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Agricultural Productivity Growth in Kagera between 1991 and 2004

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Abstract:

This paper uses data from the Kagera Health and Development survey to study changes in agricultural productivity between 1991 and 2004, as well as returns to various inputs, such as land, labor and modern inputs. We find that overall crop composition has remained fairly stable and the average farm size has decreased by more than labor used leading to a decrease in the land to labor ratio. A higher proportion of households use manure and hire in labor but fertilizer and pesticide use has decreased. Farmers experienced consumption growth, but below the average consumption growth of the sample and far below households who are employed outside of agriculture in 2004. The level of food and non-food consumption is significantly lower the larger a farmer's share of revenue coming from coffee in 2004. Reduced form estimates suggest that there has been a reduction in the value of total crop output and there is no evidence for growth in the value of output per worker or output per acre. However, pure farm households seem to have experienced some catch-up in terms of higher growth in value of crops sold. Correlates of output growth point towards capital as the most important input into production and towards no changes in the return to factors of production between the two sample periods. The slow consumption growth of farmers and reduction in the value of output might be partially attributed to the change in the terms of trade of consumer and producer prices over the sample period.

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1 Introduction

The role of agriculture in economic growth and the wider economic transformation such as urbanization and the movement from farm to non-farm activity is a key concern for policy makers. Understanding whether the main driver of income growth lies in agricultural productivity growth or exiting of farm activities is particularly important in countries like Tanzania, where 80% of its residents depend on agriculture for their livelihood and 70% reside in rural areas (United Republic of Tanzania, 2006).

Sarris, Savastano, and Christiaensen (2006) find a strong link between agricultural productivity and consumption in Kilimanjaro and Ruvuma and that households are farming below the efficient level, over-utilizing labor and under-utilizing other intermediate inputs. Using both quantitative and qualitative data, De Weerdt (2010) concludes that there are two ways out of poverty for individuals in Kagera, the region of Tanzania also studied in this paper: leaving agriculture for trade and business; or staying within agriculture but diversifying activities towards a wide range of crops for sale, home consumption and livestock. Individuals who focused on the production of traditional crops such as banana and coffee fared worst. In a recent paper, Lokina, Nerman, and Sandefur (2011) examine the role of agriculture, in particular smallholder farming, in economic growth and poverty reduction in Tanzania in the past two decades using data from the Household Budget Surveys, the National Sample Census of Agriculture and the National Panel Survey. They find a steady decline in the share of Tanzanians employed in farming over the period of 1991-2007 and a deterioration of the relative poverty of farm households compared to non-farm households. Gains in in maize yields have been modest and are mainly due to increased area usage rather than increases in yield.

The purpose of this study is to investigate the evolution of agricultural productivity from 1991 to 2004 as well as returns to various inputs, such as land, labor and modern inputs, with a focus on the Kagera region of Tanzania. We find that overall crop composition has remained fairly stable and the average farm size has decreased by more than labor used leading to a decrease in the land to labor ratio. A higher proportion of households use manure and hire in labor but fertilizer and pesticide use has decreased. Farmers experienced consumption growth, but below the average consumption growth of the sample and far below households who are employed outside of agriculture in 2004. The level of food and non-food consumption is significantly lower the larger a farmer's share of revenue coming from coffee in 2004. Reduced form estimates suggest that there has been a reduction in the value of total crop output and there is no evidence for growth in the value of output per worker or output per acre. However, pure farm households seem to have experienced some catch-up in terms of higher growth in value of crops sold. Correlates of output growth point towards capital as the most important input into production and towards no changes in the return to factors of production between the two sample periods. The slow consumption growth of farmers and reduction in the value of output might be partially attributed to the change in the terms of trade of consumer and producer prices over the sample period.

The paper is structured as follows. Section 2 introduces the data and the construction of the key output and input measures. Section 3 characterizes farm households in terms of crops planted, labor force, land use, the use of modern inputs. Further we show differences in consumption growth of different types of households. Section 4 outlines the empirical estimation and Section 5 discusses the results. Section 6 concludes. All figures and tables can be found in Section 7.

2 Data

We use data from the Kagera Health and Development Survey, a panel of individuals, collected in 6 month intervals between 1991 to 1994 and then again in 2004. The survey includes 51 villages in 4 agronomic zones: the tree crop zone, riverine zone, annual crop zone, and the urban zone. For the purpose of this study, we exclude the 4 urban communities. While the initial survey was designed to study the consequences of HIV/AIDS, the questionnaire contains detailed questions on agricultural activities of the household including information on a range of inputs as well as outputs of production.

Out of the 915 households interviewed in 1991, 888 had some land and used inputs into production. We drop those who are living in urban clusters to arrive at a total of 819 households for the first round. Out of the 2774 households interviewed in 2004, 2259 households grew crops. The section of the questionnaire which records the value of crops sold, given to laborers, lost due to pests and kept in stock was dropped for tracking households so that this information was collected for 1666 households. The value of home produced food from the consumption module is recorded for 2236 households. 2135 households own land and 2276 households cultivated shambas/gardens. In terms of inputs other than land and labor, the value of inputs (seeds, fertilizer, pesticides) is recorded for 1666 households and number of tools recorded for 2286 households. For the regression analysis, we use all households for which we have a complete crop section, in other words non-tracking households leading to a sample of 1659 households for which we computed the aggregated value of output. We exclude observations in which the quantity-price-unit combination is clearly misreported, those who report zero land use or labor use and split-offs who moved to a different village. Further, we focus on households for whom total revenue from crops is more than 50% of total agricultural output which leads us to exclude 5 households in 1991 and 5 households in 2004 who are predominantly livestock farmers.

2.1 Measure of output

Output from agricultural activity can be captured by different measures, such as yields, revenue and value added. We use value of crop output (crops sold and consumed) as measure of output, which is mainly driven by the availability of comparable data across the two sample rounds. Yields (quantity produced) are useful to compare households using a single measure of output in a common unit, investigate production trends, as well as investigate crop composition. The disadvantage of yields as a measure of output is that they give a nominal value and do not take price effects into account. Without further information on prices, they tell us relatively little about the welfare of the farm-producing household, since output could have increased but with a decrease in the price the farmer does not benefit from this increase in prices. In order to reflect spatial price dispersion converting yields into real values would require information on fairly local prices. A further difficulty of yield based output measures is how to aggregate across different crops when farmers plant more than one crop. Total revenue of agricultural output (price times quantity), on the other hand, has the advantage of reflecting price effects as well as providing a single number for the output of a farm household. To reflect changes in the price of the cost of inputs ideally we would have liked to calculate value added or profits of farmers. Unfortunately, different cost items were recorded in the questionnaires of the two rounds which does not allow for comparability of a measure of revenue minus costs.

The survey instrument contains questions on the value of 43 crops sold, given to laborers, lost due to pests and kept in stock. For crops sold, we have information on the quantity harvested and either the price at which the farmer sold the crop or the total amount received. We calculate three measures for value of output: (i) value of total revenue from crops, (ii) value of home produced food, and (iii) total value of crop output which is the sum of (i) and (ii). Thus, total revenue from crops includes crops sold, crops lost to pests, crops given to laborers, crops kept in stock and crop by-products produced. The value of home-produced food includes all food consumed out of home production.

For the descriptive statistics as well as the estimation, we slice the data along several dimensions. First, by the year of the survey. Second, given the fact that some households will have diversified their incomes and therefore might be different in their production technologies than farm households that rely entirely on farming, we classify households as pure farming households if no household member older than

7 years was employed in an activity other than agriculture. Third, we investigate how households who had the same household head in 1991 and 2004 differ from the rest of the sample.

