Volume Title: African Successes, Volume IV: Sustainable Growth

Volume Author/Editor: Sebastian Edwards, Simon Johnson, and David N. Weil, editors

Volume Publisher: University of Chicago Press

Volume ISBNs: 978-0-226-31555-3 (cloth)

Volume URL: http://www.nber.org/books/afri14-4

Conference Dates: December 11–12, 2009; July 18–20, 2010; August 3–5, 2011

Publication Date: September 2016

Chapter Title: Contract Farming and Agricultural Productivity in Western Kenya

Chapter Author(s): Lorenzo Casaburi, Michael Kremer, Sendhil Mullainathan

Chapter URL: http://www.nber.org/chapters/c13437

Chapter pages in book: (p. 137 – 160)

4

Contract Farming and Agricultural Productivity in Western Kenya

Lorenzo Casaburi, Michael Kremer, and
Sendhil Mullainathan

4.1 Introduction

The shift from subsistence to cash crops and from sales on spot markets to more complex contractual arrangements is often considered an important driver of structural transformation and growth. In the developing world, including sub-Saharan Africa, contract farming[1] is often considered one of the most successful examples of this pattern, both from the producers' and particularly from the buyers' perspectives.[2]

In contract farming, the buyer and the producer commit in advance to exchange the product. In addition, in most cases, the buyer provides credit,

Lorenzo Casaburi is a postdoctoral fellow at the Stanford Institute for Economic Policy Research. Michael Kremer is the Gates Professor of Developing Societies in the department of economics at Harvard University and a research associate of the National Bureau of Economic Research. Sendhil Mullainathan is professor of economics at Harvard University and a research associate of the National Bureau of Economic Research.

We thank Jeremy Foltz, Andrew Foster, Jon Robinson, and seminar audiences at the Harvard University Development Lunch and the NBER Africa Successes Conference for helpful comments. Helene Ba, Gretchen Carrigan, Sayon Deb, Owen Ozier, Ravindra Ramrattan, and Ian Tomb provided excellent research assistance. We acknowledge support from the National Bureau of Economic Research Africa Project and from the Sustainability Science Program at the Harvard University, with the support of Italy's Ministry for Environment, Land and Sea (project "The Impact of Rainfall Shocks on Cooperation and in Contract Farming: Evidence from Kenya"). Innovations for Poverty Action Kenya provided administrative support. The usual disclaimer applies. For acknowledgments, sources of research support, and disclosure of the authors' material financial relationships, if any, please see http://www.nber.org/chapters/c13437.ack.

1. Throughout the chapter, we use the terms "contract farming" and "outgrower scheme" interchangeably. Yet some authors (Glover 1990) define the former as purely private and stress the state role in the latter.

2. Importantly, some scholars (see, for example, Singh [2002] and Little and Watts [1994]) present a more negative view, highlighting for instance that smaller farmers are often excluded by the schemes.

monitoring, or is directly involved in part of the production process. The need for a steady supply of raw material, the scope for the buyer to provide in-kind loans, and the presence of increasing returns in some of the cultivation or postharvesting tasks are among the major factors thought to affect the emergence and the success of contract-farming schemes.

In many cases, the state had an important role in setting up contract-farming schemes. Thereafter, structural adjustment programs led both to the establishment of new private schemes and to a reduction in state ownership among existing ones. Contract-farming schemes play a disproportionate role in agricultural exports and in the provision of foreign exchange.

In this chapter we focus our attention on sugarcane outgrower schemes in western Kenya, one of the crops with the highest contract farming production share, along with tea and horticulture. In the first part of the chapter we present a brief overview of the literature on contract farming. There is a large body of work that studies the conditions determining the emergence and success of contract-farming schemes and their impact on smallholders. We apply some of the basic lessons from this literature to the specific case under study. In addition, we provide some institutional background for the Mumias Sugar Company, the largest cane outgrower scheme in Kenya.

In the second part of the chapter, we use administrative data to provide evidence on some of the questions emphasized by the above literature. We were granted access to a subset of the administrative records of the company, covering about 14,000 contracting accounts over an eighteen-year time span (1988–2006). The database contains information on production levels, yields, and net revenues (defined as the difference between cane revenues and company-provided input charges).

First, we look at patterns of entry and exit into the scheme, account splitting, and cane plot sizes. We document expansion of the scheme in areas farther away from the mill. In addition, consistent with findings from earlier periods (Ayako et al. 1989), we find relatively low levels of exits from the scheme during the sample period. However, we find clear evidence of both a reduction in cane plot sizes and of an increase in the number of contracted accounts in a given land parcel, resulting from the subdivision of the original larger plot.

Second, we focus on yields and net revenues (using the World Bank gross domestic product [GDP] deflator to deflate monetary values). We find evidence of decreasing yields and net revenues per hectare over time. In addition, our data suggest that smaller plots have, on average, both higher yields and higher net revenues per hectare. In related work in progress (Casaburi, Kremer, and Mullainathan 2012), we delve into this latter result, looking at its robustness to alternative econometric methodologies and assessing its implications for aggregate levels of output per hectare. Finally, we argue that the inverse relation between plot size and yields magnifies the potential benefits of contract farming relative to more vertically integrated organizational forms, such as plantation estates. Labor market imperfections are likely to lead to higher labor intensity in smaller plots, a result that is found throughout the developing world. By preserving the existence of small plots within the existing property rights institutions, contract-farming schemes generate higher yields while still enabling the buying company to take advantage of economies of scale in other tasks such as land preparation, transport, and processing.

The remainder of the chapter is organized as follows: Section 4.2 briefly summarizes the literature on contract farming in sub-Saharan Africa. Section 4.3 focuses on the case of sugarcane outgrower schemes in western Kenya. Section 4.4 presents relevant details of the contract-farming schemes and introduces the database. Section 4.5 looks at patterns of entry, exit, and trends in plot sizes. Section 4.6 focuses on trends and determinants of yields and net revenues per hectare. Section 4.7 concludes.

4.2 Contract Farming in Sub-Saharan Africa: An Overview

Contract farming is defined as "an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices" (Eaton and Shepherd 2001, 2). In addition, the large majority of these schemes include the provision of inputs and some form of production monitoring. Eaton and Shepherd also identify five main typologies of contract farming, primarily based on the number of contractors. Another important distinction across schemes is based on the price-setting mechanism. In "fixed-price contracts," the contracts specify in advance the price producers will receive at harvest. In "formula-price contracts," a predetermined formula determines the price received by farmers' using the current market price as a starting point, and factoring in the costs and the interest on the inputs provided by the buyer during the production process.

With the dismantling of marketing boards and the liberalization of agricultural markets, the prevalence of contract-farming schemes has been steadily increasing throughout the developing world, including Africa (Porter and Phillips-Howard 1997). In Kenya, the country we focus on in this chapter, Grosh (1994) reports an increase in the share of contracted crops over the total value of marketed crops from 22 percent in 1964 to 45–50 percent in the mid-1980s. Following the increase in the prevalence of such schemes, the body of social science research addressing the topic has expanded, too. Research typically focused on one of the following questions: Which market failures does contract farming address? What are the conditions under which contract-farming schemes succeed? What is their impact on farmers' income and welfare? While a comprehensive review of the findings of this literature is beyond the scope of this contribution, we provide a brief overview of a few important lessons. In the next section, we will then look at the case of sugarcane farming in Kenya in light of those guidelines.

