivated. Bananas are grown mainly in the Kagera and Kilimanjaro area, and like cassava, have a low value-to-bulk ratio and are generally retained for home consumption. Export crops represent 12% of the value of crop production. From 1993 to present, there has been a continuous reduction of state participation and control over marketing and input supply (i.e. the elimination of the subsidy on fertilizer).

There are several factors affecting the agriculture sector. First of all it is a rain fed agriculture and therefore unfavourable weather results into poor agriculture performance. In addition to that, low labour and land productivity due to application of poor technology, and dependence on unreliable and irregular weather conditions are further concerns. Both crops and livestock are adversely affected by periodical droughts. Earlier studies (Government of the URT, World Bank and IFPRI, 2000) found that Tanzania, despite low levels of technology, has comparative advantage in all its export crops, and in several of the main food crops. It also found that there are significant linkages between increased production of exportables and overall rural incomes and growth. Hence, the issue of how to increase agricultural production and incomes is crucial to both growth as well as poverty alleviation.

Poverty levels are high in Tanzania, and poverty reduction during the past decade occurred mainly in urban areas, while rural areas have seen relatively little change. Poverty levels are highest in rural areas, where 39.9 percent of households are below the basic needs poverty line according to the 2000/01 National Household Budget Survey (National Bureau of Statistics, 2002), and they make up about 81 percent of the poor in Tanzania. The poverty profile further suggests that changes in agricultural production and farm gate prices have the potential to significantly impact poverty in Tanzania.

According to a recent study on growth accounting in Tanzania by Ndulu and O'Connell (2003), during the most recent period covered by the growth accounting exercise, namely 1995-2000, growth per worker recovered to 1.3 percent, from negative levels during 1990-94. This recent growth performance is almost entirely driven by improved total factor productivity, while the contribution of human capital formation is small and that of physical capital formation is negative. These numbers highlight the importance of total factor productivity, in improving growth, while raising the issue which is also relevant to this study, namely why has there not yet been a stronger aggregate investment response to economic reforms and which factors explain the improvements in total factor productivity.

There is considerable international evidence from low-income agriculture-dependent countries that broad based rural growth starts with increased labor productivity in small-farm agriculture, and deepens as rural demand for rural nonfarm goods and agricultural inputs is stimulated, and as labor and financial resources are mobilized and move between sectors (for a survey see Sarris, 2001). Increased integration of poor households and sub regions into the larger economy is an essential part of this process, and national and local governments have an important role in ensuring a facilitating incentives environment, and supporting provision of essential public goods such as adaptive research, extension, physical infrastructure, laws necessary for the emergence of market institutions, and law and order.

A recent analysis by Levin and Mbamba (2004) concluded that expansion of agricultural production in Tanzania has the strongest employment and income effects, but the bulk of income increases would go to non-poor both in rural and urban areas. Nevertheless, agricultural production growth seems to have the largest impact on poverty reduction. When simulations of total factor productivity (TFP) growth in different agricultural subsectors was undertaken, it was found that the best prospects were from TFP increases in exportable crops, as these could lead to larger exportable surpluses. On the contrary TFP increases in food crops led to lower income growth, as the bulk of food crop production is nontradable, and hence a production expansion, in the face of slower domestic demand growth, would lead to domestic price declines for these products. This would affect negatively rural poor.

Growth in agriculture and farm incomes can come about in three ways. Increases in the real prices producers receive for their products, increases in physical and human capital of farmers, and increased productivity and efficiency of resource use by individual farmers. Improvements in producer prices can come about either because of an increase in domestic and international prices for the products they produce, or by a reduction in the marketing margin between producer and final consumer. These aspects of market organization and prospects will not concern this study. Instead the study will focus of the last two of the above three aspects of growth, and try to identify factors that can help increase capital investments, as well as productivity and efficiency.

With limited access to credit most rural households will have to save to invest in profitable income generating opportunities. Lack of rural growth, and hence poverty reduction, may then be caused by two things: the absence of profitable investment opportunities, or lack, or inability, to save. Preliminary evidence in Tanzania suggests that it is mostly a lack of savings that hinders the rural poor to invest. Dercon (1998) notes for instance how poor households with little wealth have to rely on the most unprofitable – low investment activities (such as brick or charcoal making) whereas wealthier households have the means to invest in more profitable activities such as keeping cattle. Kessy (2004) notes that poor rural households in Kagera rely on casual labor where households with access to resources can invest in trading shops, fishing boats and even pharmacies. It is worthwhile to further explore what prevents the poor from saving their way out of poverty and become part of the growth process. Carter and Zimmerman (2000) consider frequent exposure to risk an important element. Lack of appropriate savings mechanisms may be another. Kessy (2004) notes for instance how various poor people vented their frustration because their little savings – goats in these instances, were stolen. The paper will try to explore some of these factors.

The analysis of the paper will be based on a representative survey of 957 households in 45 villages done in the Kilimanjaro region, in November 2003, and a representative survey of 892 households in 36 villages done in the Ruvuma region in February-March 2004. Kilimanjaro is a relatively well-off region in north-eastern Tanzania. Its area is only 1.4 percent of the total of Tanzania, but its population of 1.38 million is 4 percent of the Tanzanian total, and it is the region with the third highest population density in Tanzania, after Dar-es-Salaam and Mwanza. About 75 percent of the population lives in rural areas. Coffee is the main cash crop in the region, and about 70 percent of the coffee area is held by smallholders, the remaining being cultivated by private and public plantations as well as large scale farmers. The basic needs headcount poverty rate for Kilimanjaro was 31% in 2000/01, according to the 2000/01 Tanzanian Household Budget Survey, as compared with 36 percent for mainland Tanzania as a whole. This is a predominately rural region, with only 12 percent of people living in urban areas.

Ruvuma is the southernmost region of Tanzania, and is much larger than Kilimanjaro, comprising 4.9 times the land area of the latter. Its population, however, is lower than Kilimanjaro at 1.12 million, implying that the region is sparsely populated. About 90 percent of the population lives in rural areas and agriculture constitutes 77 percent of the regional product. There are three main exportable crops in the region, namely coffee, tobacco, and cashew nuts, each grown in a distinct geographical part of the region. The basic needs headcount poverty rate for Ruvuma in 2000/01 was 41%, and this is considerably higher than the country average of 36%. This is acknowledged as one of the poorer regions of Tanzania.

The analysis of these two rural regions, one of the richest and one of the poorest in Tanzania is appropriate in order to see whether there are common factors and issues vis-à-vis Tanzanian agricultural development.

The rest of the paper proceeds as follows. In section 2, we exhibit briefly the characteristics of the rural smallholder households in Kilimanjaro and Ruvuma. In section 3 we discuss the link of farm productivity to household consumption. In section 4 we analyse issues of production and the determinants of farm productivity. In section 5 we explore allocative and technical farm efficiency. In section 6 we investigate the determinants of input demand and access to credit, which is identified as one of the key constraints. In section 7 we summarize and integrate the empirical findings into a policy context.

2. Main characteristics of farm households

The survey by design was 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. The survey was not designed to sample the large-scale public and private coffee estates but only the peasant producers.

The description of households indicated below is based on the grouping of households into various classes. An important distinction from a poverty and growth perspective is between poor and non-poor households. We classified households according to their total expenditures (cash and non-cash). We classify households as poor if their per adult equivalent total expenditure is lower than the basic needs rural poverty line that was estimated starting with the 2000/01 HBS poverty line, inflated to the year and month of the survey by the Tanzanian National Consumer Price index, further multiplied by the average per capita GDP growth rate, and subsequently also multiplied by an additional factor. This factor, which we call the ratio of "underestimation" of the consumption in the HBS survey, is equal to the ratio of average per capita total expenditure, as estimated from our surveys, and the same average from the 2000/01 HBS, inflated by the Tanzanian National Consumer Price index between the time of the HBS and the time of the survey, times the average per capita GDP growth rate. The reason we used this procedure is because by simply inflating the basic needs poverty line from the HBS and comparing with the estimated consumption figures from our survey, produced poverty incidence that was much below what is reported in the HBS (less than one third of the HBS reported poverty incidence) thus leading to questions concerning the HBS consumption and poverty estimates (or perhaps the timing of the survey and methodology of our own estimates of consumption). Our procedure, which does not have any impact on the subsequent analysis, except in the descriptive tables that follow, gave a poverty incidence for Kilimanjaro of 33%, while for Ruvuma the corresponding poverty incidence was 57.7%. These are higher than the incidence reported in the 2000/01 HBS (31% for Kilimanjaro and 41% for Ruvuma).

For both regions Table 1 presents the basic socio-economic characteristics of all rural households classified by their poverty status. The table reports results from the first round surveys, but the general picture does not change much in the second rounds. Overall, households in Ruvuma tend to be[2] poorer than those in Kilimanjaro, as reflected in the much lower value of their total wealth (820,000 Tsh versus 3,375,000 Tsh), their lower average annual per capita expenditures (162,000 Tsh versus 214,000 Tsh) and their higher poverty incidence (55.7 % versus 33.1 %). Analysis of their livelihoods structure suggests that households in Ruvuma are more agriculture and subsistence oriented. The average household in Kilimanjaro obtains 43.3 percent of total income from non-cash sources (own production and gifts) compared to 58.5 percent for households in Ruvuma. Moreover, households in Kilimanjaro appear much less dependent on cash crops for their cash income than households in Ruvuma, are more diversified, and tend to get a higher share of their cash income from non-crop agriculture and wages. Notable are the high values of the Herfindahl indices of total as well as cash income diversification. The indices reported in the tables are very large, indicating that farmers in general are very concentrated in their total as well as cash income structure. This does not appear to be reflected in the average shares of total income also reported in the table. The reason is that the H indices are averages of the individual H indices of each household, which are large, while the shares of income reported are averages of the individual shares[3].