While recall time in the 1991 round and the 2004 round is 12 months, in the remaining 3 waves the recall time was changed from 12 months to 6 months (due to the 6 month interval between the second, third and fourth round). When comparing the aggregates for the first four rounds it is obvious that the first round is an outlier compared to the second, third and fourth round. In order to avoid using an arbitrary 'conversion factor' to get broadly comparable results and to ensure that the results are not driven simply by the different recall periods, we use data from the 1991 and 2004 rounds only.

Given that there are 13 years in between the two rounds, the concept of a panel household is difficult to define. From the initial 915 baseline households the 2004 round attempted at re-interviewing all previous household members of the 1991-94 panel and consists of 2770 households. This means that if we would construct a panel, we would have to assign the baseline household multiple times to the split-off households in 2004. Further, through inheritance and division of land, there is a built-in correlation of inputs in 1991 and inputs in 2004. In the empirical part, we use the data either as a pooled cross-section of households, limit the sample to households with the same household head, or we use initial household fixed effects.

2.2 Measures of Inputs

Labor is measured as a head count of household members employed in the farm. The questionnaire has more detailed data on hours spent in the week prior to data collection on various activities in agriculture; however, as this variable is strongly dependent on the season during which the household was interviewed, we prefer a simple head count that includes the number of household members older than 12 who report to have been working on the farm during the past 12 months. Land as a factor of production is measured in acres of land that is used by the household for home production. Inputs into farm production are comprised of perishable farm inputs, tools, owned durables, livestock owned and expenditure on livestock. The inputs that are available for both rounds include perishable inputs such as fertilizer, pesticides and manure, as well as a count of the total number of tools a household has.

2.3 Consumer and Producer Prices

Based on a cluster-level price questionnaire administered in each round, a Laspeyres index has been calculated using the first round as a base. Deflating the value of output with the consumer price deflator would provide a measure of the purchasing power of revenue of agricultural output in real terms. However, it convolutes yield and return if consumer and producer prices do not rise at the same pace. The survey instrument does not contain a cluster level producer level questionnaire, but we know the producer price obtained by farmers who reported their sale in units and price per unit. The limitation with this method is that farmers reported their sale in various units. For example, to calculate the change in the price obtained for the sale of coffee in a cluster, we need at least one farmer in each community who sold coffee in both periods in the same unit. Whenever a crop was sold in different units, we calculated the average change in prices for each cluster in the same unit and then computed the mean if the change in prices was available in more than one unit, otherwise we used the price in the unit that was available. Following the methodology used to calculate the consumer price index (World Bank, 2004), we calculate a Laspeyre index I_{jt} for producer prices in cluster j at time t, defined as

$$I_{jt} = \sum_{c=0}^{C} w_c \frac{P_c^{jt}}{P_c^{jt-1}} \tag{1}$$

where

$$w_c = \frac{P_c^{jt-1} Q_c^{jt-1}}{\sum_{c=0}^{C} P_c^{jt-1} Q_c^{jt-1}}. \tag{2}$$

The index sums over the ratio of the price of crop c in 2004 to 1991, weighted by w_i which represents the weight of different products in the cluster level baseline production basket in 1991. As products were recorded in various units in both years and we therefore have a lot of missing values for changes in prices, we limit the index to using products with the highest three weights in the production basket of a cluster. Applying this rule, we consider the following products in the price index: coffee, maize, bananas, beans, Irish potatoes, sorghum, ground, mango, citrus fruits, pineapples, tomatoes, onion and wood[1]. We then re-scale the shares so that they add up to one.

Table 1 shows the consumer and producer price index calculated for the 47 communities as well as crops that were grown in at least half of the communities. Both the mean and the median of the producer price index lie below the consumer price index, indicating a negative terms of trade movement between these two indices. Therefore, if we would only deflate output by the consumer price index, we would on average overstate the reduction in output. However, there is significant crop level heterogeneity. While coffee prices increased on average by 2.6 times, the price of

[1] Due to data limitations we had to exclude sugar cane, palm oil and citrus fruits.

bananas, maize and beans increased all by more than the average consumer price index. Given that the agricultural price data are relatively noisy, as illustrated by the large standard deviation, for the empirical analysis we use the consumer price deflator as default deflator, but present all main models as well using the producer price deflator. As we explain below, using a specific deflator does not change the results substantially.

2.4 Rainfall

To account for shocks to agricultural output such as low or high rainfall, we merge a data series from rainfall stations in Kagera from the period of 1980 to 2004. All regressions include controls for the cluster-level deviation in rainfall in the short and long rains in the 2 years prior to the survey.

3 Descriptive Statistics

This section describes the main features of the KHDS sample of agricultural households in Kagera in 1991 and 2004. We first investigate the evolution of crop composition, land, labor used on a typical farm as well as adoption and expenditure on modern inputs. Then, we explore trends in consumption for farm and non-farm households and whether there is crop-specific heterogeneity.

3.1 Crop Composition

Tables 2 and 3 show the main crops that were produced in Kagera in 1991 and 2004 by all farm households and by households who sold crops, respectively[2].

The table shows that overall, crop composition remained fairly stable, with at least 90% of the households planting beans, maize, cooking bananas and cassava in 1991. In 2004, maize ranks first, followed by beans, cassava and sweet potatoes which are planted by more than 80% of the sample of households. For households selling crops, coffee ranks first both in 1991 and 2004; apart from coffee, the crops planted by the largest number of households are brewing bananas, beans, sweet bananas and maize. Therefore, there do not appear to be large shifts in the crop composition of crops planted by households.

[2]Out of the 2170 households who reported the type of crop they are planting, only the 1666 non-tracking households were administered a detailed crop questionnaire recording revenue from crops; out of those 1344 have obtained revenue from crops. If we limit the sample in 2004 to only those who completed the entire crop section, the ranking only changes for beans and maize: 96% of households grow beans and 95% of households grow maize; the ordering of the remaining main crops stays the same.

3.2 Land and Labor

Table 4 shows the evolution of land and labor by type of household. Farms size decreased from an average size of 4.7 acres to 3.57 acres (corresponding to a 24% decrease) between 1991 and 2004. While the largest farm was 31.5 acres in 1991, it is 25.5 acres in 2004. The empirical density functions of farm sizes in 1991 (solid line) and in 2004 (dashed line) in Figure 1 highlight the shift of the whole distribution so that farm sizes have decreased at all levels of size.

The average number of household members older than 7 who report having worked on the household farm in the past 12 months decreased from 3.44 in 1991 to 2.89 in 2004 (corresponding to a 16% decrease in total labor force employed on the farm except children) and the average number of adult workers per farm is higher for female workers than for male workers; in 2004 there are slightly more adult males and less adult females compared to 1991, but for both genders the biggest drop in the workforce comes from the drop in teenage employment on the farm with a reduction of 39% for male teenagers and 44% for female teenagers. This might be due to increases in school enrolment rates or out migration of the younger generation after completion of primary education. We reject the equality of means for all variables at the 5% level. Since both land and labor decreased over the period analyzed, it is informative to look at the evolution of land to labor ratios. Due to the sharper decline in land compared to labor, the mean of the land to labor ratio decreased from 1.59 to 1.42 corresponding to a 11.6% decrease; the mean of land divided by the mean of labor decreased from 1.37 to 1.24 corresponding to a 9.2% decrease.

Given the panel nature of the data it is important to take into account life cycle effects. Split-off households may be younger while the original household may be older. Although agriculture has become more labor intensive in all groups, there is strong heterogeneity. Households who have the same household head in 2004 as they had in 1991 and stayed in the same village, so the 'original' household, have had a smaller reduction both in land and labor leading overall to a smaller reduction in land per labor than in all other groups. The sharpest reduction in total labor and land was experienced by households which had a different head of the household but stayed in the same cluster. Those who changed household head but moved to the nearest village also experienced a decline in land and labor but slightly less so. We also compared pure farm households to diversified households and they are fairly similar in their land and labor use. They only differ in a statistically significant sense in that pure farm households have slightly more male teen labor and more land, leading to a 15% higher land to labor ratio.