Grosh (1994) argues that contract-farming schemes typically arise in response to one or more of the following market or coordination failures: (a) imperfections in capital markets, which limit small farmers' potentially profitable investments (particularly lumpy ones); (b) imperfections in labor markets, such as moral hazard and high monitoring costs, which make plantation cultivation unfeasible; (c) coordination problems between suppliers and processors/buyers, especially when the buyers require a steady supply of raw material in order to break even; and (d) imperfections in the insurance markets, which, in the presence of risk-averse producers, might prevent farmers from undertaking investments with positive expected return.[3]

The relevance of the above problems varies across crops and buyers. In a recent review, Bijman (2008) argues that heterogeneity in quality, perishability of the agricultural products, and technical difficulty of production make the contracting option more likely. In particular, he observes that the need for immediate processing following harvesting favors the establishment of centralized mills, which coordinate harvesting, transporting, and processing, exploiting potential increasing returns to scale in each of these tasks. In addition, Minot (2007), among others, argues that the above coordination problems are more likely to arise with large-scale processors or supermarket chains rather than with traditional wholesalers. Finally, Deb and Suri (2012), among others, propose that contract-farming schemes are more likely to succeed in areas where the contract-farming buyer is the only one who can offer high prices, as the outside option for farmers is limited. Grosh (1994) argues that this is particularly true for sub-Saharan Africa, where the cost of enforcing contracts is particularly high and, in most cases, discontinuation of the contract is the only real threat the buyer can exert. In summary, the contract-farming framework makes it possible to exploit technical increasing returns to scale in settings where contracting inefficiencies would otherwise push toward small-scale farming. In the next section, we delve into the specific contracting problems and sources of economies of scale for the case of sugarcane.

Finally, the literature that studies the impact of contract-farming schemes presents the following results. First, farmers who enter contracting almost unambiguously achieve higher yields, incomes, and input usage (Little and Watts 1994; Porter and Phillips-Howard 1997; Singh 2002).[4] For the Kenya case, Jaffee (1987) shows that income per hectare in contracted crops is much higher than noncontracted ones. Similarly, Ayako et al. (1989) argue that establishment of contract-farming schemes has led to socioeconomic ben-

3. Grosh (1994) also argues that contract farming reduces the risk buyers face because of potential expropriation relative to vertical integration options.

4. See also Barrett et al. (2012) for a recent meta-analysis.

efits for five of the six crops reviewed in the Kenya experience. However, Little (1994) provides evidence that the degree of the returns varies significantly within schemes (across farmers) and across schemes. In several case studies, income from contract farming needed to be complemented with other sources in order to achieve subsistence levels.

Second, another set of studies looks at determinants of participation of smallholders to the scheme, focusing on issues of exclusion and dualism in agricultural development. Guo et al. (2007) argue that, at least in some schemes, small producers are less likely to participate. This is consistent with the evidence reported by Grosh (1994), who argues that, to prevent the damages arising from monocropping, some contract-farming schemes limit participation to farmers that have a large plot to devote to subsistence crops.[5] Some authors then argue that contract farming might have a negative effect on nonparticipating households, for instance, by raising food crop prices. Finally, Bijman (2008) argues that, by fostering monocropping, contract farming might lead to overexploitation of natural resources.

In the next sections, we investigate whether and how the above lessons, concerning relevant market failures, determinants of success of the schemes, and impact on smallholders apply to the case of sugarcane contract farming in Kenya.

4.3 Sugarcane Contract Farming in Western Kenya

Over the last few decades, the establishment of sugarcane contract farming has radically changed the agricultural sector and farmers' livelihood in western Kenya. Following the establishment of five outgrower schemes between 1968 and 1981, sugarcane has become the most common cash crop in the area. In spite of important caveats, the establishment and expansion of these cane contract-farming schemes is generally considered a major success story in the transition toward commercial agriculture in East Africa.

Milling capacity expanded rapidly postindependence in response to targeted government investments. The construction of the parastatal mills in Nyanza and Western provinces was the driving factor of this growth. Following the establishment of the mills, there has been a significant growth in production. In Kenya, there has been an expansion of total sugar production from 369,000t in 1984 to 520,000t in 2008 as smallholder farmers have increasingly diversified away from food crops (Kenya Sugar Board 2011).

The government played a central role in the development of the sector. First, the government willingness to achieve self-sufficiency in sugar consumption was a major determinant in the establishment of the mills. Second, the schemes were initially developed as parastatals. In the Mumias Sugar

5. However, this finding does not hold in other case studies, such as the one in Senegal by Warning and Key (2002).

Company case, the state held 70 percent of the shares at the beginning of operations (Buch-Hansen and Markusen 1982). While the first two factories were organized in cooperatives, subsequent establishments, including Mumias, followed the "nucleus estate model," which include both a plantation estate (typically surrounding the mill) and an outgrowing scheme. The creation of the nucleus estate implied the eviction of thousands of farming households and was obviously a major source of concern for both politicians and processors.[6] The sector undertook substantial reforms in the nineties, with privatization of the government-owned mills (with the government often retaining majority shares).

How does the sugarcane contract-farming experience in Kenya, and particularly the Mumias one, fit into the broad questions described above? First, all of the aforementioned market failures appear to be relevant in the scheme under study. Formal credit markets and insurance markets are still severely underdeveloped (Dupas et al. 2016; Allen et al. 2016). The importance of monitoring, one of the major sources of labor market imperfections, is lower in sugarcane than in other crops since, for instance, there is no need for daily assessment of the harvesting potential of a given plot (Grosh 1994). Yet, residual-claimant outgrowers still have much stronger incentives in properly performing basic activities than hired workers in a plantation estate. Consistent with this statement, several reports show that yields in the outgrowing scheme are higher than in the nucleus. A report produced by the Kenya Sugar Board (2005) shows that the difference amounts to about 16 percent.

Sugar production processing also requires high coordination between harvesting, transporting, and processing. The contract-farming system relies on the steady supply of sugarcane, which leads to a staggering of the growing cycles across plots. Finally, transporting is relatively costly (high bulk/value ratio) and thus better suited to a large buyer who can exploit economies of scale in this task. To summarize, plantations relying on hired labor may not attain first best in the presence of monitoring costs. Yet, high fixed costs of factory processing and high transport costs imply that ex post spot markets with bargaining over the price of cane will not in general yield efficiency.

Second, while sugarcane does not present a high level of quality heterogeneity relative to other crops, it presents a high level of perishability (Sartorius, Kirsten, and Masuku 2003). Processing needs to occur shortly after harvesting as sugar content starts declining after the cane is cut. Finally, the contract-farming scheme allows the company to undertake soil tests to make an informed choice concerning some of the most "technically difficult" decisions, such as cane variety choice and fertilizer usage.

Third, when looking at the impact on smallholders' welfare, the develop-

6. For an early account of the nucleus estate establishment, see Holtham and Hazlewood (1976) and Barclay (1977).

ment of sugarcane contract farming is generally considered to have produced overall positive effects. The establishment of contract-farming schemes in the area represented a major turning point in the regional economy, leading to increased incomes, services, input usage, and nonagricultural employment (in the factory). In addition, taxation of sugarcane production is an important source of tax revenues (Ayako et al. 1989). With regard to the targeting of contracted farmers, the factory has tried to enforce both a floor on cane plot size and a minimum requirement concerning the amount of land devoted to subsistence crops. Yet, the gradual account splitting and the development of the practice of "joint farming" across years has in fact relaxed these constraints, thus potentially enabling very small holders to join. Buch-Hansen and Markusen (1982) already reported that a substantial share of smallholders already had too little land allocated to food crop production. In the presence of population growth, land scarcity, and partial inheritance, this share is likely to have increased over the last three decades. Finally, the persistence of monocropping, mentioned by Grosh (1994) as one of the potential factors reducing welfare in the long run, is likely to be one of the major sources in the decline in yields we discuss in the next section.