Concerning differences between poor and non-poor, the average per capita expenditure of the non-poor appears to be about 2.5 times that of the poor in both regions. The poorer households in each region tend to be more subsistence oriented, i.e. they have larger shares of non-cash incomes. Yet, they tend to get a larger share of cash income from wages. These findings point to both lack of land (and thus engagement in low remunerative off-farm employment) and lower agricultural productivity as underlying sources of poverty.

Concerning households' asset base, the value of average household wealth in Ruvuma is only about one fifth of that in Kilimanjaro. The bulk of household wealth in both regions consists of dwellings and consumer durables followed by land and animals. The number of total animals owned per household (in cattle equivalents), is more than twice as high in Kilimanjaro, as compared to Ruvuma. Agricultural and non-agricultural capital account for very small shares of total wealth. The average size of cultivated land is much larger in

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[2] Somewhat surprisingly, household heads in Ruvuma tend on average to be better educated than those in Kilimanjaro. This may be related to the high level of out migration in Kilimanjaro, whereby the less educated household heads stay behind.

[3] For instance, if there are two households in the survey each obtaining 100 percent of income from one source, but different source than the other, then the average shares indicated would be 0.5 for each one of the sources, but the average H index indicated would be 1, as each household would have an H index equal to 1.

Ruvuma, compared to Kilimanjaro, but the poor possess on average less land than the non-poor in both regions.

A most interesting observation is that in Kilimanjaro, which is considered to be the main coffee producing region in Tanzania, cash income from coffee appears to be a very small share of total cash income among coffee producing households[4] (a mere 8.7 percent of total cash income of coffee producers). This suggests that coffee producers have reduced considerably coffee production given the substantial decline of coffee prices in recent years. This, by contrast does not appear to be the case in Ruvuma, where the shares of the relevant cash crop in total cash income among cash crop producers are much higher (44% for coffee producers, 61% for tobacco producers, and 37% for cashew nut producers).

Crops other than cash crops make up a large share of total cash income (27.1 percent in Kilimanjaro and 28.1 percent in Ruvuma). Income from non-crop agriculture (largely livestock) also makes up a significant share of cash income in Kilimanjaro (14.6 percent on average with larger shares among the non-poor, but a very small share in Ruvuma (only 3% on average, with small variations across groups).

Yields for maize, the major food staple crop in both regions, differ significantly among regions but even more so between poor and non-poor households within both regions, with yields among the non-poor about 50 percent higher than among the poor. A similar picture emerges when looking at total agricultural crop value added per acre which appears on average more than twice as high in Kilimanjaro than in Ruvuma. Within each region there appear to be significant differences between the productivity of poor and non-poor farmers, with the value added of non-poor farmers about 25 percent higher than that of the poor in Kilimanjaro and 54 percent higher in Ruvuma. Land productivity emerges a major factor in distinguishing farmers among poor and non-poor.

The value of productivity seems related to the value of purchased inputs (more than three times as large in Kilimanjaro compared to in Ruvuma and substantially higher among the non-poor compared to the poor. Moreover, despite the small share of agricultural capital in total wealth the average value of total agricultural capital per household (value of machines, implements, etc) is about twice as high in Kilimanjaro compared to Ruvuma, and since the average amount of cultivated land is lower in Kilimanjaro, capital/land ratios is considerably higher in Kilimanjaro.

As purchased input use appears to be a major differentiating factor in land productivity, we explored credit related information (not reported in the table). A very small share of households are members of the local credit cooperatives (called Sacco), less than 14 percent in both regions, or have a bank account (less than 13 percent). The incidence, however, is higher among non-poor households in both regions. It is impressive that more than 80 percent of all households, without much differentiation among various groups declared that it was difficult to get seasonal credit from any source, for purchasing inputs, and less than 15 percent declared that it was easy to obtain formal seasonal credit. An even smaller share (8.2 percent in Kilimanjaro and 9.3 percent in Ruvuma) declared that it was easy to obtain credit for farm investments. Lack of seasonal credit, as well as the small amount of accumulated agricultural capital emerge as potentially important constraints for the farmers in the survey.

The picture that emerges from the above descriptive analysis is that farm households have a low overall capital asset base (agricultural as well as non-agricultural), and use mostly labour

[4] The detailed characteristics of coffee and other cash crop producing households are not shown for brevity. They are available from the authors.

intensive technology. They also seem to have very little access to formal credit, both seasonal as well as for investme nts, potentially limiting the use of modern inputs. There seem to be significant differences between poor and no-poor households as far as agricultural productivity is concerned, and this seems to be due to differences in overall agricultural and total capital availability.

3. Household welfare and farm productivity.

The hypothesis that was alluded to in the descriptive tables of the previous section was that agricultural productivity is related to overall household income and consumption. In this section we explore this relationship directly by regressing the per capita total (cash and non-cash) consumption expenditures on agricultural land productivity, and a set of other variables.

Tables 2 and 3 indicate the results of OLS and IV regressions of the log of total consumption expenditures per capita on the log of gross value of crop production per acre for Kilimanjaro. To eliminate concerns about endogeneity, gross crop value per acre has been instrumented using the proportion of area irrigated, the availability of rainfall, the number of plots, and whether the household used fertilizer and chemicals in the preceding agricultural season. These instruments proved to have sufficient explanatory power and passed the overidentifying restrictions test.

We note that agricultural productivity significantly affects household consumption. It is also the case that the IV estimates significantly increase the size of coefficient of the land productivity variable. Other significant variables are the size of cultivated land (positive), the age of the household head (negative), the size of the household (negative), some education variables in Kilimanjaro, the dummy of whether the household has electricity, some of the asset variables, and the dummy of whether the household receives remittances (positive in Ruvuma), and the dummy denoting easy access to seasonal credit (positive in Kilimanjaro).

The elasticity of total consumption per capita with respect to the of gross crop value per acre is equal to 0.15 in Kilimanjaro and 0.57 in Ruvuma. The larger elasticity in Ruvuma follows numerically from the fact that a larger share of income is derived from agriculture in Ruvuma. Clearly the welfare gains from increasing agricultural productivity are likely to be substantial, especially in Ruvuma where households are still less diversified and depend more on agriculture for their livelihoods.

To explore further how changes in agricultural productivity would affect poverty, we perform some simulations relating to increases in agric ultural productivity. The first simulation assumes that every household that has crop land productivity, as measured by the gross value of crop production per acre, below the median value for the sample, increases its land productivity to the median value. For the record, the median value of crop productivity in Kilimanjaro is equal to 65 percent of the average value of gross crop income per acre in the same region, while in Ruvuma, the median is equal to 85 percent of the average. Hence this simulation basically assumes that the least productive farmers are brought up to par with the median productivity of all farmers. In a second simulation we assume that the gross value of crop output is increased by 10 percent for all producers.

Table 4 indicates the results of these simulations for Kilimanjaro and Ruvuma. In the table the first column indicates the average value of the relevant poverty measure as computed from the actual survey. The second column indicates the average value of the same indicator but computed utilizing the consumption IV regressions of tables 2 and 3. This is the reference point for the simulations. The third column indicates the average indicators using the simulated consumption from the regressions under the assumptions of each simulation. The final column indicates the percentage differences between the averages of the simulations and the predicted values.

The results for the first simulation indicate a reduction in the poverty headcount by 6 percentage points (or 21.4 percent) in Kilimanjaro and a reduction in head count poverty of 19 percentage points (or by 34.1 percent) in Ruvuma. These figures are consistent with the observed negative correlation between agricultural productivity and poverty. Similar large reductions in the other poverty indices are indicated. The average per capita consumption would increase by 6.3 percent in Kilimanjaro and by 21.5 percent in Ruvuma. The results of the second simulation indicate that in this case the poverty impact is much larger in Ruvuma, as it is the region with the larger poverty rate, and the region where farmers are much more reliant on agriculture. The results generally confirm that broad based agricultural productivity improvements can have substantial impact on poverty reduction.

To make more definite statements about the poverty impact of an increase in farm productivity, however, further analysis is necessary. Our estimates most likely capture the direct/first order effects. Yet, a widespread increase in agricultural productivity is likely to affect prices and wages as well, and these second order effects can be substantial (Christiaensen and Demery, 2006). Increases in agricultural production of partly or non traded products can lead to decrease in prices. On the other hand increases in incomes arising out of productivity increases tend to spill over into demand for other products and activities, and this tends to increase rural wages.

Depending on the price elasticity of demand, the ensuing price effects may actually erode the benefits from increased agricultural productivity for net sellers, while they may well benefit net buyers. The net welfare effect will depend on whether households are net food buyers or sellers. Table 5 exhibits this classification of rural households in Kilimanjaro and Ruvuma according to expenditure quintile. Given that the majority of the poor in Kilimanjaro are net food buyers, the poor are on average likely to gain from an increase in agricultural productivity, on both income as well as price grounds. While there are more net food sellers among the poor in Ruvuma, the majority are still net buyers, and the poor would on average likely gain as well. On the other hand, when the increase in agricultural productivity concerns traditional cash crops such as coffee, tobacco or cashew nuts, this will not only generate a direct income effect for the cash crop farmers, but is also likely to increase the demand for wage labourers and will thus put upward pressure on wages for unskilled workers, who are often poorer.