3.3 Input use

Figure 3(a) shows the proportion of households in 1991 and 2004 who use fertilizer, manure, pesticide or hired some labor. The graphs are presented by type of household, distinguishing between diversifying and pure farm households. Comparing diversifying and pure farm households in 1991, a larger proportion of the diversifying households use any type of modern inputs, which could be due to cash constraints faced by subsistence farmers. When comparing across time periods, a larger proportion of both diversified households and pure farmers used manure and hired some labor on their farm, compared to 1991. However, for both types of households there is a reduction in the proportion of households that use fertilizer or pesticides. Figure 3(b) shows average expenditure on inputs of households who report positive expenditure, deflated to 1991 prices using the consumer price deflator as price series of inputs were not available. There appears to have been a sharp decline in average expenditure from 1991 to 2004, possibly due to the reduction in farm size and farming activities.

3.4 Consumption

Table 5 shows that per capita household consumption grew substantially in real terms between 1991 and 2004. Average household total consumption grew by 26% or by 1.8% annually; household food consumption per capita by 21% or 1.5% annually and non-food consumption grew by 37% or 2.5% annually. However, there is large heterogeneity when we look at the growth rates of different types of households. The slowest growth has been for pure farmers, so households in which there is no household member employed outside agriculture.

Starting with the lowest level of consumption in 1991 (20% lower total consumption and 30% lower non-food consumption compared to the sample mean), they experience slow growth in total consumption of 0.3% per year and 1.5% in non-food consumption, which is below the average growth rate in the sample of 2.5%. This is in line with Lokina, Nerman, and Sandefur (2011) who find an average consumption growth at the national level for farmers of 0.4% annually. Diversified farmers, in other words, households who are involved in farming but also in wage employment, saw moderate growth with 0.7% annually between 1991 and 2004. The biggest winners in terms of consumption growth are households who were employed outside of agriculture in 2004. Compared to the sample average in 1991 (when almost all households were employed in agriculture), their total consumption grew by 4.9% annually and non-food consumption grew by 5.9% annually. We also plotted the share of revenue households get from major crops (coffee, bananas, maize, beans) against consumption in the two time periods but there was no relationship between the level of consumption and the share derived from different crops (results available upon request). We then regressed the log of food and non-food consumption per capita on the share of revenue from main crops, including community fixed effects and a dummy variable for pure farmers. We find a significant and negative effect of being a pure farmer on the level of consumption as well as significant and negative relationship between the share of revenue coming from the sale of coffee and the level of consumption. This relationship is significant only for 2004. When we further interact these two variables there does not seem to be additional effects from being a pure farmer and growing coffee.

To summarize, the picture that emerges from the descriptive statistics is that (i) overall crop composition has remained fairly stable; (ii) the average farm size has decreased by more than labor used leading to a decrease in the land to labor ratio; (iii) a higher proportion of households use manure and hired labor but fertilizer and pesticide use has decreased; (iv) farmers appear to be experiencing consumption growth, but this is below the average consumption growth of the sample and far below households who are employed outside of agriculture in 2004; (v) the level of food and non-food consumption is significantly lower the larger the share of revenue coming from coffee in 2004.

4 Empirical Models

We start by estimating a reduced form specification that will be informative of how average productivity changed over time for both farming as well as diversifying households. We then augment the reduced form by including controls for the various factors of production to explore correlates of total crop output. Finally, we estimate the correlates of total crop output separately for the main crops.

4.1 Reduced Form

We estimate the following model

$$lnY_{it} = \beta_0 + \beta_1 D_{it}^{04} + \beta_2 PFHH_{it} + \beta_3 D_{it}^{04} * PFHH_{it} + \varepsilon_{it} \qquad (3)$$

for household $i = 1, \ldots, N$ at time $t = 1, \ldots, T$; where Y_{it} is the log of revenue from crop sales, crop eaten or total crop output (=cropsales + cropeaten); we also estimate the model using output per acre and output per worker as the dependent variable. D_{it}^{04} denotes a dummy variable that is equal to one for the year 2004 and $PFHH_{it}$ is a dummy variable that is equal to one if the household is a pure farming household. Thereby, β_1 gives us an estimate of the average growth in Total Factor Productivity (TFP) over time for diversifying households while for farm households

TFP growth is given by $\beta_1 + \beta_3$.

4.2 Correlates of Output

We also investigate the correlates of total crop output using the following specification

$$lnY_{it} = \alpha_0 + \alpha_1 lnK_{it} + \alpha_2 lnL_{it} + \alpha_3 lnLand_{it} + \alpha_4 X_{it} + \alpha_5 D^{04}_{it} + \epsilon_{it} \quad (4)$$

for household $i = 1, \ldots, N$ at time $t = 1, \ldots, T$; Y_{it} is revenue from total crop output, K_{it} captures capital inputs used, L_{it} is a head count of the individuals in the household employed on the farm and $Land_{it}$ denotes the acres of land used for farming by the household; X_{it} includes a dummy variable for whether the household used perishable inputs and the years of education of the household head; α_5 now gives an estimate of the average growth in Total Factor Productivity (TFP) over time for the households in the sample after controlling for the main factors of production.

It is not clear how to best treat zero expenditures on certain inputs as they are undefined when taking logarithms of the variables. A frequently employed method is to add a very small number and then take logs. Since use of inputs is extremely low for many inputs (uptake of less than 5%), we prefer to code a dummy variable that is equal to one if the household employs the input and zero otherwise.

Both models as outlined in equation 3 and 4 control for the cluster-specific deviation of rainfall during long and short rains from a cluster-specific 23-year average (1980-2003) in 1989, 1990, 1991, 2002 and 2003, interacted with the trend variable[3].

We also present the above specification separately for coffee, banana, maize and beans where the dependent variable is the total revenue from sale of a specific crop. One data limitation is that inputs into production are not recorded at the level of the plot or crop but only at the aggregate household level so it is important to keep in mind that most households plant a variety of crops. Therefore, we present specifications gradually limiting the sample to higher and higher shares of revenue coming from a specific crop.

5 Results

5.1 Reduced Form

Tables 6 - 14 show the reduced form estimates for the parameters as outlined in equation 3. Column (4) includes community fixed effects and column (5) deflates output using the producer price deflator while retaining community fixed effects.

[3] Unfortunately, the data are mainly missing for 2004.

The total value of crop output has decreased by about 45% between 1991 and 2004. However, Tables 7 and 8 show that the decrease in output is lower when we look at output per acre or per worker, which is explained by the significantly smaller farm size in 2004 compared to 1991. Output per worker is not significantly lower in 2004 compared to 1991. Pure farm households have had on average 14% higher total value of crop output per worker compared to diversifying households in both rounds, but this effect disappears when we include community fixed effects. Their total value of crop output is not significantly higher in 2004 compared to 1991.

A fairly different picture emerges from Table 9. While the coefficient on the trend is still negative and significant, when we account for land and labor in tables 10 and 11 it looses its significance. Pure farming households, one the other hand, who had significantly lower crop sales in 1991 compared to diversified households seem to be catching up and experiencing growth of about 25% between 1991 and 2004.

The value of home produced food, on the other hand, is exhibiting a similar pattern as total value of crop output: there is an overall significant and negative trend, farming households produce a higher value of home produced food per worker, but this does not change significantly over time. Again, when using output per acre or worker measures, the decrease is smaller.