In the rest of the chapter, we use newly collected data to provide rigorous evidence on a subset of the questions discussed so far. This first requires that we provide some administrative detail on the functioning of the specific sugarcane contract-farming scheme we target for our analysis.

4.4 The Mumias Outgrowing Scheme: Background and Data Description

In the contract-farming scheme under study, the company and the contracting farmer sign a contract that typically spans for one replant cycle, made up of one planting and several ratoon harvests. Ratooning leaves the root and lower parts of the plant uncut at the time of harvesting. The main benefit of ratooning is that the crop matures earlier. However, the yield of the ratoon crop decreases after each cycle. The contract typically includes the initial planting harvest and two ratoon harvests, for a total of five to six years. Formally, the company decides whether to enter another ratoon cycle versus replanting, based on yields from the last harvest agronomic analysis. However, farmers' opinion, which can certainly differ from the company's best interests, can have an important role in shaping extensions to the original contract.

The duration of each harvest cycle spans between eighteen and twenty-four months, though early or late harvesting can occur following specific raw material demand from the mill. Planting and harvesting occur in a staggered fashion throughout most of the year, in order to provide a constant supply of cane to the processing mill. The length of the harvest cycle is a major difference from the other major crop in the area, maize, which is harvested twice a year. The difference in harvest durations is an important factor in shaping the farmer's decision to allocate land to one of the two crops.

Farmers are paid based on the tonnage of cane provided at harvest time. The cane prices are based on the current sugar price, via a formula that includes the conversion rate between cane and final sugar output and taxes on sugar production. The Kenya Sugar Board provides a recommended sugar price. Fluctuations in the international sugar prices affect this recommended price and the one the company uses. However, case studies and discussions with both company management and Kenya Sugar Board officials suggest that other factors affect sugar prices. For instance, politicians often advocate higher prices for farmers, especially around election times. In addition, the intensity of competition with other contract-farming schemes also impacts the company prices. As a result of the pricing formula, the company is expected to make a profit on each unit of cane purchased from the outgrowers. In turn, this shapes the company incentives to achieve higher output.

Cane prices are homogeneous for all the farmers that harvest at the same time. Price changes are typically announced a few weeks before their implementation. Timing of the changes are plausibly orthogonal to the characteristics of the farmers who are approaching harvest in that specific period. The relevant price for a given farmer is the one set at the harvest time, not the one in place at the beginning of the cycle. Thus, following the terminology used by Grosh (1994) the scheme sets formula price contracts, not fixed price ones.

The company provides several inputs on credit. These include land preparation (ploughing, harrowing) in the replant cycles, fertilizer (DAP and UREA), harvesting, and transport to the mill. The unit cost of transport per ton of cane varies according to discrete transport zones. The farmer's main duties include weeding (several times during the harvest cycle) and fertilizer application, both of which are important determinants of the final yield level and, particularly for the latter, would require costly monitoring if undertaken by hired workers. The company extension workers occasionally monitor the weeding activity of the farmers. If a farmer fails to weed, the company issues a warning and eventually hires an external contractor to perform the task, charging the cost of the inputs to the farmer's account. In 1996, the company outgrowing scheme spanned across sixty-six sublocations. The scheme included about 65,000 smallholder farmers. The administrative unit used by the company, and thus the unit used for our analysis, is the "account." At any point in time an account is held by one or more contracting farmers.

The contracting farmer recorded on a given account can vary over time. First, the changes can reflect transmission of plot management across members of the same household or inheritance episodes. Second, land rental markets are quite developed in the area. Following a formal rental agreement, the tenant can then replace the landlord on the contract.

Each account is typically matched to one (sub)parcel as defined by the Kenyan land registry. Different accounts can share the same parcel in cases where a parcel gets split into two parts, for instance, between two brothers or between a landlord and a tenant. In addition, accounts are aggregated into fields, sets of plots that are usually treated homogeneously for input provision, in order to exploit economies of scale.

The target population for the database included of all the accounts that had processed at least one payment between 1997 and mid-2006 in sixteen target sublocations. Administrative paper records had to be located in the company register, scanned, and entered. Among the target accounts, approximately 92 percent were located. About two-thirds of the attrition comes from three sublocations. The final sample is comprised of 14,516 accounts, close to a full census of the population of accounts in the target sublocations. In addition, we estimate that in about 5 percent of the cases a certain harvest document is missing from our database. This can occur if the form is missing from the account folder in the registry or if its quality makes it unfit for data entry (image deteriorated, blurred printing, waning ink).

The database is based on the forms the company records at each harvest. This includes information spanning between 1988 and mid-2006. The staggered fashion in which harvesting occurs implies that we have a continuous flow of observations across months and years. We have information on cane production tonnage and net amount paid to the farmer (which can also be negative). The data also include information on plot sizes registered by the account at each harvest. These can change from harvest to harvest, due to the outcome of the maize versus cane allocation choice or the subdivision of the plot across different household members.[7]

Using the information contained in our database, we attempt to provide evidence on two broad questions. First, we focus on participation in the scheme, looking at patterns of entry, exit, and cane plot sizes. Second, we study yields and value added. For each of these variables, we focus on: (a) the moments of their distribution, (b) their evolution over time, and (c) their observable determinants. Finally, we interpret these results on the basis of the conclusions of the literature we reviewed in previous sections.

4.5 Participation in the Scheme: Entry, Exit, and Plot Size

Over the time span of the sample, the Mumias outgrowing scheme grew substantially. Grosh (1994) reports that the scheme more than doubled, from 30,000 to about 65,000 accounts, between 1984 and the mid-1990s. Figure 4.1 shows the number of account-harvest observations in our database across harvest years, by plant cycle (i.e., plant vs. ratoon).

7. Plot sizes are typically approximated to one-tenth of a hectare.

Our database enables us to look at the patterns of entry and exit into the scheme in the target zones. As we discussed above, we target accounts that harvested at least once between 1997 and 2006. Yet, we have information on these accounts for the previous decade, too. First, this allows us to look at patterns of entry across years, conditional on surviving until 1997. More precisely, we define the "entry" year as the first harvest year in which a given account appears in the database. Obviously, a substantial share of accounts had been operating pre-1988. Thus, our entry variable spikes in the first couple of years of the sample. However, figure 4.2 shows that a substantial share of accounts appears for the first time in the database after 1990, suggesting real entry (or reentry) into the scheme, rather than merely first occurrence in the data. More specifically, we find that about 50 percent of the targeted accounts entered between 1991 and 2006 and about 26 percent entered after 1997.