The most important conclusion from this analysis is that agricultural productivity is a significant determinant of household consumption, and hence a determinant of household poverty. Given that agricultural productivity is quite low in absolute terms, as indicated earlier, the question arises concerning the factors that keep agricultural productivity low, and the constraints in expanding agricultural production.

4. **Analysis of farm production and total factor productivity**

In this section we explore the issue of total factor productivity of crop and aggregate agricultural production of households. Total factor productivity (TFP) refers to that part of total production that is not accounted for by the normal basic primary production factors, such as labour and capital.

To analyze farm production we fit a standard Cobb-Douglas production function, using instrumental variables for the endogenously determined right hand variables[5]. We introduce a variety of potential productivity determining variables in the right hand side in order to explore the determinants of TFP. Our estimations use the following general form

$$\ln Q = a + \sum b_i \log X_i + \sum g_j Z_j + u \qquad (1)$$

Where Q is a measure of the value of production of the farm, X_i is a set of factors of production such as land, labour and inputs, b_i are the estimated coefficients of each factor (the elasticities, if the log specification is chosen), Z_j is a vector of TFP determinants such as household characteristics, and u is an i.i.d. error term.

The dependent variable is equal to the gross value of total farm output, where we have used for each household the unique median producer price of Kilimanjaro and Ruvuma respectively, same for all producers. In this fashion we account only for differences in quantities of production and avoid differences in value of production due to differences in realized prices due to seasonality, and also value all production utilized for home production at the same prices.

In our setting, explanatory variables such as inputs of land and labour, as well as intermediate inputs, may be considered as endogenous variables and jointly determined with Q and thus are dependent on the stochastic disturbance. To avoid biases in the estimates we used instrumental variables to estimate the endogenous ones.

For the production function analysis, we use several sets of explanatory variables. First we utilize the standard factors of production, namely land, labour, capital, and intermediate inputs (purchased and own produced). We also use a dummy variable which is equal to 1 if the household hires labour for crop production. This variable is supposed to capture whether the household is facing supervision constraints in hired labour. If this is the case the sign of this variable should be negative.

Secondly we utilize household and farm characteristics such as age and education of the head, land quality variables such as soil quality, proportion of the land cultivated that is irrigated, etc. Third we control for current and past shock variables that may have affected current farm production. Such variable include the household assessment of whether rainfall in the plot was below normal, and whether the household has experienced different types of shocks in the past few years.

To control for endogeneity of intermediate inputs, land and labour, we have used, as a set of instruments, lagged values of these factors, such as the size of land cultivated three years ago, number of months spent by household members and hired labours working on the farm the previous year, and a dummy indicating whether fertilizers were used the previous year; two dummies for specific cash crop production, and, finally, variables related to credit access, as credit constraints have been hypothesized for a long time to affect production and size (Feder, 1995; Eswaran and Kotwal, 1986). The basic assumption used in all studies is that assets, including land, affect positively the availability of credit and through this the availability of inputs and hired labour, and hence they should affect positively land and agricultural productivity. The capital factor, being a fixed factor, has not been instrumented and is not considered endogenous.

[5] We also tried more flexible functional forms such as translog, but there was no significance in any of the higher order explanatory variables.

An issue arises regarding the use of lagged factors as instruments. While these variables are expected to be related to the use of the current factors, and be exogenous to current production, it maybe that they incorporate individual household heterogeneity that is the same from year to year. If they do, however, then this household heterogeneity would be captured in the instrumenting regressions, and should not be a problem for the main regression. The same holds for the dummies for coffee and banana production, as the mere production for these crops may entail some specific factor input unrelated to other product outputs.

Tables 6, and 7 indicate the IV estimation of the agricultural production functions for Kilimanjaro and Ruvuma under two assumptions concerning village level effects. The first column includes simple dummies for each village. In the second column we include instead of village dummies a range of variables destined to describe the infrastructure and other variables available at village level. Given that not all variables were available from the village level questionnaires, there is a significant reduction in the degrees of freedom. The tests for endogeneity in Kilimanjaro suggest that the OLS model is rejected by both the Durbin-Wu-Hausman test, as well as the Wu-Hausman test, and hence the IV procedure is valid. For Ruvuma, the same tests do not reject the OLS modelin both cases.

For Kilimanjaro, all factors of production are significant with the expected signs. The dummy for whether the household hires labour is negative and significant. This dummy is supposed to test whether there are supervision constraints by the farm household, and the results appear to suggest that such constraints may exist, despite the fact that the amount of hired labour is quite small. Note that the F test for the hypothesis that the sum of the coefficients on the land, inputs, labour and capital variables is equal to 1 is strongly rejected, and the sum of these coefficients is larger than 1, suggesting increasing economies of scale.

In Kilimanjaro, age and education do not appear to be significant. Production appears to be affected by only one of the various land quality or improvement variables. Production, however, appears to be affected negatively by bad rainfall, as expected. The inclusion of major shocks such as major illness and death in the household in the five years before the survey do not seem to have affected agricultural production. The results on the negative influence of bad weather are compatible with the significant and positive impact of the irrigation variable, which measures the share of land irrigated, and which is substantial in Kilimanjaro. The unbundling of the village effects indicates that there are no variables that affect agricultural production.

In the first stage (not shown) the value of intermediate inputs is a function of hired labour, and the amount of capital. Also both age (negative) as well as education (positive) significantly affect intermediate inputs. The dummies for lagged use of improved seeds, chemicals and chemical fertilizer, all appear to strongly influence the amount of inputs used. The input of household labour seems to be influenced positively by hired labour, suggesting that there maybe supervision constraints, as well as illness and drought, which affect family labour input negatively, and the lack of rain, which seems to affect positively family labour input. It thus appears that the lack of rain leads to efforts by households to use labour and inputs to make up for the shortfall in production. The first stage regressions explain more than half the variation of the variables.

The results for Ruvuma in table 7 (which are almost identical to the OLS results) indicate significance with the expected signs for all basic factors of production, land, labour, purchased inputs, and capital. Note also, just as in Kilimanjaro, that the hypothesis of increasing returns to scale (sum of the coefficients of the four main variables (land, inputs, labour, and capital) equal to 1) is rejected in the fixed effects model, but not rejected in the village variables model, suggesting some ambiguity with respect to economies of scale.

Education of head here is a significant positive determinant of agricultural production. Land improvement variables appear to be not significant, as in Kilimanjaro, but soil quality here appears to affect negatively crop production. This is a bit surprising and it may have something to do with overuse of good quality land. The current rainfall variables do not seem to affect current crop production, and this is compatible with the general impression in the region that rainfall is much more reliable compared to Kilimanjaro. Non-rainfall shocks do not seem to affect farm production. However, the dummy for a drought shock since 1998 seems to affect positively farm production, which seems counterintuitive.

The results confirm the expected role of standard production primary inputs. Concerning TFP, they partially point towards the role of education and irrigation in TFP improvement, the negative role of weather shocks, the role of education and formal credit in purchased inputs, and the importance (positive or negative) of specific types of cash or food crop growing in affecting the total value of output. This latter effect maybe reflect historical reasons or institutional reasons pertaining to producers of specific crops.

5. Allocative and technical efficiency

Allocative efficiency relates to the issue of whether farmers use resources in line with market signals. Allocative efficiency refers to the use of inputs (labour, capital) that gives a given quantity of output at a minimum cost or maximum profit. Thus, allocative efficiency determines whether the factors of production are used in proportions that ensure maximum output given the prices for output and inputs. To explore allocative efficiency we use the estimated production functions to calculate the value of marginal product of factors i (VMP_i) as in Lerman and Grazhdaninova (2005) and Carter and Wiebe (1990).

For each farmer (we omit an index of the farmer to simplify notation) the marginal product of factor X_i can be calculated as follows:

$$MPX = \frac{\partial Q}{\partial X_i} = \left(\frac{\partial \ln Q}{\partial \ln X_i}\right)\frac{Q}{X_i} = b_i \frac{Q}{X_i} \qquad (2)$$

Where b_i is the estimated Cobb-Douglas regression coefficient for factor X_i .

Allocative efficiency is determined by comparing the value of marginal product of factor X_i (VMP_i) with the marginal factor cost (MFC_i). We assume that farmers are price takers in input markets, so that the price of factor X_i (P_i) approximates MFC_i. If $VMP_i > P_i$, factor i is underused and farm profits or efficiency can be raised by increasing the use of this factor. If, conversely, $VMP_i < P_i$, the input is overused and to raise farm profits its use should be reduced. The point of allocative efficiency (and maximum profit or minimum cost) is reached when $VMP_i = P_i$.