The coefficients on the explanatory variables, including the trend, are fairly robust to the inclusion of community fixed effects in column (4). However, the coefficient on the trend is the average growth rate across all communities, so they do not tell us whether the negative coefficient on the trend is experienced by the majority of communities or simply driven by a few communities in which agricultural output is declining rapidly. Therefore, we re-estimate model 3 using different output measures (deflated by producer prices) with community fixed effects and a full set of time-community interaction effects to capture different community level trends, controlling for cluster level rainfall deviations. We then add the coefficient of the trend variable and the community-time interaction effects to get the community-specific difference in output between 1991 and 2004. The distribution of these community specific trends for the same set of outcome variables used in the reduced form estimates is shown in table3[4]. From this it becomes clear that households in most communities experienced a negative trend in output growth and this holds for all outcome variables. When we normalize output by land or workers, there are a few more communities with positive output growth, but the majority is still experiencing negative output growth. Deflating the dependent variable using the constructed

[4]As we are interested mainly in the overall distribution of the different community level trends, we do not weight the coefficients by their precision; the coefficient on the trend is negative and significantly different from zero at the 5% level while the community-trend interactions vary in sign and significance.

producer price index instead of the consumer price index in column (5) does not change neither sign nor significance of the result.

In summary, the picture emerging from these estimates is that there is an overall reduction in the value of output produced by households, but this reduction is significantly lower when we use output per worker or per acre as the dependent variable. Further, it is not significant anymore when we only look at the revenue from crops excluding the value of crops eaten. Pure farm households appear to have started to lower revenue from sales in 1991 but have grown faster than diversified farmers. We now augment these specifications to explore the correlates of revenue of total crop output.

5.2 Correlates of Output

Tables 15 shows the estimates for the correlates of revenue from total crop output. Columns (2) and (5) add initial household fixed effects and columns (3) and (6) restrict the sample to households with the same household head in 1991 and 2004 which amounts to a sample of 411 diversifying and 206 pure farming households. This is an interesting subsample as one would expect knowledge of the land and farming techniques by the household head would lead to improved returns to various inputs. For this subsample, the distribution of farm inputs is fairly different. The average farm is larger with 4.24 acres (compared to 3.57 acres for the full sample) and total number of people employed in the farm is higher with 3.27 compared to 2.89 for the full sample. This amounts to a slightly higher land to labor ratio of 1.52 compared to 1.40 for the full sample. Columns (1) - (3) deflate output using consumer prices; columns (4) - (6) deflate output using producer prices; all models include community fixed effects and control for rainfall[5].

The most important input into production is capital with a share of about 0.4, while land and labor enter the production function with shares of 0.25 and 0.26. Similar to the reduced form regressions, pure farming households have higher total crop output for both years. They seem to have a lower return to land and capital and a higher return to labor, but the point estimate is not significantly different from zero until we limit the sample to households who had the same household head in 1991 and 2004. Even after accounting for factors of production, the coefficient on the trend variable is still negative and significantly different from zero until we include initial household fixed effects. Households who used fertilizer, manure and hired labor had significantly higher crop output. The inclusion of initial household

[5] We have also estimated a model that includes a full set of interaction effects with both time and type of household (results not shown); Wald tests for the significance of the interactions terms suggest that we fail to reject that the time interaction effects are equal to zero. We fail to reject the null that the production technology is different for pure farmers when community fixed effects are included; therefore we run all specifications allowing for different slopes for pure farming households

fixed effects in columns (2) and (4) does not change the the size of the coefficients but some are estimated slightly less precisely and therefore lose statistical significance at the 10% level, such as the trend variable.

Limiting the sample to households with the same household head gives slightly different input shares. Land and capital have lower input shares with 0.21 and 0.29, respectively, and labor has a slightly higher share with 0.3. Pure farm households with the same household head also have significantly lower returns to land and capital and higher returns to labor. The lower return to land might be due to the fact that since they are not involved in other activities and fertile land becoming scarcer, they had to start planting their crops on less fertile land. Adding up the input shares for pure farm households with the same household head, land and capital are dominated by labor as the main input. Further, households with the same household head have higher and significant returns to using modern inputs, which suggests that knowledge about farming techniques is passed on through the household head. Deflating output with the producer price index in columns (4) - (6) does again not change the results.

Tables 16 - 19 present the correlates of output growth for the major crops planted in Kagera. Column (1) uses all farmers who sold beans and column (2) is the same as (1) using producer prices as deflator. Columns (3), (4) and (5) restrict the sample to farmers for whom revenue from a particular crop accounts for at least 25%, 50% and 75% of total revenue from crop sales, respectively, to account for the fact that we do not know the inputs that are spent on the production of a specific crop. All models also include community fixed effects and controls for rainfall shocks. What is common across all crops is that the most important inputs into production are land and capital, while the coefficient on labor is close to zero or negative, but never statistically different from zero and positive (which is not surprising given the data limitation as explained above). The value of bananas sold is the only crop that has decreased significantly between the two time periods. The results also suggest that the returns to fertilizer are highest for bananas and coffee, manure matters most for bananas. Hiring in of labor is correlated with higher value of output across all crops and the education of the household head is positively correlated with the revenue from planting bananas and beans.

6 Conclusion

This paper used data from the Kagera Health and Development survey to study changes in agricultural productivity between 1991 and 2004, as well as returns to various inputs, such as land, labor and modern inputs. We find that the crop composition of farmers remained fairly stable across this period with the main crops for households selling their products are coffee, bananas, beans and maize both in 1991 and 2004. The average farm is significantly smaller in 2004 compared to 1991 in terms of labor employed and land cultivated and has become more labor intensive. The total number of household members employed in the farm decreased by 16% and the average farm size decreased by 24%, leading to a reduction in the average land to labor ratio from 1.59 to 1.42, corresponding to a 12% decrease. The sharpest drop in workforce is among 12-19 year old females and males, probably due to increases in school enrolment rates or out migration of the younger generation after completion of primary education.

We observe an increase in the proportion of households using manure and employing some hired labor, but a decrease (from already low levels) of fertilizer and pesticides use, and this holds both for pure farming as well as diversifying households. Credit constraints might play a role in the low uptake of modern inputs, which explains why diversifying households who have alternative sources for cash income have higher levels of adoption. However, with 3.4% and 7.9% of diversifying households using fertilizer or pesticides in 2004, this suggests that returns to the modern inputs are too low to pay off.

Annual consumption growth of pure farmers is 0.3% which is below consumption growth of diversified farmers (0.7%) and far below growth for individuals who moved out of agriculture in 2004 who experienced consumption growth per capita of 4.9%. Further, there is a statistically significant and negative correlation between the share of revenue a farm household gets from the sale of coffee and consumption in 2004 which does not exist in 1991. This might be due to the low price obtained for coffee in 2004.

Reduced form estimates suggest that there has been a reduction in the value of total crop output and there is no evidence for growth in the value of output per worker or output per acre. However, pure farm households seem to have experienced some catch-up in terms of higher growth in value of crops sold. Correlates of output growth point towards capital as the most important input into production with a share of 0.4, while land and labor enter the production function with shares of 0.25 and 0.26. There do not seem to be changes in the return to factors of production between the two sample periods and even after we account for factors of production, the coefficient on the trend variable is still negative and significantly different from zero.

In conclusion, the findings of this study suggest that the agriculture sector only made a moderate contribution to growth in Kagera in the period of 1991-2004. The highest consumption growth arose to individuals who left agriculture and those who stayed did not intensify production through the increased use of modern inputs but rather through increased use of labor on more limited land. The relative prices of agricultural versus non-agricultural products may have played a role in affecting production decisions of farmers and input use. The crude producer price index calculated in this paper suggests that farmers did experience adverse terms of trade shocks. Therefore, the role of relative prices of inputs and outputs in affecting farmer's production decisions and welfare is a topic which is crucial to understand farmer's production decisions and merits further study.