The establishment of new accounts can arise either from the splitting of land from old accounts or from the entry of new land into the scheme. In order to partially address this difference, we look at the entry of land registry parcels (as opposed to accounts) into our database. We find that approximately 70 percent of land parcels entered the scheme by 1990, and 87 percent by 1997. When compared to the 50 percent entry of accounts post-1991, these figures suggest that splitting of cane plots across multiple accounts played an important role in the increase in the number of accounts, a fact that we further document below. Nevertheless, we still detect a general

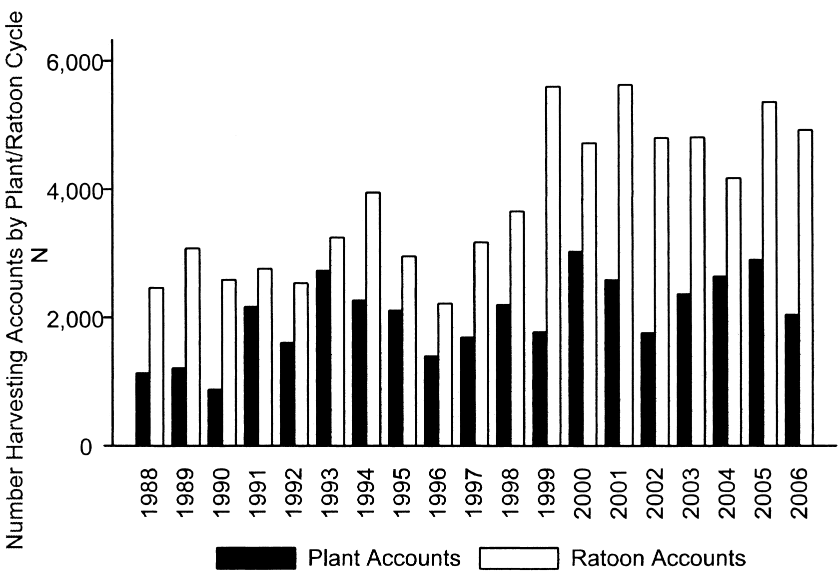

Fig. 4.1 Number of observations per harvest year by plant cycle

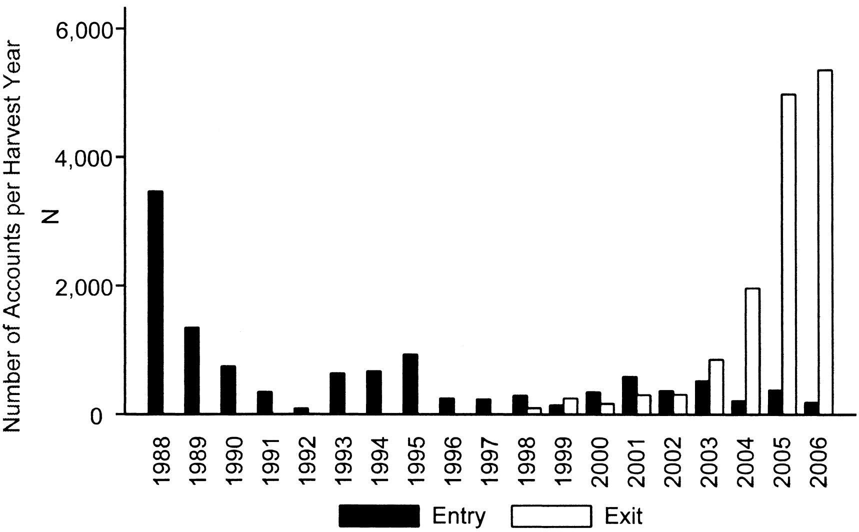

Fig. 4.2 Entry and exit by harvest year

positive trend in the amount of land harvested on a yearly basis in the targeted sublocations, although the increase is not constant across years (for instance, some years present substantial decreases relative to the previous one). Finally, it must be noted that, over the years, the company expanded its catchment area to locations farther away from the mill. However, our database is focused on zones that were already included in the scheme by 1988 and thus does not capture this pattern.

Given that we targeted accounts with at least one harvest between 1997 and 2006, we cannot observe patterns of exit before 1997, but can only look at exit after that. In figure 4.2, an account is defined as an "exit" in a given harvest year if we observe it for the last time in that year. This variable is highly clustered in the last three years of our sample. We find that 85 percent of the accounts appear lastly in 2004 or later, and 90 perent in 2003 or later. Thus, 10 percent of accounts are observed for the last time between 1997 and 2002, probably because of real exit from the scheme. For the remaining 90 percent, we cannot disentangle leaving the scheme from just final observation in the data. Assuming an equal likelihood of exit across years of the sample, we can estimate that about 16 percent of the accounts left the scheme between 1997 and 2006. Using administrative data for other sublocations in the scheme, for which we lack other variables we use in the subsequent analysis, we obtain very similar figures on the rate of exit, suggesting that the low exit rates in the above sample are not driven by the attrition described above.

Another important margin of adjustment is account plot size. Accounts could decrease their plot size to reallocate part of the plot to other crops. In

Fig. 4.3 Number of accounts per land registry parcel

addition, accounts could gradually be split across different family members. This could lead both to an increase in the number of accounts and to an increase in the prevalence of "joint accounts," accounts where two or more farmers cultivate the plot, often two separate subplots. Below, we provide evidence for both these patterns.

We have information about the specific (sub)parcel in the land registry a given account is located in. Partial inheritance, which implies that land is split across male heirs, is one of the factors potentially driving subdivision of one original account into multiple smaller accounts, thus leading to an increase in the number of accounts per land parcel. Figure 4.3 presents strong evidence of this pattern. The number of accounts per land registry parcel increases from 1.23 in 1988 to 1.48 in 2006, a 20 percent increase. The increase between 1988 and 1997, the first half of our sample time span, was 13 percent instead. Given the rates of population growth, this pattern is likely to continue. More and more plots will hit the floors the company sets for cane plot accounts. While this varies across years, company staff report the floor to be at 1 acre (0.4 ha). However, we find evidence that a growing share of plots falls below this figure. We provide more evidence on these patterns below.

In order to comply with the company-imposed guidelines on minimum cane plot size, another response to demographic pressure is having more than one farmer contracting over the same account. Throughout our sample, approximately 30 percent of the account/harvest observations include more than one contracting farmer. According to our discussions with the company extension staff, joint contracting instances can arise for several reasons. First, two members of the same family can decide to share a plot of land if its size is too small to enable contracting under two different accounts (throughout the span of the sample the company discouraged contracting of extremely small plots). Typically, in this case, each of the two (or more) farmers is in charge of a well-defined subplot. At harvest, the company is then able to track the amount of cane coming from each subplot in the revenue computation. Second, the presence of more than one contracted farmer can in other cases arise from standard renting or sharecropping arrangements, with the landowner renting out the plot (or a portion of it) but keeping her name on the contract.

In response to increased demographic pressure and partial inheritance, we expect the prevalence of joint accounts to rise across years. Figure 4.4 clearly shows that this is indeed the case. We observe a steady increase in the prevalence of joint plot contracting over the years of our sample, with a share of about 40 percent toward the end of the period. In more recent years, the company has discouraged the establishment of joint plots, which might explain part of the substantial increase in the number of accounts across the sample years.