From the results of the (IV) regressions for total agricultural production we can compute the marginal products of the four basic factors of production for each household and compare them with the respective market prices. Table 8 reports the averages of these marginal products for Kilimanjaro and Ruvuma, and the comparisons with the respective market values. Concerning land, we use the average crop value added per acre as reported in table 1. It would have been more appropriate to use land rental values, or land sales prices multiplied by some discount rate, but there are no rentals reported in the survey, and very few land sales reported in the survey, and hence averaging these would not be reliable. In any case the land market in Tanzania operates largely under a traditional tenure system, where sales and purchases are not common. Concerning intermediate inputs the marginal products must be compared to 1, as the variables used for inputs and capital are expressed in ‘000 TSH, and so is output. Concerning capital, the variables for capital and output are expressed in '000 TSH. We do not have rental values of capital, nor do we have local interest rates. Nevertheless, if the discount rate is smaller than 1, the VMP of capital should be compared to a value smaller than 1. For lack of any better value, we utilize an approximate value of 0.2 for the comparisons in the tables. Finally concerning labour we have direct observations from each household concerning the wage rates they pay for hired labour (both in cash and in kind, which we average).

The results suggest that the agricultural households in Tanzania are utilizing some resources efficiently but some others very inefficiently. The marginal product of land in Kilimanjaro is on average as well as for the two groups of households, larger than its "optimal" value as proxied by the crop value added per acre, and much more so for non-poor households, and non-food sellers. This suggests that there must be some constraints in expanding land cultivation in Kilimanjaro, and this is consistent with the general view in Tanzania, that good productive land in Kilimanjaro is in short supply.

In Ruvuma the average marginal products of land for all, as well as separately for poor and non-poor are below the optimal market values. This suggests that households use more land than what is justified. These results seem to be in line with conventional wisdom in Tanzania, whereby good agricultural land is more abundant in Ruvuma. They also suggest that land is not a constraint among farm households in Ruvuma, but it is a constraint in Kilimanjaro.

As expected and as suggested by the earlier descriptive tables the marginal product of land is much higher in Kilimanjaro than in Ruvuma (about four times higher on average) and the same holds for the estimated value added per acre (in Kilimanjaro it is a little more than twice as large as the value in Ruvuma). This difference between the ratios of the marginal product of land, seems consistent with the higher scarcity of productive and cash crop land in Kilimanjaro.

Concerning intermediate inputs, the marginal products for all groups and in both regions are substantially larger than 1, which suggests that intermediate inputs are used much below their optimum amount, and in fact the results suggest that there is considerable room for input use expansion to boost farm production. An interesting exception, however, not indicated here, concerns tobacco producers in Ruvuma, which constitute a small subset of producers there. Similar tabulations for this group only indicate that they are the only group for whom the average value of the marginal product of inputs is below 1, which in fact means that they are over utilizing inputs, contrary to what is experienced by other households. The reason for this could be that tobacco producers in Ruvuma operate largely on contract from tobacco companies, who supply inputs as part of their contracting arrangements. Other farmers do not operate under contracts, and this means they have to finance input purchases, from their own financing sources, and these maybe insufficient.

Concerning labour, the results show that the marginal products of labour used on the farms are much lower than the market wages, which suggests excess labour use in farm production. This suggests considerable "excess labour" in farm production. In fact the average amount of family labour days spend by households on their farms, computed but not shown here, is very high. These results are consistent with separate calculations which allude to considerable excess supply of family labour in farm households. This excess labour may be the result of lack of off-farm wage earning opportunities, or credit constraints in expanding labour intensive production.

Concerning the marginal product of capital the overall average marginal product appears to be much larger than 0.2, and is close to 1 in Kilimanjaro, and much above 1 in Ruvuma. This suggests that much less than optimal agricultural capital is utilized. And hence capital is used much below its marginal product. There are significant differences among poor and non-poor farmers, with the average marginal product of capital for the non-poor much lower than for the non-poor in both regions, indicating that the poor are much more constrained on the capital side. It thus appears that there are capital accumulation constraints and more so among the poor.

These results, namely that capital appears on average to be inefficiently utilized coupled with the very low overall capital intensity of production (already indicated in table 1), maybe due to other types of constraints such as low possibility for capital accumulation, or investment credit constraints.

If farmers do not have enough capital and cannot obtain formal or informal credit for it, then the issue of development is one of facilitating the savings of farmers, in order for them to invest more with own resources, or facilitating the provision or conditions for more formal investment capital. We explore this issue further later.

To supplement the above analysis we analyse technical efficiency of farmers. Technical efficiency generally relates to how the farms allocate scarce resources (inputs) to produce the maximum amount of output. A technically efficient farm is that which produces the maximum amount of output attainable from each input level. Technical efficiency can generally be measured as the deviation from the frontier isoquant. In this paper we estimate technical efficiency using a stochastic production frontier approach (Coelli, 1995, Coelli and Battese, 1996).

We do not report the detailed results for lack of space. There are several variables that appear to increase efficiency among farmers. In Kilimanjaro, they include the household size, the average distance of parcels from the main road, the dummy about having easy access to formal credit, the dummy for the household being involved in non-farm business, and one of the dummies designed to inform about the education of adult females in the household. In this case efficiency appears to be increased when a household has more than 2 females having completed primary education. In Ruvuma significant efficie ncy increasing variables are age of the head of the household, household size, a dummy about whether the household has a bank account, and two of the dummies concerning females' primary education in the household. It thus appears consistent across the two surveys that household size, availability of formal credit, and females' education seems to boost farm efficiency. Also age (which could be a proxy for experience) seems to be significant in Ruvuma, while being involved in a non-farm activity also contributes to efficiency in Kilimanjaro, both reasonable results.

Table 9 exhibits the technical efficiency in Kilimanjaro and Ruvuma by level of efficiency. Overall it appears that the average technical efficiency in Kilimanjaro is lower than that of Ruvuma (59 versus 65 percent). No major difference in efficiency appears among the major groups within each region. More than half of households appear to have technical efficiency scores between 50 and 75 percent, and less than 8 percent of households have technical efficiency below 25 percent. The conclusion is that farms in both Kilimanjaro as well as Ruvuma, appear to farm relatively inefficiently.

6. Determinants of intermediate input demand and access to seasonal credit

Given the apparent underutilization of inputs evidenced by the allocative efficiency analysis, it is useful to explore in more depth what determines the demand for inputs. To do so, we separately estimated a reduced input demand function for both Kilimanjaro and Ruvuma using a model controlling for village characteristics through village fixed effects as well as a model whereby the village characteristics are explicitly introduced to unbundled the village effects. As almost all farmers used at least some inputs, the coefficients were estimated using OLS. The results are exhibited in Tables 10 and 11 for Kilimanjaro and Ruvuma respectively.

The dependent variable is the (log of the) total value of intermediate inputs used for agricultural production by the household per acre[6]. This includes both purchased inputs as well as the value of own produced inputs (such as seeds and organic fertilizer) valued at median village prices. It turns out that purchased inputs constitute about 60 percent of total intermediate inputs. The regressions reported below were also done using as dependent variable only with purchased inputs, with similar results.

We saw that households express great difficulties in obtaining seasonal capital for production. Hence, one of the constraints that looms as critical is the working capital constraint. We test the significance of this constraint by including as an independent variable the household's perception of whether it is easy to obtain seasonal credit. Given the large benefit that was found from spending working capital for intermediate inputs, nevertheless, one must question why households do not spend more of their own resources. Concerning own resources, the ways for a household to generate cash is either by selling some produced and/or stored products, or sell labour, or sell some asset. It appears unlikely that households would sell assets to obtain working capital, so the other two explanations are more likely. Concerning selling labour, it is likely that demand for agricultural labour in rural areas will coincide with demand for labour for the household's own farm. Hence the most likely source of labour cash income in rural areas is from non-agricultural rural and non-rural labour activities in times of non-peak labour demand. Lack of such activities would prevent households to obtain extra cash. Hence one policy concern is the availability of off farm labour opportunities at slack labour periods. Concerning non-labour cash source, it is hypothesized that households with non-farm non-labour income would have lass of a working capital constraint. We test the significance of these effects by including as explanatory variables a dummy for whether the household has non-farm non-labour income, the share of wage in total income, as well as the share of nonwage nonfarm income in total income.

Concerning sales of stored products, this brings out a key decision of the household relating to whether they should use stored products as working capital (selling when cash for inputs is needed) or for food security (namely for the lean season when supplies are low and food prices are high). It may well be that the opportunity cost of selling a unit of stored product (e.g. maize) in terms of increased risk of food shortage is higher than the perceived benefit from increased application of inputs on the farm, thus preventing households from using own funds from sales of stored products. If this is the case, and holding of liquid assets such as food stocks is very valuable from a food security perspective, it is not apparent that if more working capital is made available to the household, it would be utilized for purchasing inputs rather than augmenting the consumption smoothing capacity in terms of liquid assets of the household.

To test this insight, in the regressions on intermediate inputs we added among the independent variables a vulnerability index, estimated by reference to covariate and idiosyncratic risks faced by households (Sarris, and Karfakis, 2006). The index measures the probability that a household's consumption will fall below poverty in the next period. Hence more vulnerable households will exhibit higher values of the index. According to the discussion above, if the food security motive is strong, more vulnerable households should be expected to utilize smaller amounts of intermediate inputs per acre, as they would need to have adequate own funds in case of an external shock.

[6] We also ran regressions using the value of crop related inputs per acre as a dependent variable, with almost identical results as crop related and total intermediate inputs are very close to each other.

The empirical results appear to support several of the above hypotheses. The dummy for whether seasonal credit is easily available is positive and significant in Ruvuma, a region which is poorer and hence one expects that it faces tighter credit constraints. The value of input use among households who reported to have easy access to seasonal credit for inputs was 17 to 23 percent higher in Ruvuma. On the other hand the share of nonwage nonfarm income to total income is significant in Kilimanjaro, consistent with the view that those households who have non-farm businesses, have much easier access to credit and intermediate inputs. The vulnerability index is negative as hypothesized and significant, supporting the view that food security and self insurance related own reserves (monetary or otherwise) are substitutes for productive working capital.