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7 Figures and Tables

Figure 1: Farm Size in 1991 and 2004

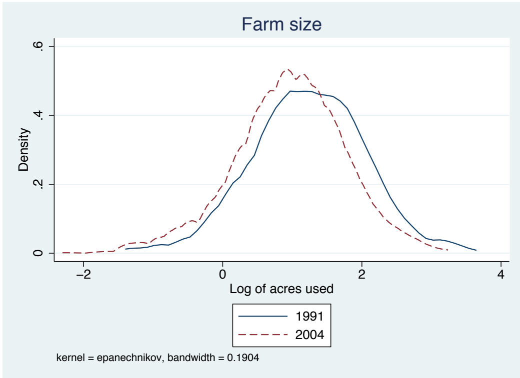
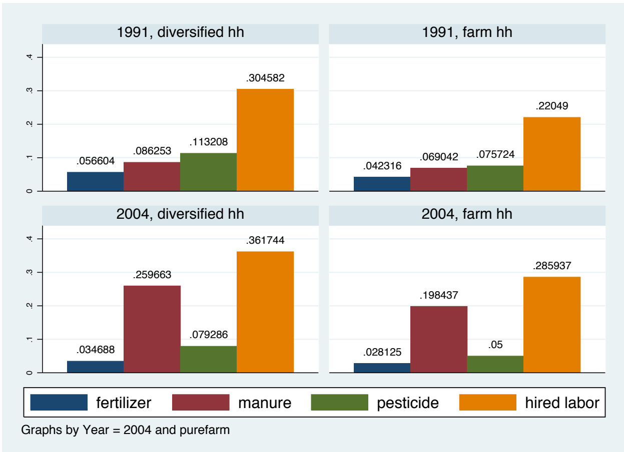
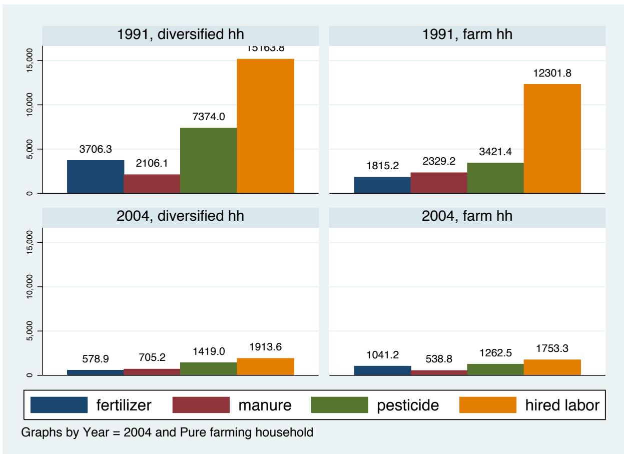


Figure 2: Input Use

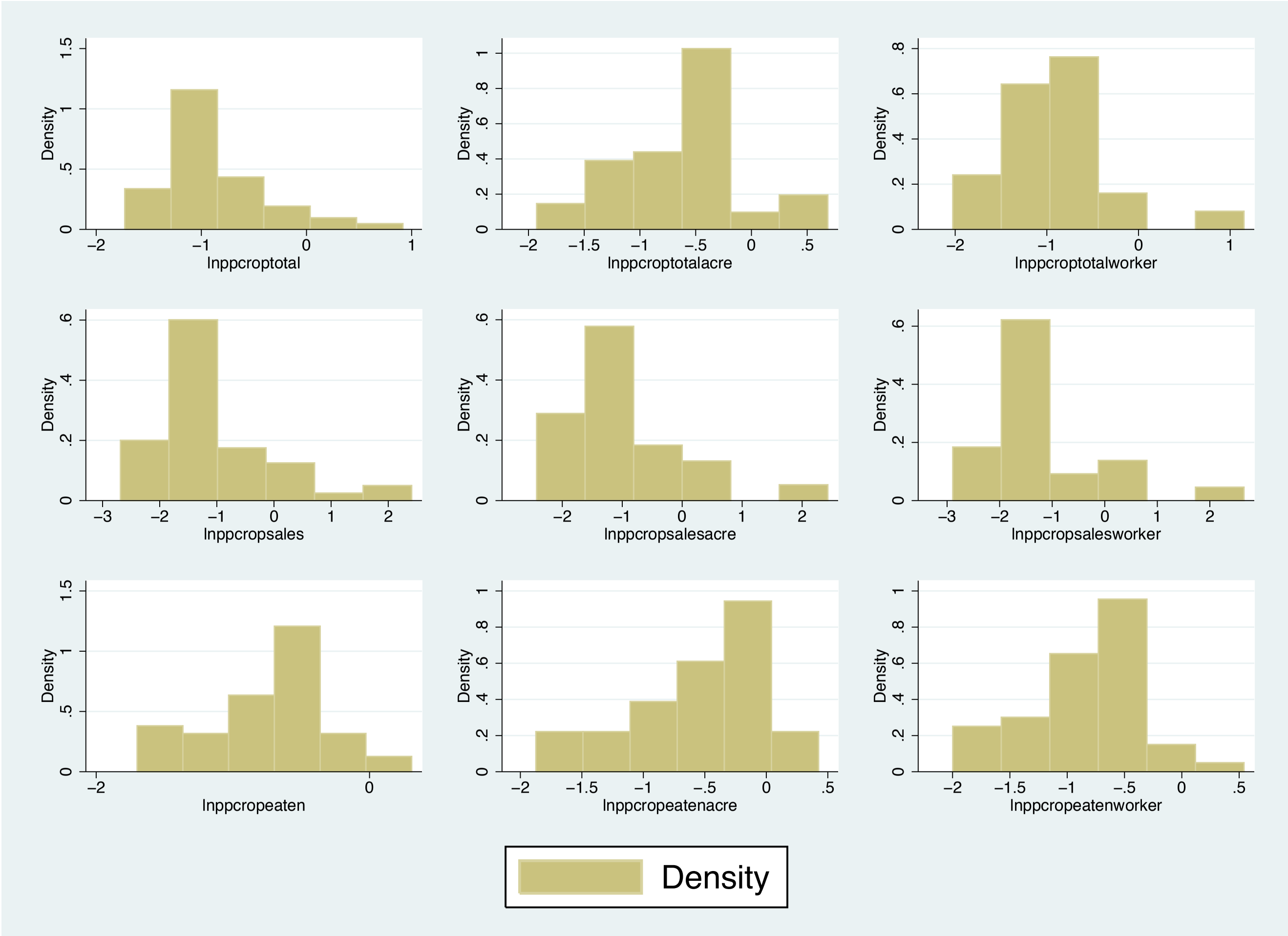


(a) Proportion of households using inputs



(b) Total expenditure on inputs

Figure 3: Distribution of Community-trend interaction effects



Notes: Coefficients on time-community fixed effect interactions from a regression of output on community fixed effects and a full set of time-community interactions.