So far, we have found basic evidence consistent with the hypothesis that demographic pressure, which increased over time, has led to account splitting and to an increase of the prevalence of joint plots. What is the trend in the other adjustment margin, the size of cane plots? Figure 4.5 provides

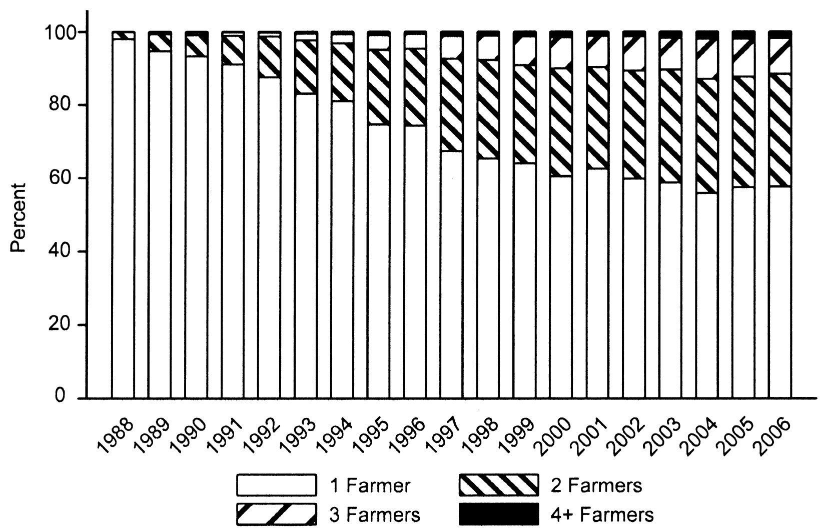

Fig. 4.4 Number of contracting farmers per account

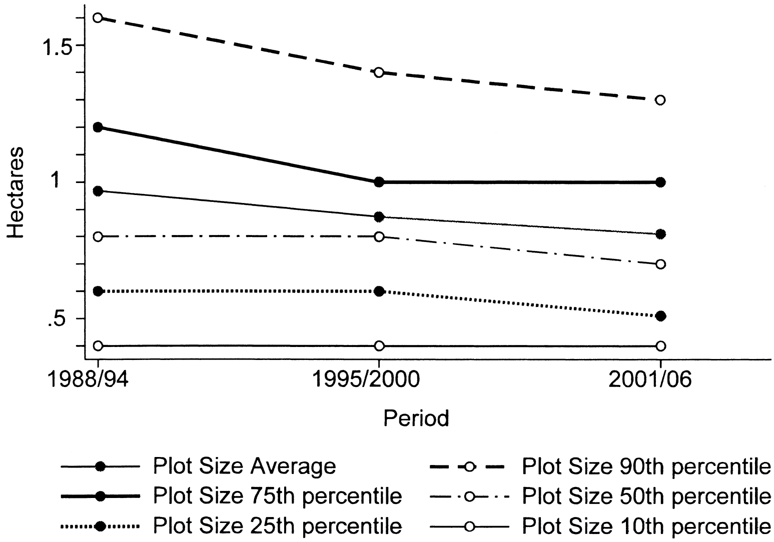

Fig. 4.5 Plot-size distribution

some evidence with regard to this question. The graph shows the 10th, 25th, 50th (median), 75th, and 90th percentile of the distribution, as well as the average, for three different periods: 1988/94, 1995/2000, and 2001/06. With the exception of the 10th percentile, which stays at the floor of 0.4 hectares throughout the sample period, all the other percentiles and the average plot size fall by 15 to 20 percent over the sample period. Consistent with the account-splitting findings, the highest percentiles experience the largest drops in absolute terms.

We then attempt to shed more light on the relation between initial plot size and subsequent plot-size growth rates. Large plots have more margin for adjustment. On the contrary, very small plots cannot further decrease their size without reaching the company-imposed limits on plot size. We focus on the growth rates (logarithmic difference) in plot sizes between two subsequent replant cycles and we correlate these with the plot size in the first of the two cycles. Figure 4.6 provides a kernel-weighted local polynomial smoothing of this relation, including also the 95 percent confidence intervals. There is strong evidence of a negative relationship between initial plot size and subsequent growth. One potential concern with the above results is the presence of transitory measurement error leading to mechanical regression to the mean (Romer 1989). In order to partially address these concerns, we first adapt the strategy adopted by Barro (1991) to deal with similar issues when looking at income per capita convergence across countries. Specifically, we run a linear regression of the growth in plot size between plant t and $t + 1$ on plot size in t instrumented with plot size in $t - 1$. This strategy

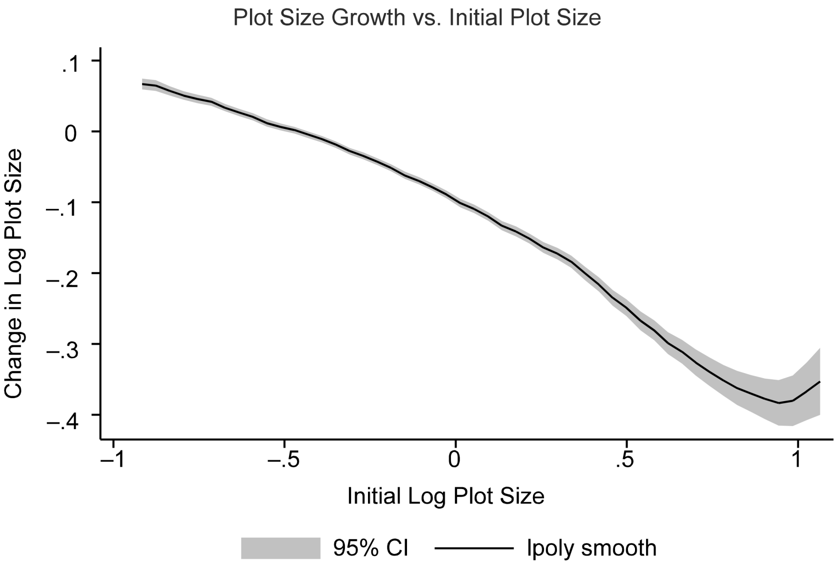

Fig. 4.6 Size last harvest/size first harvest versus size first harvest
Note: Kernel = epanechnikov, degree = 0, bandwidth = .16, and pwidth = .24.

deals with measurement error, as long as this is uncorrelated over time (on the other hand, if measurement error in plot sizes were strongly correlated across plant cycles, it would be less of a concern to start with). We find a coefficient of –0.021 (S. E.= 0.008). This estimate is comparable to the coefficient obtained in a simple ordinary least squares (OLS) regression (–0.024), suggesting that the above effect is not a regression artifact (the standard error in the OLS regression is about half of the IV one, because the sample size is larger).[8] In addition, we define a binary indicator that takes value one if the plot size fell by more than 30 percent between the first and the last observation for a given account. This discrete measure is likely to be less subject to measurement error than the continuous one since a large mismeasurement in the continuous variable is required to turn the value of the dummy to one. In addition, given that the measure is in relative terms, standard measurement error will mechanically lead to a higher number of "false positives" for initially small plots, thus pushing against a positive correlation between baseline plot size and nonzero values of the above binary indicator. Yet, we still find that the probability of such large cuts significantly grows with baseline plot size ($\beta = 0.25$, S. E. = 0.024).

We summarize the results of this section. First, we find that over the

8. We note that 90 percent of the plots of our sample have three or fewer plant cycles. As a consequence, we cannot apply more sophisticated GMM techniques that require longer lags.

observation period, there are low levels of exits. Second, we find substantial evidence of plot splitting, either via an increase in the number of accounts in a given land registry parcel or through an increased prevalence of joint contracts. Finally, we document a decreasing trend in plot size, concentrated primarily among plots with relatively large size initially.

4.6 Yields and Net Revenues: Trends and Determinants

In this section, we focus our attention on yields and net revenues per hectare. First, we describe the evolution of these indicators over time, focusing on different moments and quantiles of the distribution. Second we study to which extent differences in performance arise from systematic differences across accounts as opposed to transitory shocks. Finally, we look at the specific role of plot size in shaping yields and net revenues per hectare.