From the tables, input use appears to be negatively correlated with the land area cultivated, or put differently, the smaller the landholding, the more intensively it is cultivated. This effect is even more pronounced in Kilimanjaro (elasticity of input value per acre to land size estimated at -0.52 to -0.65) where land scarcity is much more pronounced than in Ruvuma (input to land elasticity of -0.15 to -0.25), where land is more abundant in most districts. Input use is also higher among more educated and younger households. However, it is especially the educational attainment of the most educated woman which positively affects input use, and to a much lesser extent the educational attainment of the men. While post secondary education appears not to affect input use in Kilimanjaro, it positively affects input use in Ruvuma when it concerns the most educated male, but negatively when it concerns the most educated female. Some of the household asset variables, such as the value of dwelling or the value of durables, and, for Kilimanjaro, the number of animals are also associated with more intermediate inputs use, consistently with the notion that higher values of assets should manifest a less stringent credit constraint.

Regarding the village characteristics, having easy access to the inputs themselves as well as being well connected with the rest of the economy emerges as quantitatively important determinants of input use. Households in villages with a bus service (a proxy for the village's integration in the economy) spent on average 56 percent more on inputs in Ruvuma respectively. And households in villages with an agricultural input supply shop spent on average 31 and 55 percent more on inputs in Kilimanjaro and Ruvuma respectively. The marginal effects of being connected and having easy access to inputs are substantially larger in Ruvuma compared with Kilimanjaro consistent with the more remote nature of villages in Ruvuma as well as the Ruvuma region itself compared with Kilimanjaro. Finally, while these estimates are likely upward biased as they may capture placement effects[7] as well, they are nonetheless sufficiently large to underscore the critical importance of connectivity and easy access to inputs in promoting input adoption.

The total value of inputs used was also positively associated with regular interaction with extension services. Households who had consulted an extension agent in the past year were also found to spend more on inputs. Nonetheless, caution is warranted again in interpreting the size of the coefficients as placement effects cannot be excluded.

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[7] Placement effects refer to the fact that if placement of, for instance, an input supply shop wasn't random, but purposively to target a fertile area where there was already a lot of demand for fertilizer to begin with, then one cannot be sure that the estimated coefficient is actually picking up the effect of the fertilizer supply only. It could pick up both the effect of the supply as well as the effect of there being a lot of demand for fertilizer in the village and hence a shop. In other words, providing another area with a supply point may not necessarily yield the same increase in inputs. Hence one needs to be careful in interpreting the coefficient as it might overestimate the effect, unless one fully controls for all the characteristics in the environment. This is sometimes a quantitatively important issue, which one cannot simply disregard.

Given the critical importance of access to credit in input use, we also explored the correlates of having access to credit a bit further. In particular we run probit regressions with dependent variable a dummy, which is equal to 1 if the head of the household reports that it is easy to obtain seasonal credit for intermediate inputs. Note that this ease does not concern only formal credit, but credit from any source. Tables 12 and 13 for Kilimanjaro and Ruvuma respectively exhibit the results. The results suggest that the amount of cultivated land affects positively the ease of obtaining credit for seasonal inputs in Kilimanjaro but not in Ruvuma. This may be related to the differential scarcity and hence the differential value of land in both two regions, as land may function as collateral. Households who belong to a SACCO or who have a bank account are about 10 percent more likely to obtain a seasonal credit for input purchases. While it is a priori not fully clear how the causality runs, the importance of fostering savings among households and the development of appropriate institutional arrangements to do so, as a means to increase their access to inputs deserves to be further explored.

A good case in point is the fact that being tobacco farmers is strongly associated with having easy access to credit—tobacco farmers in Ruvuma are 33 percent more likely to have access to seasonal credit. This follows from their contractual arrangements with the tobacco companies who provide inputs on credit and agronomic advice in exchange for a guaranteed supply of quality produce. Such contractual arrangements have disappeared in the coffee sector after markets were opened up to private traders and contractual enforcement became more difficult. Nonetheless, this finding supports the notion that interlinked factor markets operating through contracts or membership in credit cooperatives are beneficial for producers, in credit constrained rural economies.

Interestingly, households in Ruvuma in villages with a sales point for agricultural inputs were also much more likely to have easy access to credit. As it is however not immediately clear how contract enforcement would operate under such conditions, this finding deserves further investigation. Finally, while irrigation did not directly increase the use of inputs in Kilimanjaro, it appears to affect the use of inputs indirectly by facilitating the household's access to credit.

7. Conclusions and policy implications

The results presented in this paper present an interesting picture of smallholders in Tanzania and hint at several areas that could be important for policy and poverty reducing development.

Firstly it appears that farm households in Kilimanjaro are differentiated. In other words there appear to be substantial differences in average incomes among poor or non-poor. However, there also do not appear to be substantial differences among poor and non-poor in a variety of other attributes.

A second result is that overall asset ownership among rural households in Tanzania is quite low. This holds not only in terms of human capital, but also in terms of physical capital, as well as access to a variety of infrastructure variables. Education levels are very low, and so is access to basic rural infrastructural services such as electricity and tap water.

A third major conclusion is that the main differentiating factor among rural households in both Kilimanjaro as well as Ruvuma is agricultural productivity. These results suggest that a pro-poor rural development strategy in Kilimanjaro may need to be anchored around improvements in agricultural productivity.

The analysis of allocative efficiency concluded that family labour is substantially over utilized, suggesting considerable excess labour on farm households. On the contrary farm households appear to utilize substantially smaller amounts of intermediate inputs than would be commensurate with their estimated marginal productivities. Further investigation shows that the demand for inputs is especially higher among younger households with educated female household members. Households who are better connected with the wider economy through bus services and closer to input supply points farmers are also much more likely to use modern inputs, and this emerges as a major constraint in Ruvuma. Finally, households with easy access to credit spent on average between 17 to 23 percent more on inputs, at least in Ruvuma. Access to credit seems in turn largely determined by 1) the contractual arrangements under which farming takes place (e.g. tobacco versus coffee farmers) and 2) being a member of a savings and credit organization, underscoring the need to better understand how the development of better saving mechanism could help boost the use of modern inputs.

We also found that the use of intermediate inputs appears to be negatively related to the household's vulnerability, implying that consumption smoothing and using own resources to deal with unpredictable risks, are significant determinants of low input use and hence farm productivity. This indicates that interventions on the consumption safety net side could have important production and income increasing effects.

The empirical results highlighted in this paper lead to the following policy conclusions. First, it appears that there remains a lot of scope for improving agricultural productivity among farmers. If this is to be done by improvements in technology, the results point that such improvements should be land saving in the land scarce region in Kilimanjaro while labour saving in the relatively more land abundant region of Ruvuma. However, while improvements in technology will indeed increase agricultural productivity and reduce poverty, we found that considerable progress in agricultural productivity and poverty reduction can be had by working within the confines of existing technologies. Two areas of policy intervention loom important. The first involves policies and institutions that facilitate easier access by farmers to seasonal credit for intermediate inputs. Such policies may include wider use of credit cooperatives, promotion of other membership type of organizations like cooperatives that can facilitate access to credit by farmers, and promotion of contractual types of arrangements that can be combined with easier access to productive inputs.

The second area of policy intervention involves more efficient rural consumption safety nets. While these maybe advocated on humanitarian and emergency relief grounds we found evidence that such policies, by helping households release own resources that maybe locked in own reserves for risk coping activities, can help households find own resources for productive activities.

It also appears that in Tanzania there is considerable room for improvements in allocative efficiency by better access to off farm activities, so that farmers do not utilize labour so inefficiently. An alternative maybe easier access to credit for expansion of land cultivation in areas with land expansion potential like Ruvuma, so as to utilize more efficiently the excess family labour.

We also found that major gains to agricultural productivity are to be expected from better village connectivity, especially in relatively isolated regions like Ruvuma. This of course has the clear implication that rural infrastructure is another key area for productivity improvements and poverty reduction

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TABLE 1: General characteristics of rural households in Kilimanjaro and Ruvuma