Table 1: Consumer and Producer Prices

Variable	Mean	Median	Sd
Laspeyre Consumer Price Deflator	4.01	4.12	0.55
Laspeyre Producer Price Deflator	3.42	3.27	1.16
Coffee	2.60	2.56	0.93
Maize	5.59	4.84	2.87
Beans	4.28	4.68	1.78
Cooking Bananas	5.02	4.33	3.03
Sweet Bananas	4.17	4.00	2.99
Other Bananas	4.25	3.77	2.84

Notes: Consumer and Producer price index and selected products for the 47 rural communities

Table 2: Main crops in 1991 and 2004, full sample

1991			**2004**		
crop	**no**	**%**	**crop**	**no**	**%**
Beans	818	98.6%	Maize	2058	94.8%
Maize	780	94.0%	Beans	2055	94.7%
Cook Banana	767	92.4%	Cassava	1856	85.5%
Cassava	749	90.2%	Sweet potatoes	1797	82.8%
Sweet Banana	707	85.2%	Coffee	1748	80.6%
Coffee	659	79.4%	Cook bananas (trad)	1743	80.3%
Sweet Potatoe	622	74.9%	Brewing bananas	1513	69.7%
Oth Banana	583	70.2%	Mangoes	1325	61.1%
Mangoes	524	63.1%	Sweet bananas (trad)	1127	51.9%
Pawpaw	515	62.0%	Pawpaw	1100	50.7%
Other Vegs	449	54.1%	Yams	993	45.8%
Spices	437	52.7%	Avocado	964	44.4%
	830			2170	

Table 3: Main crops in 1991 and 2004, sellers only

1991			2004		
crop	**no**	**%**	**crop**	**no**	**%**
Coffee	510	73.4%	Coffee	919	68.4%
Oth Banana	237	34.1%	Brewing bananas	609	45.3%
Sweet Banana	224	32.2%	Beans	422	31.4%
Beans	169	24.3%	Cook Bananas (trad)	316	23.5%
Cook Banana	128	18.4%	Maize	312	23.2%
Maize	115	16.5%	Sweet bananas (trad)	259	19.3%
Cassava	92	13.2%	Cassava	158	11.8%
Sorghum	62	8.9%	Sweet potatoes	102	7.6%
Groundnut	62	8.9%	Cook bananas (impr)	101	7.5%
Tomatoes	46	6.6%	Tomatoes	87	6.5%
Sweet Potatoe	43	6.2%	Trees (firewood,poles)	74	5.5%
Sugar Cane	29	4.2%	Finger millet	67	5.0%
	695			1344	

Table 4: Evolution of Labor and Land use by type of household

	1991	2004	2004, same head		2004, different head	
Variable			same cluster	nearby village	same cluster	nearby village
Male (above 20yrs)	0.89	0.96	0.98	0.77	0.95	0.96
Female (above 20yrs)	1.20	1.14	1.21	1.43	1.01	1.16
Male (12-19yrs)	0.65	0.40	0.57	0.53	0.28	0.30
Female (12-19yrs)	0.69	0.39	0.50	0.37	0.29	0.37
Children (7-12yrs)	0.41	0.29	0.31	0.33	0.26	0.29
Total Labor (except children)	3.44	2.89	3.26	3.10	2.53	2.78
Land used (in acres)	4.70	3.57	4.14	3.44	2.87	3.48
Land/Total Labor	1.59	1.40	1.48	1.29	1.27	1.42
Mean(Land)/Mean(Total Labor)	1.37	1.24	1.27	1.11	1.13	1.25
N	819	1624	625	30	602	366
Change in Total Labor		-16.0%	-5.1%	-9.8%	-26.3%	-19.0%
Change in Land		-23.9%	-11.9%	-26.8%	-38.9%	-25.9%
Change in Land/Labor		-11.6%	-6.6%	-18.5%	-20.3%	-10.4%
Change in Mean(Land)/Mean(Total Labor)		-9.4%	-7.1%	-18.8%	-17.0%	-8.5%

Table 5: Consumption Growth by Type of Household between 1991 and 2004

	1991	2004	Total Change	Annual Change
Complete Sample				
Total consumption	207,905	261,863	26.0%	1.8%
Food consumption	142,073	171,939	21.0%	1.5%
Non-food consumption	66,432	91,028	37.0%	2.5%
Diversified Farmers				
Total consumption	193,088	211,937	9.8%	0.7%
Food consumption	129,745	142,281	9.7%	0.7%
Non-food consumption	65,304	69,932	7.1%	0.5%
Pure Farmers				
Total consumption	168,513	175,734	4.3%	0.3%
Food consumption	122,324	118,902	-2.8%	-0.2%
Non-food consumption	46,630	56,746	21.7%	1.5%
Non-Agriculture in 2004				
Total consumption	207,905	386,131	85.7%	4.9%
Food consumption	142,073	247,530	74.2%	4.4%
Non-food consumption	66,432	140,580	111.6%	5.9%

Notes: Annualized Household Consumption per capita in 2004 TZS.

Table 6: Dependent Variable: Value of total crop output

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.478		-.493	-.518	-.581
	(0.203)**		(0.206)**	(0.191)***	(0.187)***
Pure farming household*2004			0.07	0.099	0.101
			(0.081)	(0.08)	(0.08)
Pure farming household		0.069	0.026	-.019	-.014
		(0.041)*	(0.06)	(0.06)	(0.061)
Obs.	2045	2045	2045	2045	2016
R^2	0.145	0.142	0.146	0.241	0.214

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 7: Dependent Variable: Value of total crop output per acre

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.328		-.344	-.319	-.382
	(0.192)*		(0.195)*	(0.192)*	(0.188)**
Pure farming household*2004			0.059	0.058	0.059
			(0.083)	(0.081)	(0.08)
Pure farming household		0.033	-.002	-.008	-.003
		(0.04)	(0.059)	(0.058)	(0.058)
Obs.	2045	2045	2045	2045	2016
R^2	0.136	0.134	0.136	0.198	0.252

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 8: Dependent Variable: Value of total crop output per worker

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.212		-.204	-.223	-.285
	(0.197)		(0.198)	(0.185)	(0.181)
Pure farming household*2004			0.034	0.057	0.059
			(0.079)	(0.077)	(0.077)
Pure farming household		0.143	0.123	0.075	0.08
		(0.038)***	(0.058)**	(0.057)	(0.057)
Obs.	2045	2045	2045	2045	2016
R^2	0.103	0.108	0.109	0.211	0.217

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 9: Dependent Variable: Total Crop Revenue

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.449		-.521	-.541	-.605
	(0.312)		(0.317)	(0.302)*	(0.297)**
Pure farming household*2004			0.188	0.281	0.276
			(0.136)	(0.134)**	(0.134)**
Pure farming household		-.044	-.149	-.220	-.215
		(0.072)	(0.106)	(0.105)**	(0.104)**
Obs.	2008	2008	2008	2008	1985
R^2	0.104	0.103	0.105	0.191	0.167

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 10: Dependent Variable: Total Crop Revenue per acre

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.283		-.348	-.324	-.387
	(0.285)		(0.29)	(0.282)	(0.276)
Pure farming household*2004			0.159	0.217	0.209
			(0.123)	(0.122)*	(0.121)*
Pure farming household		-.070	-.159	-.195	-.189
		(0.063)	(0.093)*	(0.09)**	(0.09)**
Obs.	2008	2008	2008	2008	1985
R^2	0.091	0.091	0.092	0.169	0.176

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 11: Dependent Variable: Total Crop Revenue per worker

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.164		-.207	-.220	-.283
	(0.317)		(0.323)	(0.308)	(0.302)
Pure farming household*2004			0.143	0.23	0.224
			(0.135)	(0.133)*	(0.132)*
Pure farming household		0.034	-.044	-.119	-.113
		(0.07)	(0.103)	(0.101)	(0.1)
Obs.	2008	2008	2008	2008	1985
R^2	0.075	0.075	0.076	0.169	0.155

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 12: Dependent Variable: Value of Crop and crop by-products eaten

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.555		-.562	-.589	-.654
	(0.188)***		(0.19)***	(0.178)***	(0.177)***
Pure farming household*2004			0.048	0.054	0.059
			(0.078)	(0.076)	(0.077)
Pure farming household		0.073	0.042	0.008	0.013
		(0.04)*	(0.055)	(0.056)	(0.057)
Obs.	2040	2040	2040	2040	2011
R^2	0.134	0.13	0.135	0.224	0.211