Figure 4.7 reports the trend in yields in the three "periods" previously defined for plant cycles (1988–1995, 1996–2000, 2001–2006). We find a clear negative trend. The average yield in the 2001–2006 period is about 75 percent of the average yield in 1988–1995. The decline is more pronounced in the lowest percentiles. For instance, the bottom decile of yields in the third period is 61 percent of the same decile in the first period. The reduction between the second and the last period is generally steeper than the one between the first and the second. We observe similar patterns when looking at ratoon yields (results not reported). Unsurprisingly, average yields are always higher in plant than in ratoon cycles.

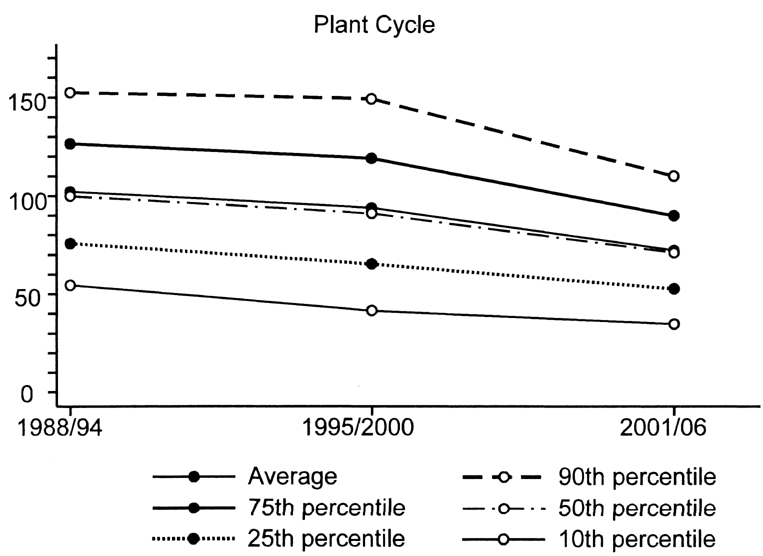

Fig. 4.7 Yields (tons/ha)

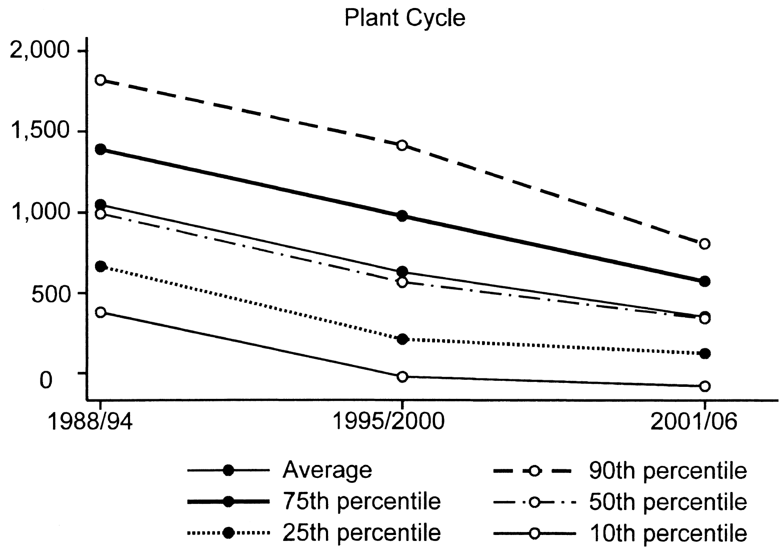

Fig. 4.8 Net revenues per hectare

The evidence of declining yields from our database is consistent with data reported in other sectoral publications (Kenya Sugar Board 2005), although the levels in our database are 10–15 percent lower than the aggregate levels reported there. Declining soil fertility and continuous sugarcane monoculture are often reported as primary causes of these trends. However, we do not have information on soil quality in our database. Thus, we cannot reach any conclusion of the role of soil fertility in shaping these patterns.

We also have data on net revenues realized at each harvest. This variable is defined as the difference between the payment the farmers receive from the company and the amount charged for company-provided inputs. We deflate monetary values using national GDP deflators from the World Bank World Development Index for the 1988–2006 period. We focus on net revenues per hectare. When looking at plant cycles, which include higher charges for company-provided inputs because of land preparation and seedcane distribution, we find evidence of a decline even starker than that of yields. Figure 4.8 summarizes the results. We find that the average of deflated net revenues in the last period is 34 percent of the value in the first period. The decline is steeper for lowest percentiles of the distribution. The 25th percentile falls by 81 percent between the first and the last period. The 75th percentile declines by 60 percent.

Figure 4.9 shows the trends for ratoon cycles. While still remarkable, the decline is less steep than the one in planting cycles. For instance, the average of deflated net revenues in the last period is 58 percent of the value in the first period. The change in net revenues can arise from three sources: a decline in

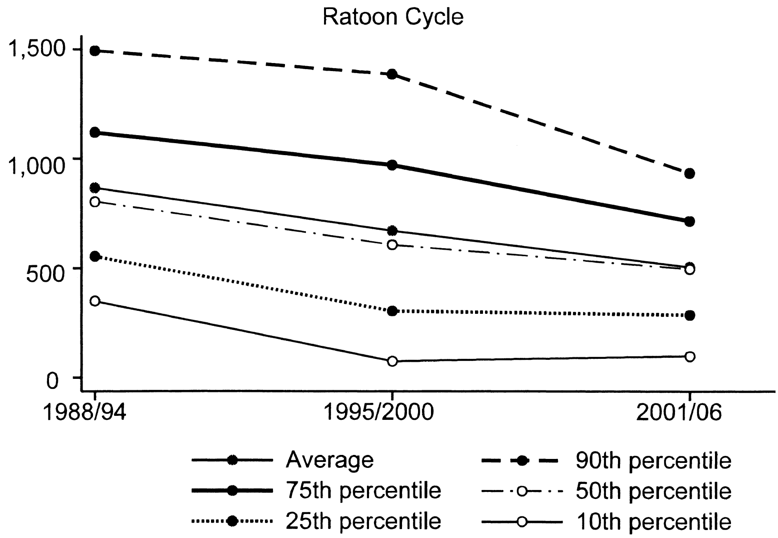

Fig. 4.9 Net revenues per hectare

tonnage per hectare, a decline in the ratio between cane revenues and input charges, and a decline in the price of cane in real terms. We documented the patterns in yields above. In addition, we find that the ratio between revenues and input charges decreases substantially for plant cycles (a decline of 25 percent on average) but is relatively stable for ratoon cycles (an average decline of 9 percent). Finally, the price of cane in real terms falls by 25 percent. However, it must be noted that the GDP deflator used to estimate this change does not necessarily capture the consumption bundle in the areas targeted by our study. This bias could potentially lead to an overestimation of the reduction in net revenues over time.

While the previous results show a clear declining pattern in yields and net revenues, another question concerns whether, over time, certain producers experience systematically higher returns from cane cultivation. To shed light on these issues, we exploit the panel structure of our data. We decompose the variance in yields into a "within" and a "between" component. The former is the portion of variance that captures the variability in the yields for a given account, possibly controlling for important determinants of production levels such as plant cycle. The latter captures systematic differences in the average levels of output per hectare across different accounts. The analysis provides several insights. First, the overall dispersion of the distribution of yields does not change systematically over time. The coefficient of variation takes values of 0.41, 0.49, and 0.45 in periods 1, 2, and 3, respectively. Second, using a basic fixed effect variance model, we find that permanent characteristics of the accounts over the sample period explain about 31.7 percent of the variance in logarithmic yields. The share rises to 43 percent once we include plant cycle and harvest year dummies in the model. In an alternative model, we allow a fixed effect for any account-period combination, thus capturing the portion of variance explained by fixed characteristics of an account in a given period (where the periods are again defined as 1988–1995, 1996–2000, and 2001–2006). We find that in this model, the between variance amounts to at least 45 percent of the total variance, with the fraction increasing to 61 percent if one includes other determinants of yields. Finally, we find that the between portion of the variance does not significantly change across periods.