		Kilimanjaro			Ruvuma		
	Unit	All	Poor	Non Poor	All	Poor	Non Poor
Number of households	No	190744	63171	128351	173921	96897	77024
Household size	Number	5.3	6.5	4.7	5.2	5.7	4.6
Age of Head	Years	53.5	50.8	54.8	43.37	43.93	42.67
Annual per capita total expenditure	'000 Tsh	214	105	268	162	93	249
Annual per capita total income	'000 Tsh	158	80	204	148.6	85.7	227.9
Livelihoods							
Share of non-cash income in total income	Percent	43.3	46.5	41.7	58.5	61.0	55.3
Share in total cash income of							
Coffee	Percent	5.4	6.5	4.8	13.5	12.2	15.2
Tobacco	Percent				2.4	3.0	1.7
Cashew nuts	Percent				9.2	13.0	4.6
Other crops	Percent	27.1	22.6	29.3	28.1	26.6	29.9
Non-crop agriculture	Percent	14.6	12.4	15.8	3.0	3.3	2.8
Wages	Percent	21.8	27.8	18.9	15.5	18.0	12.4
Other non-farm income	Percent	31.0	30.7	31.2	28.2	24.1	33.3
Herfindhal Index of cash income diversification	Index 0 to 1	0.4831	0.5272	0.4614	0.5217	0.5474	0.4893
Herfindhal Index of total income diversification	Index 0 to 1	0.438	0.439	0.437	0.361	0.367	0.353
Asset base							
Value of wealth per household	000 Tsh	3375	2334	3888	820	671	1006
Share of wealth from							
Agriculture capital	Percent	1.6	1.2	1.8	2.9	2.0	4.1
Non agriculture capital	Percent	1.4	1.0	1.6	1.0	0.7	1.3
Consumer durables	Percent	28.0	23.2	30.4	17.3	17.0	17.8
Agricultural land	Percent	18.4	21.3	17.0	23.3	23.9	22.6
Dwellings	Percent	58.2	63.3	55.8	45.0	48.1	43.1
Animals	Percent	10.2	10.8	10.0	9.5	8.3	11.0
Area of land cultivated	Acres	2.66	2.36	2.81	6.1	5.6	5.9
Number of plots cultivated	Number	1.96	1.93	1.97	2.6	2.9	3.0
Number of animals in cattle equivalent	Number	2.43	1.97	2.65	1.04	.747	1.42
Education of the head	Years	6.3	5.8	6.3	8.1	8.3	8.0
Agricultural productivity							
Yield from maize	kg/acre	217	160	245	203	167	248
Value added from crop production/acre	'000 Tsh/acre	84	75	89	37	31	43
Value of input for crop production/acre	'000 Tsh/acre	32	25	35	9.8	4.4	11.6

Source: Authors' calculations

Table 2. KILIMANJARO: Impact of agricultural crop productivity on household per capita consumption expenditures

Dependent variable Log of total consumption expenditures per capita	OLS Regression	IV Regression
Log gross value of crop production per acre	0.0354***	0.1458**
	(2.89)	(2.08)
Log size of land 3 years ago	0.1892***	0.2045***
	(5.76)	(5.53)
Dependency Ratio	0.3133**	0.2756**
	(2.22)	(1.97)
Log age of the head	-0.1193*	-0.0911
	(1.74)	(1.25)
Head belongs to pare ethnic group	0.0071	-0.0472
	(0.12)	(0.67)
Household size	-0.1228***	-0.1271***
	(13.54)	(12.48)
Years of education of most educated male	0.0196***	0.0183**
	(2.65)	(2.32)
Years of education of most educated female	0.0013	-0.0010
	(0.13)	(0.10)
Dummy=1 if most educated male has post secondary education	-0.0516	-0.0531
	(0.81)	(0.79)
Dummy=1 if most educated female has post secondary education	0.0576	0.0590
	(0.73)	(0.72)
Dummy: household has electricity	0.2182***	0.1932***
	(4.48)	(3.82)
Dummy: household has tap water	0.0210	0.0193
	(0.59)	(0.53)
Value of durables	0.0194	0.0184
	(1.58)	(1.63)
Value of dwelling	-0.0090	-0.0060
	(0.55)	(0.38)
Number of small animals	0.0032**	0.0034**
	(2.26)	(2.27)
Number of medium animals	0.0037	0.0044
	(1.16)	(1.28)
Number of big animals	0.0087	0.0082
	(1.42)	(1.25)
Dummy=1 if household received remittances	0.0188	0.0156
	(0.54)	(0.43)
Dummy=1 if it is easy to get seasonal credit for inputs on the farm	0.1251**	0.1198**
	(2.52)	(2.26)
Constant	5.6712***	5.0661***
	(19.16)	(10.14)
Observations	940	940
R-squared	0.469	0.469
Test Results:		
Anderson canon. corr. LR statistic (identification/IV relevance test)[8]:		
Chi-sq		45.865
P-value		0.0000
Sargan statistic (overidentification test of all instruments)[9]		
Chi-sq		7.472
P-value		0.1878

Source: computed by Authors

Absolute value of z statistics in parentheses. * denotes significance at 10%; ** denotes significance at 5%; *** denotes significance at 1%. Dummies for wards estimated but not reported.

[8] Anderson canonical correlation likelihood-ratio test of whether the equation is identified, i.e., that the excluded instruments are relevant. The null hypothesis of the test is that the equation is underidentified. Under the null of underidentification, the statistic is distributed as chi-squared with degrees of freedom=(L-K+1), where L=number of instruments. Rejection of the null indicates that the model is identified.

[9] The Hansen-Sargan test is a test of overidentifying restrictions. The joint null hypothesis is that the instruments are valid instruments, i.e., uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restictions. A rejection casts doubt on the validity of the instruments.

Table 3. RUVUMA: Impact of agricultural crop productivity on household per capita consumption expenditures

Dependent variable Log of total consumption expenditures per capita	OLS Regression	IV Regression
Log gross value of crop prod per acre.	0.1751***	0.5720***
	(6.98)	(2.61)
Log size of land 3 years ago	0.2634***	0.3698***
	(8.28)	(5.14)
Dependency Ratio	0.2060	0.1240
	(1.10)	(0.57)
Log age of the head	-0.2139***	-0.1217
	(3.16)	(1.29)
Dummy for ethnicity: Ngoni	-0.0893	-0.0661
	(1.55)	(0.88)
Household size	-0.1331***	-0.1436***
	(14.78)	(11.79)
Years of education of most educated male	0.0119	0.0050
	(1.33)	(0.43)
Years of education of most educated female	0.0111	0.0017
	(1.38)	(0.15)
Dummy=1 if most educated male has post secondary education	0.1080	0.1064
	(1.40)	(1.17)
Dummy=1 if most educated female has post secondary education	0.0355	0.1460
	(0.39)	(1.27)
Dummy: household has electricity	0.4433***	0.5875***
	(3.82)	(3.53)
Dummy: household has tap water	-0.0887	-0.0929
	(1.24)	(1.13)
Value of durables	0.2179***	0.2111***
	(4.32)	(3.69)
Value of dwelling	-0.0705	
	(0.53)	
Number of small animals	0.0036***	0.0009
	(3.30)	(0.46)
Number of medium animals	0.0110***	0.0063
	(2.84)	(1.14)
Number of big animals	0.0259**	0.0047
	(2.33)	(0.24)
Dummy household received remittances	0.1517***	0.1308**
	(3.41)	(2.44)
Dummy=1 if it is easy to get seasonal credit for inputs on the farm	-0.0357	-0.0515
	(0.90)	(1.11)
Constant	5.0629***	3.2555***
	(16.76)	(3.19)
Observations	889	889
R-squared	0.4901	0.2952
Test Results:		
Anderson canon. corr. LR statistic (identification/IV relevance test):		
Chi-sq		10.668
P-value		0.0992
Sargan statistic (overidentification test of all instruments)		
Chi-sq		2.275
P-value		0.8099

Source: computed by Authors

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Dummies for villages estimated but not reported.

Table 4. Simulations of the poverty impact of raising the farm productivity of half of the least productive farmers to the median levels of farm productivity (case A) and of raising the farm productivity of all farmers by 10 percent (case B).

A. Kilimanjaro

	Observed Value	Predicted value	Simulation result (Case A)	Average percent change between simulated and predicted (Case A)	Simulation result (Case B)	Average percent change between simulated and predicted (Case B)
Poverty headcount rate (percent)	34.3	29.4	23.1	-21.4	28.2	-4.3
Average poverty gap index	0.027	0.017	0.012	-32.5	0.014	-17.0
Severity of poverty index[10] (percent)	0.36	0.16	0.10	-37.9	0.12	-23.2
Value of total consumption from IV regression (000Tsh per capita)		183.0	194.6	6.3	183.8	0.4

B. Ruvuma

	Observed Value	Predicted values	Simulation result (Case A)	Average percent change between simulated and predicted (Case A)	Simulation result (Case B)	Average percent change between simulated and predicted (Case B)
Poverty headcount rate (percent)	57.3	55.6	36.7	-34.1	40.7	-26.8
Average poverty gap index	0.056	0.052	0.021	-60.3	0.036	-31.4
Severity of poverty index (percent)	0.85	0.81	0.19	-77.0	0.56	-30.9
Value of total consumption from IV regression (000Tsh per capita)		144.7	175.8	21.5	179.5	24.0

Source: Computed by authors.

[10] This is the Foster Greer, Thorbecke (1984) poverty index with parameter equal to 2.

Table 5. Classification of rural households by quintile according to whether they are net food buyers or sellers

A. Kilimanjaro

Quintile of expenditure	**Net Food Buyers (Percent of total)**	**Net Food Sellers (Percent of total)**
Q1	88.9	11.1
Q2	80.9	19.1
Q3	71.6	28.4
Q4	75.7	24.3
Q5	72.5	27.5

A. Ruvuma

Quintile of expenditure	**Net Food Buyers (Percent of total)**	**Net Food Sellers (Percent of total)**
Q1	47.2	52.8
Q2	61.2	38.8
Q3	52.8	47.2
Q4	60.7	39.3
Q5	68.0	32.0

Source: Computed by authors.