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 13: Dependent Variable: Value of Crop and crop by-products eaten per acre

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.412		-.422	-.398	-.462
	(0.192)**		(0.194)**	(0.194)**	(0.192)**
Pure farming household*2004			0.046	0.023	0.027
			(0.086)	(0.083)	(0.084)
Pure farming household		0.042	0.014	0.02	0.025
		(0.044)	(0.061)	(0.061)	(0.061)
Obs.	2040	2040	2040	2040	2011
R^2	0.141	0.139	0.141	0.194	0.256

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 14: Dependent Variable: Value of Crop and crop by-products eaten per worker

	EQ1	EQ2	EQ3	EQ3FE	EQ4FE
	(1)	(2)	(3)	(4)	(5)
Year = 2004	-.298		-.284	-.303	-.367
	(0.183)		(0.184)	(0.174)*	(0.171)**
Pure farming household*2004			0.018	0.016	0.021
			(0.076)	(0.074)	(0.074)
Pure farming household		0.151	0.139	0.102	0.107
		(0.037)***	(0.053)***	(0.053)*	(0.053)**
Obs.	2040	2040	2040	2040	2011
R^2	0.102	0.107	0.109	0.201	0.226

Notes: robust standard errors in parentheses, clustered at the initial household level; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 15: Correlates of Total Crop Output

	Base	IHHFE	Head	PBase	PIHHFE	PHead
	(1)	(2)	(3)	(4)	(5)	(6)
Log of acres used	0.258 (0.031)***	0.236 (0.056)***	0.209 (0.055)***	0.255 (0.032)***	0.23 (0.056)***	0.209 (0.055)***
Log or Labor	0.265 (0.04)***	0.203 (0.07)***	0.299 (0.07)***	0.279 (0.04)***	0.21 (0.068)***	0.299 (0.07)***
Log of Capital	0.409 (0.041)***	0.424 (0.072)***	0.297 (0.078)***	0.404 (0.041)***	0.431 (0.072)***	0.297 (0.078)***
Pure farming household	0.335 (0.144)**	0.534 (0.229)**	0.462 (0.188)**	0.307 (0.144)**	0.485 (0.228)**	0.462 (0.188)**
Log of acres used*purefarm	-.033 (0.054)	-.048 (0.092)	-.144 (0.079)*	-.033 (0.055)	-.028 (0.093)	-.144 (0.079)*
Log of Labor*purefarm	0.089 (0.072)	0.239 (0.125)*	0.249 (0.111)**	0.085 (0.072)	0.244 (0.124)**	0.249 (0.111)**
Log of Capital*purefarm	-.170 (0.073)**	-.342 (0.113)***	-.222 (0.113)**	-.152 (0.074)**	-.331 (0.114)***	-.222 (0.113)**
Year = 2004	-.334 (0.163)**	-.326 (0.229)		-.394 (0.159)**	-.378 (0.223)*	
Pure farming household*2004	0.035 (0.069)	-.028 (0.121)		0.039 (0.069)	-.028 (0.121)	
Fertilizer=1	0.255 (0.082)***	0.333 (0.151)**	-.019 (0.119)	0.255 (0.082)***	0.328 (0.151)**	-.019 (0.119)
Pesticide=1	0.059 (0.056)	0.127 (0.099)	0.238 (0.116)**	0.055 (0.058)	0.118 (0.1)	0.238 (0.116)**
Manure=1	0.17 (0.04)***	0.122 (0.071)*	0.223 (0.063)***	0.162 (0.04)***	0.123 (0.071)*	0.223 (0.063)***
Hired Labor=1	0.133 (0.036)***	0.12 (0.064)*	0.301 (0.06)***	0.14 (0.036)***	0.131 (0.064)**	0.301 (0.06)***
Educ of hh head	0.005 (0.005)	-.00009 (0.011)	0.019 (0.009)**	0.004 (0.005)	-.001 (0.011)	0.019 (0.009)**
Obs.	2038	2038	620	2009	2009	620
R^2	0.513	0.718	0.55	0.496	0.702	0.55

Notes: robust standard errors in parentheses, clustered at the initial household level; all models include community fixed effects and controls for rainfall shocks; columns (2) and (5) add initial household fixed effects and columns (3) and (6) restrict the sample to households with the same household head in both years; columns (1) - (3) deflate output using consumer prices; columns (4) - (6) deflate output using producer prices; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 16: Correlates of Value of Coffee Sold

	EQ1	EQ2	EQ3	EQ4	EQ5
	(1)	(2)	(3)	(4)	(5)
Log of acres used	0.333	0.327	0.43	0.495	0.466
	(0.069)***	(0.07)***	(0.069)***	(0.086)***	(0.126)***
Log or Labor	0.012	0.011	-.135	-.177	-.135
	(0.104)	(0.104)	(0.104)	(0.126)	(0.188)
Log of Capital	0.693	0.704	0.823	0.759	0.857
	(0.103)***	(0.103)***	(0.109)***	(0.141)***	(0.195)***
Pure farming household	0.356	0.305	0.589	0.683	1.119
	(0.332)	(0.333)	(0.348)*	(0.411)*	(0.61)*
Log of acres used*purefarm	0.175	0.183	0.062	0.055	0.252
	(0.131)	(0.131)	(0.139)	(0.17)	(0.238)
Log of Labor*purefarm	0.199	0.215	0.148	-.010	0.049
	(0.175)	(0.175)	(0.189)	(0.239)	(0.305)
Log of Capital*purefarm	-.301	-.290	-.251	-.210	-.510
	(0.182)*	(0.182)	(0.187)	(0.246)	(0.377)
Year = 2004	-.287	-.279	-.336	-.518	0.07
	(0.339)	(0.339)	(0.334)	(0.442)	(0.592)
Pure farming household*2004	-.091	-.082	-.123	-.123	0.023
	(0.172)	(0.173)	(0.173)	(0.202)	(0.303)
Fertilizer=1	0.406	0.389	0.374	0.684	0.822
	(0.203)**	(0.205)*	(0.28)	(0.297)**	(0.375)**
Pesticide=1	0.229	0.226	0.367	0.413	0.483
	(0.142)	(0.142)	(0.157)**	(0.205)**	(0.301)
Manure=1	0.239	0.268	0.273	0.434	0.27
	(0.114)**	(0.115)**	(0.12)**	(0.134)***	(0.209)
Hired Labor=1	0.056	0.062	0.194	0.319	0.309
	(0.095)	(0.095)	(0.095)**	(0.115)***	(0.165)*
Educ of hh head	0.0008	-.002	0.012	0.01	0.022
	(0.013)	(0.013)	(0.014)	(0.016)	(0.023)
Obs.	1036	1031	788	589	385
R^2	0.405	0.377	0.495	0.495	0.498

Notes: robust standard errors in parentheses, clustered at the initial household level; all models include community fixed effects and controls for rainfall shocks; column (1) uses all farmers who sold coffee column; (2) is the same as (1) using producer prices as deflator; column (3), (4) and (5) restrict the sample to farmers for whom coffee accounts for at least 25%, 50% and 75% of total revenue from crop sales, respectively; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 17: Correlates of Value of Bananas Sold