These results point at an important role of permanent heterogeneity across accounts. Yet, our model cannot disentangle differences in land quality from differences in producers' ability and labor intensity. Lack of soil quality data prevents us from providing a definitive answer on this. Nevertheless, we use precise information on the geographical location of each account to make some progress in this direction. Specifically, we exploit the fact that, as we described above, accounts are grouped into "fields," macroplots containing on average eleven accounts across our sample. Accounts belonging to the same field receive similar land preparation and harvesting services from the company and, in a given harvest year, have comparable soil quality, rainfall exposure, and temperature. In order to assess the importance of permanent heterogeneity across producers in a given field, we residualize the raw yield data after taking into account the effect of plot size, plant cycle, and field-harvest year dummies. Permanent heterogeneity across accounts of a given field, as opposed to transitory shocks, still explains 32 percent of the variance in these residual yields. Even for a crop that is considered to have relatively low labor intensity and in a scheme where the buyer provides a substantial amount of inputs and supervision, we find that a substantial share of variance in yields is explained by unobserved time-invariant (or "period-invariant") characteristics across accounts. In addition, this does not seem to arise only from variation in soil quality, but rather points at the importance of permanent differences in productivity and labor intensity across producers.

Finally, we shed light on another potentially important determinant of productivity: plot size. The relation between plot size and output per hectare has spanned a huge literature covering a wide range of crops, countries, and time periods. While the literature still lacks a definitive answer (see Eastwood, Lipton, and Newell [2010] for a recent review), evidence of an inverse relationship has been found in many contexts. Here, we provide some basic evidence on the occurrence of the inverse relationship in our database. Figure 4.10 presents the results of a kernel-weighted local polynomial smoothing of log yields on log plot size. The graph shows that, throughout

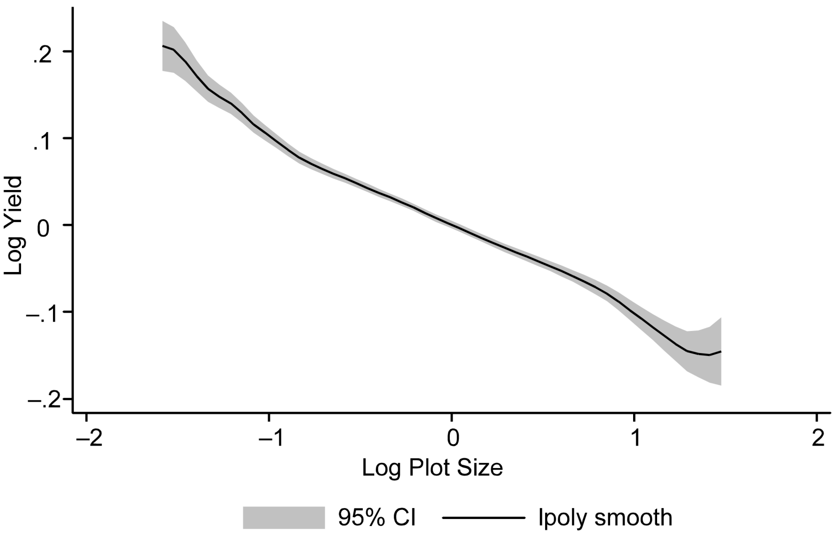

Fig. 4.10 Log yields versus plot size
Note: Variables demeaned by plant cycle * harvest year dummies.

the domain of observed plot sizes, there is a significant decreasing relation between plot size and plot yields.[9] Using parametric estimates, we find that an increase in 10 log points in plot size decreases yields by 2 to 5 log points. Casaburi, Kremer, and Mullainathan (2012) fully exploit the panel-data structure. The detailed information on the locations of the plots allows us to control for potential alternative explanations that might drive a spurious relation, such as unobserved heterogeneity in soil quality or contracting farmer characteristics. The above relation becomes even stronger when including those controls.

Figure 4.11 shows the results of a similar analysis focusing on net revenues per hectare. Given that this variable can take negative values, we choose to estimate a level-log model, rather than a log-log one. The graph shows a negative and significant relationship in this case, too. However, the magnitude of the relation is much weaker. In a simple linear level-log cross-sectional regression, we find that a 10 percent increase in plot size reduces net revenues per hectare by less than 1 percent of the mean value.[10]

The relation highlighted in figure 4.11 suggests that, for a given total amount of land allocated to cane in the company catchment area, the company profitability decreases with the average cane plot size. Two caveats

9. In figures 4.10 and 4.11 the variables are first demeaned by harvest year and plant cycle.
10. However, in Casaburi, Kremer, and Mullainathan (2012) we find that the magnitude of the coefficient rises significantly when including account fixed effects.

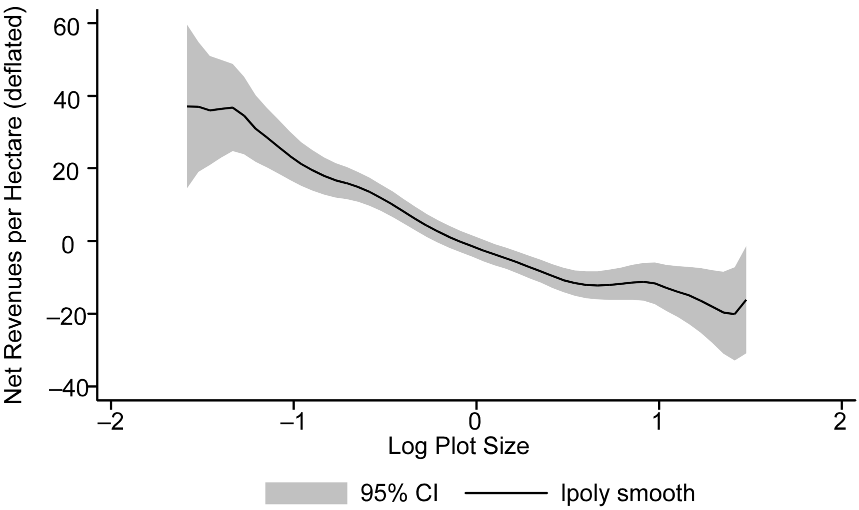

Fig. 4.11 Net revenues per hectare versus plot size

Note: Net revenues deflated by GDP deflator from World Bank World Development Indicators. Variables demeaned by plant cycle * harvest year dummies.

apply to this conclusion. First, transaction costs (for instance, the administrative cost of managing an account in terms of agricultural extension or payroll) could be higher for small plots. However, it is unlikely that administrative costs are large enough to offset the estimated yield differentials. Second, gradual subdivision of plots across family members might decrease total amount of land allocated to cane, for instance, if each subplot needs to allocate a minimum share to food-crop farming, and reduce profitability in the presence of economies of scale in the processing. We do not find evidence of these patterns in our data. The amount of land allocated to cane in a given land registry parcel is increasing in the number of active accounts that are matched to it. However, this result does not completely rule out the above concern as we cannot distinguish instances of splitting of an old account from entry into the scheme of new subparcels within the same parcel (i.e., cases where two or more producers were already sharing the land but only one was previously involved in cane).