Table 6: KILIMANJARO Estimation of thetotal agricultural production function

Dependent variable Log gross value of total agricultural production	(1) **IV regression with dummies for villages**	(2) **IV regression with village variables**
Log acres of land cultivated (1)	0.649***	0.621***
	(4.08)	(3.70)
Log value of total inputs used (1)	0.420***	0.449***
	(3.72)	(4.11)
Log Total (hired family) labour (number of days) (1)	0.334**	0.266**
	(2.51)	(2.06)
Dummy for hired labour	-0.278*	-0.311*
	(1.87)	(1.91)
Log value of agricult. capital	0.047**	0.063***
	(2.14)	(2.80)
Log age of the head	0.162	0.148
	(1.10)	(0.92)
Log mean years of education of the head	0.015	0.032
	(0.23)	(0.43)
Share of land improved with rock bund	0.354	0.299
	(1.38)	(1.21)
Share of land improved with soil bund	0.281**	0.244*
	(1.99)	(1.71)
Share of land improved with mulching	0.224	0.239
	(1.56)	(1.61)
Share of land improved with terraces	-0.061	0.015
	(0.35)	(0.08)
Share of land improved with grass lines	-0.066	0.109
	(0.44)	(0.59)
Share of land with soil of medium good quality	0.058	-0.007
	(0.32)	(0.03)
Share of land with gentle or steep slope	0.457*	0.508*
	(1.78)	(1.90)
Dummy: 1=death since 1998 affected living conditions	0.042	0.025
	(0.46)	(0.26)
Dummy: 1=illnes since 1998 affected living conditions	0.075	0.042
	(0.81)	(0.42)
Dummy Average rain on parcel is below normal	-0.394***	-0.393***
	(4.69)	(4.47)
Dummy Average rain on parcel is much below normal	-0.483***	-0.409***
	(4.36)	(3.45)
Dummy: 1=drought since 1998 affected living conditions	-0.115	-0.119
	(1.21)	(1.24)
Proportion of land irrigated	0.233*	0.263**
	(1.88)	(2.25)
Dummy senior secondary school available in the village		-0.077
		(0.45)
Dummy hospital available in the village		-0.099
		(0.25)
Dummy bore hole for water available in the village		0.001
		(0.01)
Dummy community well water available in the village		0.101
		(0.56)
Dummy market available in the village		-0.112
		(0.92)
Dummy all weather road (tarmac) available in the village		0.100
		(0.44)
Dummy electricity available in the village		0.093
		(0.67)
Dummy public telephone available in the village		0.089
		(0.82)
Dummy availability of bus services to nearby village		-0.084
		(0.79)
Dummy agricultural extension agent available in the village		-0.049

			(0.53)
Dummy veterinary service available			-0.024
			(0.23)
Dummy agricultural input supply shop available			0.180
			(1.49)
Constant		0.575	0.640
		(0.60)	(0.62)
Observations		925	798
R-squared		0.39	0.33
Test for Return to scale			
Test H0= land + inputs + total labour + ag. Capital = 1			
	F-value	10.14	1782.36
	P value	0.0015	0.0000
Test for exogeneity of regressors H0=Regressors are exogenous			
Wu-Hausman			
	F Test	2.53307	1.74897
	P-Value	0.05578	0.15555
Durbin-Wu-Hausman			
	Chi-sq test Chi-sq(3)	8.13010	5.45723
	P-Value	0.04340	0.14122

Source. Computed by authors

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

In column 1: Dummies for ward estimated but not reported

(1) Variables instrumented

Table 7: RUVUMA Estimation of the total agricultural production function.

	IV with dummies for villages	IV with village variables
Log acres of land cultivated (1)	0.523***	0.310***
	(5.91)	(4.14)
Log total inputs used (1)	0.169***	0.286***
	(3.13)	(6.23)
log total labour on farm (1)	0.443***	0.479***
	(4.22)	(4.43)
Dummy hired labour	0.017	-0.089
	(0.20)	(1.06)
Log value of capital	0.064***	0.066***
	(4.28)	(4.71)
Log age of the head	-0.007	0.098
	(0.07)	(0.98)
Dummy for corrections on age of the head #	-0.127	-0.195
	(0.53)	(0.79)
Log average years of education of head	0.102**	0.096*
	(2.15)	(1.96)
Share of land improved with rock bund	0.665*	0.627**
	(1.88)	(2.45)
Share of land improved with soil bund	0.092	0.152*
	(1.03)	(1.81)
Share of land improved with mulching	0.148	0.256
	(0.82)	(1.41)
Share of land improved with terraces	-0.059	-0.036
	(1.02)	(0.60)
Share of land improved with grass lines	-0.251	-0.173
	(1.32)	(0.90)
Share of land with soil of medium good quality	-0.161***	-0.155***
	(3.01)	(2.84)
Share of land with gentle or steep slope	0.005	0.091
	(0.08)	(1.49)
Dummy: 1=death shock since 1998	0.097	0.122*
	(1.41)	(1.76)
Dummy: 1=illness shock since 1998	-0.029	-0.009
	(0.45)	(0.13)
Dummy average rain on parcel is below normal	0.035	0.006
	(0.50)	(0.09)
Dummy average rain on parcel is much below normal	0.046	-0.029
	(0.57)	(0.37)
Dummy: 1=drought shock since 1998	0.199**	0.177*
	(2.10)	(1.87)
Proportion of land irrigated	0.294	0.367**
	(1.62)	(1.97)
Dummy for Junior secondary school available in the village		0.189**
		(1.99)
Dummy for Hospital available in the village		0.396**
		(2.48)
Dummy for Village well available in the village		-0.320***
		(4.31)
Dummy for Public water tap available in the village		0.169**
		(2.10)
Dummy for Market available in the village		0.211***
		(3.12)
Dummy for All weather road (tarmac) available in the village		-0.071
		(0.36)
Dummy for Bus service to nearby town available in the village		0.182
		(1.63)
Dummy for Village bank or other formal credit society or association available i		0.139

		(1.24)
Dummy for Agricultural Extension agent available in the village		0.257**
		(2.56)
Dummy for Veterinary service available in the village		-0.166*
		(1.80)
Dummy for Primary society available in the village		-0.309***
		(4.59)
Constant	1.111	0.348
	(1.48)	(0.47)
Observations	881	881
R-squared	0.58	0.52
Test for Return to scale		
Test H0= land + inputs + total labour + ag. Capital = 1		
F-value	4.77	2.42
P value	0.0292	0.1201
Test for exogeneity of regressors H0=Regressors are exogenous		
Wu-Hausman		
F Test	0.90184	1.86753
P-Value	0.43976	0.13350
Durbin-Wu-Hausman		
Chi-sq test Chi-sq(3)	2.89350	5.80256
P-Value	0.40834	0.12162

Source. Computed by authors
Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Column 1- Dummies for villages estimated but not reported
(#) To recover 11 missing observations on age of the head we have replaced the age of the head with the average head's age of the sample and added a dummy for the observations that we have changed.

(1) Variables instrumented.

Table 8. Marginal products of production factors compared to market prices of the factors (means across the reported groups)

A. Kilimanjaro

	Unit	All	Poor	Non Poor
Marginal Product of Land	'000 Ts/acre	130	143	104.6
Value Added Crop Prod./acre	*'000 TSH/acre*	*84*	*75*	*89*
Marginal Product of Purchased inputs (compared to 1)		13.9	14.0	13.5
Marginal Product of Labour	'000 Tsh/day/man	0.64	0.72	0.49
Market Price of Labour	*'000 Tsh/day/man*	*1.5*	*1.3*	*1.6*
Marginal Product of Capital (Compared to 0.2)		1.11	1.24	1.06

B. Ruvuma

	Unit	All	Poor	Non Poor
Marginal Product of Land	'000 Ts/acre	29.5	22.9	37.7
Value Added Crop Prod./acre	*'000 TSH/acre*	*37*	*31*	*43*
Marginal Product of Purchased Inputs (compared to 1)		5.06	5.50	4.50
Marginal Product of Labour	'000 Tsh/ day/man	0.28	0.21	0.37
Market Price of Labour	*'000 Tsh/ /day/man*	1.10	1.09	1.10
Marginal product of capital (compared to 0.2)		2.21	3.96	1.08

Source. Computed by authors

Table 9. Proportions of households in different ranges of technical efficiency scores

A. Kilimanjaro

Technical efficiency range	**All Households**	***Poor***	***Non Poor***
0-25%	4.0	2.0	5.0
25-50%	19.7	18.1	20.4
50-75%	60.5	65.3	58.2
75-100%	15.8	14.6	16.4

B. Ruvuma

Technical Efficiency	**All Households**	***Poor***	***Non Poor***
0-25%	2.4	2.7	2.1
25-50%	13.4	15.3	10.9
50-75%	57.0	59.9	53.5
75-100%	27.2	22.1	33.5

Source. Computed by authors

Table 10. Kilimanjaro: Determinants of demand for intermediate inputs for agricultural production