	EQ1	EQ2	EQ3	EQ4	EQ5
	(1)	(2)	(3)	(4)	(5)
Log of acres used	0.394	0.386	0.479	0.401	0.468
	(0.087)***	(0.088)***	(0.109)***	(0.158)**	(0.259)*
Log or Labor	-.185	-.178	-.156	-.269	-.243
	(0.114)	(0.112)	(0.146)	(0.235)	(0.416)
Log of Capital	0.299	0.304	0.414	0.514	-.073
	(0.114)***	(0.115)***	(0.137)***	(0.205)**	(0.293)
Pure farming household	-1.010	-1.107	-.553	-.504	-1.714
	(0.377)***	(0.38)***	(0.43)	(0.688)	(1.018)*
Log of acres used*purefarm	-.095	-.083	0.051	0.179	0.081
	(0.152)	(0.154)	(0.176)	(0.282)	(0.436)
Log of Labor*purefarm	0.261	0.283	0.134	0.15	0.169
	(0.211)	(0.209)	(0.246)	(0.393)	(0.672)
Log of Capital*purefarm	0.457	0.473	0.203	0.107	0.711
	(0.188)**	(0.193)**	(0.21)	(0.339)	(0.496)
Year = 2004	-1.319	-1.291	-.544	-1.139	-.277
	(0.382)***	(0.38)***	(0.476)	(0.772)	(1.189)
Pure farming household*2004	0.154	0.202	0.106	0.216	0.459
	(0.209)	(0.21)	(0.244)	(0.362)	(0.55)
Fertilizer=1	0.352	0.353	0.637	0.436	0.47
	(0.221)	(0.22)	(0.288)**	(0.364)	(0.445)
Pesticide=1	0.028	0.021	-.027	0.177	0.391
	(0.157)	(0.155)	(0.212)	(0.361)	(0.557)
Manure=1	0.422	0.417	0.366	0.391	0.93
	(0.104)***	(0.104)***	(0.124)***	(0.251)	(0.397)**
Hired Labor=1	0.263	0.281	0.324	0.573	0.536
	(0.095)***	(0.096)***	(0.12)***	(0.177)***	(0.32)*
Educ of hh head	0.034	0.035	0.034	0.069	0.061
	(0.015)**	(0.015)**	(0.018)*	(0.029)**	(0.045)
Obs.	993	987	599	346	195
R^2	0.328	0.327	0.416	0.458	0.555

Notes: robust standard errors in parentheses, clustered at the initial household level; all models include community fixed effects and controls for rainfall shocks; column (1) uses all farmers who sold bananas; column (2) is the same as (1) using producer prices as deflator; column (3), (4) and (5) restrict the sample to farmers for whom bananas account for at least 25%, 50% and 75% of total revenue from crop sales, respectively; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 18: Correlates of Value of Maize Sold

	EQ1	EQ2	EQ3	EQ4	EQ5
	(1)	(2)	(3)	(4)	(5)
Log of acres used	0.066	0.062	0.191	-.479	0.445
	(0.146)	(0.144)	(0.217)	(0.73)	(1.425)
Log or Labor	-.109	-.106	-.562	0.071	0.601
	(0.198)	(0.198)	(0.255)**	(0.745)	(1.258)
Log of Capital	0.656	0.634	1.029	1.018	-2.123
	(0.181)***	(0.183)***	(0.341)***	(0.993)	(1.532)
Pure farming household	-.559	-.820	1.282		1.232
	(0.648)	(0.65)	(1.299)		(3.539)
Log of acres used*purefarm	0.037	0.045	-.044	1.033	-.040
	(0.284)	(0.279)	(0.465)	(1.139)	(1.938)
Log of Labor*purefarm	0.765	0.755	0.796	-.391	-.475
	(0.331)**	(0.329)**	(0.594)	(1.135)	(2.356)
Log of Capital*purefarm	-.130	-.042	-.714	-.752	0.726
	(0.321)	(0.325)	(0.61)	(1.255)	(3.028)
Year = 2004	0.578	0.366	2.784		
	(0.472)	(0.473)	(5.437)		
Pure farming household*2004	-.113	-.037	-.510	1.159	
	(0.381)	(0.38)	(0.768)	(1.223)	
Fertilizer=1	0.209	0.247	0.127	1.758	
	(0.325)	(0.318)	(0.567)	(2.291)	
Pesticide=1	-.345	-.339	-.238	-.807	
	(0.184)*	(0.184)*	(0.363)	(1.397)	
Manure=1	0.206	0.22	0.222	0.695	2.558
	(0.188)	(0.19)	(0.3)	(1.040)	(0.946)***
Hired Labor=1	0.405	0.422	0.451	1.024	2.050
	(0.146)***	(0.145)***	(0.262)*	(0.614)*	(1.307)
Educ of hh head	0.018	0.015	0.055	-.048	-.069
	(0.023)	(0.023)	(0.04)	(0.074)	(0.156)
Obs.	329	328	137	69	41
R^2	0.443	0.432	0.668	0.759	0.894

Notes: robust standard errors in parentheses, clustered at the initial household level; all models include community fixed effects and controls for rainfall shocks; column (1) uses all farmers who sold maize column; (2) is the same as (1) using producer prices as deflator; column (3), (4) and (5) restrict the sample to farmers for whom maize accounts for at least 25%, 50% and 75% of total revenue from crop sales, respectively; *, **, *** denote significance at 10%, 5% and 1% levels.

Table 19: Correlates of Value of Beans Sold

	EQ1	EQ2	EQ3	EQ4	EQ5
	(1)	(2)	(3)	(4)	(5)
Log of acres used	0.102	0.107	0.139	0.099	0.366
	(0.111)	(0.111)	(0.141)	(0.243)	(0.312)
Log or Labor	0.004	-.005	0.329	0.447	0.692
	(0.15)	(0.151)	(0.179)*	(0.394)	(0.58)
Log of Capital	0.489	0.475	0.243	0.379	0.515
	(0.142)***	(0.141)***	(0.158)	(0.325)	(0.414)
Pure farming household	-.535	-.611	-.629	-.421	0.984
	(0.392)	(0.393)	(0.503)	(0.938)	(1.259)
Log of acres used*purefarm	0.315	0.334	0.442	0.515	1.071
	(0.173)*	(0.176)*	(0.231)*	(0.395)	(0.622)*
Log of Labor*purefarm	-.103	-.087	-.679	-.558	-2.387
	(0.227)	(0.228)	(0.329)**	(0.558)	(1.011)**
Log of Capital*purefarm	-.006	0.016	0.357	-.106	-.805
	(0.2)	(0.202)	(0.225)	(0.434)	(0.612)
Year = 2004	0.776	0.677	0.44	0.625	-2.003
	(0.422)*	(0.421)	(0.511)	(0.923)	(1.578)
Pure farming household*2004	0.43	0.426	0.178	0.655	0.985
	(0.214)**	(0.214)**	(0.322)	(0.77)	(0.864)
Fertilizer=1	0.229	0.225	0.128	-1.357	-.023
	(0.268)	(0.274)	(0.378)	(0.396)***	(0.622)
Pesticide=1	-.179	-.175	-.262	-.968	-2.530
	(0.144)	(0.146)	(0.266)	(0.532)*	(0.585)***
Manure=1	0.104	0.11	-.191	-.182	0.43
	(0.133)	(0.135)	(0.179)	(0.393)	(0.765)
Hired Labor=1	0.355	0.373	0.26	0.341	0.817
	(0.106)***	(0.106)***	(0.133)**	(0.263)	(0.319)**
Educ of hh head	0.063	0.061	0.078	0.071	0.103
	(0.016)***	(0.016)***	(0.02)***	(0.038)*	(0.052)**
Obs.	465	464	236	109	62
R^2	0.525	0.477	0.708	0.73	0.879

Notes: robust standard errors in parentheses, clustered at the initial household level; all models include community fixed effects and controls for rainfall shocks; column (1) uses all farmers who sold beans; column (2) is the same as (1) using producer prices as deflator; column (3), (4) and (5) restrict the sample to farmers for whom beans account for at least 25%, 50% and 75% of total revenue from crop sales, respectively; *, **, *** denote significance at 10%, 5% and 1% levels.

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