4.7 Conclusion

The prevalence of contract-farming schemes in Africa has been growing over the last few decades. As a result, such schemes are attracting the interest of a growing number of scholars from different disciplines. Yet, there are few studies that use microdata to assess trends and productivity determinants in these contexts. In this chapter we have used administrative data for a large sample of Kenyan farmers over a two-decade time span in order to provide rigorous evidence on participation and productivity within one of the largest contract-farming schemes in East Africa.

After reviewing the scheme's origins and impact through the lens of the existing literature, our data analysis has highlighted several stylized facts. First, across our sample time span, there is a net entry of producers into the scheme. Second, average cane plot sizes decrease over time. Plot splits across family members seem to play an important role in this pattern. Third, yields and net revenues decrease over time. Fourth, unobserved producer-level characteristics explain a large share of the variance in yields. Fifth, yields are decreasing in plot size, consistent with the hypothesis that labor intensity is higher in small plots.

The latter finding provides important policy implications. While our database does not include labor data, evidence from fieldwork and interactions with the company extension staff suggests that the main hypothesis for the inverse relation is that labor intensity decreases with plot size. This is driven by monitoring costs, limited outside worker hiring, and a wedge between inside and outside workers. This provides strong empirical support to a key argument for contract farming. Outgrower schemes allow the processor to exploit key economies of scale in some of the production and processing tasks—for instance, by ensuring enforcement of farmers' obligations with regard to inputs provided on credit—but they also preserve existing property rights over the land. On the one hand, in the presence of monitoring costs and other labor market imperfections, a contractual form that preserves decentralized land holdings has key advantages over a plantation estate. On the other hand, the contract-farming arrangement prevents some of the failures that would likely arise in a fully decentralized market, such as underinvestment in inputs due to credit constraints or lack of commitment ability for a monopsonist buyer.

The experience of Kenyan sugarcane contract-farming schemes represents an important case study in the development of a formal market-oriented agricultural sector in sub-Saharan Africa. Analysis of new data for the coming years will contribute to shed light on how the sector responds to the increased challenges and opportunities arising from the economic integration that will follow the dismantling of sugar trade restrictions in Kenya in the coming years.

References

Allen, F., E. Carletti, R. Cull, J. Qian, L. Senbet, and P. Valenzuela. 2016. "Resolving the African Financial Development Gap: Cross-Country Comparisons and a Within-Country Study of Kenya." In *African Successes, Volume III: Moderniza-*

tion and Development, edited by S. Edwards, S. Johnson, and D. N. Weil, 13–62. Chicago: University of Chicago Press.

Ayako, A. B., D. M. Makanda, S. M. Mwabu, L. M. Awiti, and Okech-Owiti. 1989. "Contract Farming and Outgrower Schemes in Kenya: Case Studies." *Eastern Africa Economic Review* 5:4–14.

Barclay, A. H. 1977. "The Mumias Sugar Project: A Study of Rural Development in Western Kenya." PhD diss., Columbia University.

Barrett, C. B., M. E. Bachke, M. F. Bellemare, H. C. Michelson, S. Narayanan, and T. F. Walker. 2012. "Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries." *World Development* 4 (4): 715–30.

Barro, R. J. 1991. "Economic Growth in a Cross Section of Countries." *Quarterly Journal of Economics* 106 (2): 407–43.

Bijman, J. 2008. "Contract Farming in Developing Countries." Working Paper, Wageningen University.

Buch-Hansen, M., and H. S. Markusen. 1982. "Contract Farming and the Peasantry: Cases from Western Kenya." *Review of African Political Economy* 23:9–36.

Casaburi, L., M. Kremer, and S. Mullainathan. 2012. "Contract Farming, Rainfall Shocks, and Agricultural Dynamics in Western Kenya." Working paper, Harvard University.

Deb, R., and T. Suri. 2013. "Endogenous Emergence of Credit Markets: Contracting in Response to a New Technology in Ghana." *Journal of Development Economics* 101 (2013): 268–83.

Dupas, P., S. Green, A. Keats, and J. Robinson. 2016. "Challenges in Banking the Rural Poor: Evidence from Kenya's Western Province." In *African Successes, Volume III: Modernization and Development*, edited by S. Edwards, S. Johnson, and D. N. Weil, 63–101. Chicago: University of Chicago Press.

Eastwood, R., M. Lipton, and A. Newell. 2010. "Farm Size." *Handbook of Agricultural Economics* 4 (2010): 3323–97.

Eaton, C., and A. Shepherd. 2001. *Contract Farming: Partnerships for Growth*. Rome: Food and Agriculture Organization of the UN (FAO).

Glover, D. J. 1990. "Contract Farming and Outgrowers Schemes in East and Southern Africa." *Journal of Agricultural Economics* 41 (3): 303–15.

Grosh, M. 1994. "Contract Farming in Africa: An Application of the New Institutional Economics." *Journal of African Economies* 3 (2): 231–61.

Guo, H., R. W. Jolly, and J. Zhu. 2007. "Contract Farming in China: Perspectives of Farm Households and Agribusiness Firms." *Comparative Economic Studies* 49 (2): 285–312.

Holtham, G., and A. Hazlewood. 1976. *Aid and Inequality in Kenya: British Development Assistance to Kenya*. Kent, UK: Croom Helm.

Jaffee, S. M. 1987. "Case Studies of Contract Farming in the Horticultural Sector of Kenya." IDA Working Paper no. 83, Institute for Development Anthropology.

Kenya Sugar Board. 2005. *Year Book of Sugar Statistics*. http://www.kenyasugar.co.ke/new/.

———. 2011. *Kenya Sugar Industry Strategic Plan, 2010–2014*. http://www.kenyasugar.co.ke/new/.

Little, P. D. 1994. "Contract Farming and the Development Question." In *Living under Contract: Contract Farming and Agrarian Transformation in Sub-Saharan Africa*, edited by P. D. Little and M. J. Watts, 216–47 Madison: University of Wisconsin Press.

Little, P. D., and M. J. Watts, eds. 1994. *Living under Contract: Contract Farming and Agrarian Transformation in Sub-Saharan Africa*. Madison: University of Wisconsin Press.

Minot, N. 2007. "Contract Farming in Developing Countries: Patterns, Impact, and Policy Implications." In *Food Policy for Developing Countries: Case Studies*, edited by Per Pintstrup-Andersen and Fuzhi Cheng. Ithica, NY: Cornell University. http://cip.cornell.edu/DPubS?verb=Display&version=1.0&service=UI&handle=dns.gfs/1200428173&page=record.

Porter, G., and K. Phillips-Howard. 1997. "Comparing Contracts: An Evaluation of Contract Farming Schemes in Africa." *World Development* 25 (2): 227–38.

Romer, P. M. 1989. "Human Capital and Growth: Theory and Evidence." NBER Working Paper no. 3173, Cambridge, MA.

Sartorius, K., J. Kirsten, and M. Masuku. 2003. "A New Institutional Economic Analysis of Small Farmer Contracts and Relations in the Sugar Supply Chains in South Africa and Swaziland." Department of Agricultural Economics, University of Pretoria.

Singh, S. 2002. "Contracting Out Solutions: Political Economy of Contract Farming in the Indian Punjab." *World Development* 30 (9): 1621–38.

Warning, M., and N. Key. 2002. "The Social Performance and Distributional Consequences of Contract Farming: An Equilibrium Analysis of the Arachide de Bouche Program in Senegal." *World Development* 30 (2): 255–63.