Dependent variable. Log value of total inputs per acre	(1) With dummies for villages	(2) With village variables
Easy to get seasonal credit for inputs on the farm	0.0643	0.0832
	(0.72)	(0.86)
Dummy. Household has non farm business	-0.0014	-0.1069
	(0.02)	(1.30)
Share of nonwage non farm income to total household income	0.3917***	0.3917**
	(2.59)	(2.47)
Share of wages in total household income	-0.1089	-0.0039
	(0.76)	(0.03)
Vulnerability index	-1.1484***	-1.5723***
	(4.81)	(6.40)
Log acres of land cultivated	-0.5159***	-0.6522***
	(6.09)	(7.66)
Log value agric. capital per acre	0.0580**	0.0557**
	(2.40)	(2.14)
Log value non agric. capital per acre	-0.0079	-0.0001
	(0.36)	(0.00)
Number of small animals	0.0053*	0.0056
	(1.66)	(1.61)
Number of medium animals	0.0162***	0.0096*
	(2.74)	(1.66)
Number of big animals	0.0107	0.0116
	(1.15)	(1.33)
Value of durables	0.0151	0.0190
	(1.03)	(1.23)
Value of dwelling	0.1023**	0.0515*
	(2.18)	(1.70)
Log age of the head	-0.4143**	-0.4474**
	(2.43)	(2.39)
Head belongs to pare ethnic group	0.1204	-0.2334**
	(0.82)	(2.18)
Years of education of most educated male	0.0188	0.0277
	(0.98)	(1.31)
Years of education of most educated female	0.0366	0.0517**
	(1.64)	(2.26)
Dummy most educated male has post secondary education	0.0276	-0.0193
	(0.16)	(0.10)
Dummy most educated female has post secondary education	-0.0188	-0.1962
	(0.10)	(1.02)
Log household size	0.4314***	0.4053***
	(3.45)	(3.08)
Dependency Ratio	0.0858	-0.1531
	(0.25)	(0.40)
Share of land with soil of good quality	0.0603	0.1443*
	(0.74)	(1.65)
Share of land improved with mulching	0.0612	0.0585
	(0.43)	(0.39)
Share of land improved with terraces	-0.0394	-0.0968
	(0.30)	(0.71)
Proportion of land irrigated	-0.1503	0.0872
	(1.19)	(0.72)
Dummy. Household has consulted an extension officer	0.1865**	0.1810**
	(2.28)	(1.99)
Dummy market available in the village		0.1168
		(1.02)
Dummy electricity available in the village		-0.0117
		(0.11)
Dummy availability of bus services to nearby village		0.1210
		(1.38)
Dummy agricultural extension agent available in the village		-0.1829**
		(2.02)

Dummy agricultural input supply shop available		0.3106***
		(2.75)
Constant	3.8035***	4.4956***
	(5.24)	(6.39)
Observations	948	818
R-squared	0.38	0.31

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 11. Ruvuma: Determinants of the demand for agricultural inputs

Dependent variable. Log value of total agricultural inputs per acre

	(1) With dummies for village	(2) With village variables
Easy to get seasonal credit for inputs on the farm	0.1653** (2.21)	0.2268*** (2.94)
Dummy non farm business	0.2863 (1.16)	0.1955 (0.68)
Share of nonwage non farm income in total household income	0.0212 (0.11)	-0.0046 (0.03)
Share of wage in total household income	0.0629 (0.35)	0.0864 (0.50)
Vulnerability index	-1.2184*** (8.26)	-1.1635*** (7.85)
Log acres of land cultivated	-0.1485** (2.35)	-0.2507*** (4.10)
Log value agric. capital per acre	0.0069 (0.23)	-0.0206 (0.71)
Log value non agric. capital per acre	0.0068 (0.26)	0.0093 (0.34)
Number of small animals	0.0093*** (4.00)	0.0120*** (5.34)
Number of medium animals	0.0210*** (2.63)	0.0224*** (2.78)
Number of big animals	-0.0044 (0.18)	-0.0192 (0.83)
Value of durables	0.1900*** (3.07)	0.2223*** (3.65)
Value of dwelling	0.0000 (.)	1.2939*** (6.66)
Log age of the head	-0.1479 (1.13)	-0.1152 (0.89)
Dummy for ethnicity: Matengo	-0.4725** (2.27)	-0.8428*** (5.94)
Dummy for ethnicity: Ngoni	-0.0046 (0.03)	-0.0959 (0.61)
Dummy for ethnicity: Yao	-0.2572 (1.59)	-0.5288*** (3.76)
Dummy for ethnicity: other	-0.2631 (1.50)	-0.4947*** (3.34)
Years of education of most educated male	-0.0141 (0.91)	-0.0066 (0.43)
Years of education of most educated female	0.0361** (2.49)	0.0343** (2.38)
Dummy most educated male has post secondary education	0.2568* (1.87)	0.2251 (1.60)
Dummy most educated female has post secondary education	-0.2415* (1.78)	-0.2481* (1.84)
Log household size	0.2614*** (3.31)	0.2605*** (3.25)
Dependency Ratio	0.0996 (0.27)	0.2277 (0.62)
Share of land with soil of good quality	0.0572 (0.91)	0.0336 (0.53)
Share of land improved with mulching	0.2565 (1.11)	0.0647 (0.30)
Share of land improved with terraces	0.0498 (0.68)	0.0172 (0.24)
Proportion of land irrigated	-0.0502 (0.25)	0.1435 (0.63)
Dummy has consulted extension officer	0.2155*** (2.96)	0.3007*** (4.12)
Dummy for Market available in the village		-0.0028

		(0.04)
Dummy for Bus service to nearby town available in the village		0.5605***
		(6.06)
Dummy for Agricultural Extension agent available in the village		0.0298
		(0.41)
Dummy for Sales point for agricultural inputs available in village		0.5465**
		(2.36)
Dummy for Primary society available in the village		-0.0160
		(0.23)
Constant	3.2831***	2.3098***
	(6.32)	(4.56)
Observations	891	891
R-squared	0.54	0.49

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 12. Kilimanjaro. Probit on the determinants of easy access to seasonal credit

Dependent variable. Dummy. Easy access to credit =1; else=0	**With village dummies**	**With village variables**
Log acres of land cultivated	0.063***	0.062**
	(2.73)	(2.36)
Value of durables	-0.002	-0.002
	(0.53)	(0.62)
Value of dwelling	0.010	0.014
	(0.77)	(0.96)
Log household size	-0.054*	-0.054
	(1.71)	(1.51)
Log age of the head	0.013	0.021
	(0.30)	(0.45)
Head belongs to pare ethnic group	0.031	0.012
	(0.67)	(0.24)
Years of education of most educated male	-0.003	-0.003
	(0.55)	(0.49)
Years of education of most educated female	-0.001	-0.001
	(0.20)	(0.19)
Dummy most educated male with post secondary education	-0.005	-0.004
	(0.09)	(0.07)
Dummy most educated female with post secondary education	-0.010	-0.017
	(0.18)	(0.27)
Dummy: 1=have bank account	0.108***	0.118**
	(2.68)	(2.45)
Dummy: 1=belong to sacco	0.107***	0.099**
	(2.65)	(2.29)
Proportion of land irrigated	0.076**	0.124***
	(2.13)	(2.92)
Dummy non farm business	0.034	0.050
	(1.26)	(1.62)
Share of non wage non farm income to total household income	0.007	-0.024
	(0.15)	(0.46)
Share of wage in total household income	0.015	0.029
	(0.43)	(0.77)
Share of hh who have consulted an extension officer	0.019	0.019
	(0.75)	(0.66)
Dummy market available in the village		0.053
		(0.64)
Dummy electricity available in the village		0.101
		(1.33)
Dummy availability of bus services to nearby village		0.040
		(0.58)
Dummy agricultural extension agent available in the village		-0.031
		(0.37)
Dummy agricultural input supply shop available in village		0.022
		(0.27)
Observations	942	815

Robust z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
First Column: dummies for ward estimated but not reported

Table 13. Ruvuma. Probit on the determinants of easy access to seasonal credit

Dependent variable. Dummy (easy access to credit =1; else = 0)	**With villages dummies**	**With village variables**
Log acres of land cultivated	-0.002	-0.009
	(0.06)	(0.28)
Value of durables	-0.0003	-0.0002
	(0.83)	(0.95)
Value of dwelling	-0.0004	-0.0003
	(1.26)	(0.52)
Dummy tobacco production	0.320***	0.333***
	(2.76)	(3.06)
Log household size	0.052	0.035
	(1.50)	(1.04)
Log age of the head	-0.025	-0.006
	(0.42)	(0.12)
Dummy for ethnicity: Matengo	0.137	0.094
	(1.42)	(1.32)
Dummy for ethnicity: Ngoni	-0.061	-0.019
	(0.79)	(0.24)
Dummy for ethnicity: Yao	-0.013	0.015
	(0.15)	(0.20)
Dummy for ethnicity: Other	0.026	0.021
	(0.30)	(0.27)
Years of education of most educated male	0.011	0.010
	(1.40)	(1.30)
Years of education of most educated female	-0.001	0.000
	(0.18)	(0.04)
Dummy most educated male has post secondary education	0.009	0.018
	(0.15)	(0.30)
Dummy most educated female has post secondary education	0.061	0.054
	(0.79)	(0.74)
Dummy: 1=have bank account	0.073	0.053
	(1.25)	(0.97)
Dummy: 1=belong to sacco	0.105**	0.118**
	(2.05)	(2.38)
Proportion of land irrigated	0.046	0.042
	(0.48)	(0.48)
Share of non wage non farm income in total household income	0.060	0.023
	(0.87)	(0.36)
Share of wages in total household income	0.066	0.068
	(1.00)	(1.09)
Dummy. Household has consulted an extension officer	0.067*	0.050
	(1.66)	(1.27)
Dummy for Market available in the village		-0.026
		(0.77)
Dummy for Bus service to nearby town available in the village		-0.032
		(0.72)
Dummy for Agricultural Extension agent available in the village		-0.020
		(0.58)
Dummy for Sales point for agricultural inputs available in village		0.371***
		(2.99)
Dummy for Primary society available in the village		0.018
		(0.54)
Observations	836	884

Robust z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
First Column: dummies for villages estimated but not reported