Growing Export-Oriented Crops in Kenya: An Evaluation of DrumNet Services

Nava Ashraf
Harvard Business School

Xavier Giné
The World Bank

Dean Karlan
Yale University and
Innovations for Poverty Action

March 2006

Abstract

This paper evaluates a program in Kenya that encourages the production of export-oriented crops by providing smallholder farmers with credit linked to agricultural extension and marketing services. We use an experimental design in which farmer self-help groups are randomly assigned to either a control group, a group receiving all DrumNet services, or a group receiving all services except credit. We find among the services offered by DrumNet, credit is the most important. Since the production of export crops requires a significant investment in capital and inputs, without credit farmers are less likely to plant the suggested crops. Overall, the results show that DrumNet is an effective model for encouraging the production of export-oriented crops.

We wish to thank Jonathan Campaigne, Vince Groh and Zack Lenawamuro for their patience and encouragement throughout this research. We also would like to thank IDS for the data collection efforts and IDRC for making it possible. All errors are our own.

1. Introduction

Kenya's horticultural sector[1] has received a great deal of attention over the past decade (Jaffee 1994, 1995, Dolan et al., 2001 Minot and Ngigi, 2002, Muendo and Tschirley, 2004) due to the rapid and sustained growth of its exports to Europe. This impressive growth has undoubtedly contributed to increased rural incomes and reduced rural poverty. Yet despite this growth, exports remain a small fraction of Kenya's overall horticultural sector. For the past decade, over 90 percent of all fruit and vegetable production was consumed domestically, and the domestic market accounted for over 95 percent of the total growth in quantity of fruit and vegetable production. While over 90 percent of smallholder farmers in all but the arid regions of Kenya produce horticultural products, fewer than 2 percent do so directly for export (Bawden et al., 2002).

The few Kenyan smallholders who have succeeded in producing for the export market face a new set of challenges since January 2005 under the EUREPGAP requirements. These requirements are driven by increasing consumer demand for quality and food safety in the UK and continental Europe, and by an increased emphasis on the traceability of horticultural production. Exporters want to be able to trace production back to the specific farm from which it came in order to ensure quality and safe production and handling procedures. Evidence that it has become increasingly difficult for smallholders to maintain their participation in the export sector can be seen in the steady decline in the share of exports by smallholders, from about 75 percent in the early 1990s to less than 50 percent by 2004 (Minot and Ngigi 2002, Jaffee 1995, Muendo and Tschirley, 2004).

More generally, the lack of information flows among producers, financial institutions, and marketers of agricultural produce is a major hurdle for economic development. The lack of means of transportation among smallholders and poor road infrastructure are two factors that prevent markets from functioning properly (Axinn, 1988; Freeman and Silim,

[1] Horticulture sector is defined here to include fruit and vegetable production and marketing, but not flowers

2002). Banks and MFIs have experimented with crop financing and farm input loans and have experienced poor repayment rates, and high transaction costs. Exporters have ventured into smallholder group extension activity and out-grower credit schemes to ensure reliable supplies of produce for their business with mixed results. Rural, mostly independent, small-scale agro-supply vendors often sell their seeds and agro-chemicals on credit to increase farmer demand, but in the process they reduce their ability to maintain stocks. Finally, smallholder self-help groups and cooperatives – powerful organizations for information sharing and produce aggregation – have proven to be unreliable vehicles for basic financial services such as credit provision, payment distribution, or savings mobilization.

DrumNet tries to overcome the lack of information flows by directly linking commercial banks, smallholder farmers, and retail providers of farm inputs through a cashless micro-credit program that encourages the production of export-oriented crops. Its model tries to overcome the constraints to technology adoption that farmers typically face (Feder et al., 1985; Evenson and Westphal, 1995). Understanding the nature of these constraints and their relative importance is crucial to providing sound policy advice. In Kenya, for example, improved maize seeds have been available for a long time and yet few farmers use them. What are these barriers to technology adoption? Recent work on agricultural technology adoption has focused on information flows and social learning (Conley and Udry, 2003; Foster and Rosenzweig, 1995; Munshi, 2003; Bandiera and Rasul, 2003). They show that farmers learn how to cultivate a new crop from past choices of others in their social network. However, as Conley and Udry (2003) emphasize, even if information flows were unimportant, individuals may still behave like their peers as a result of interdependent preferences and technologies, or because they are subject to related unobservable shocks.

Indeed, the measurement of the impact of agricultural services and adoption of new crops is plagued with problems because of the many factors (observed and unobserved) that determine farm productivity and farmer's choices. Researchers have resorted to fairly sophisticated econometric and quasi-experimental methods to deal with selectivity biases

and methodological issues. In the area of agricultural extension, although there seems to be agreement about the positive contribution of extension programs, there is some debate on the magnitude of these effects. As Birkhaeuser, Evenson and Feder (1991) and Evenson (1997) document, some of the early studies found large impacts but very few studies did a systematic comparison of costs and benefits with and without a project. Where extension programs have been more carefully evaluated by comparing outcomes in similar contiguous regions, the results have been nuanced[2]. To date, a systematic social experiment in similar areas with and without a given extension project has not been carried out.

The literature review on agricultural services by Anderson and Feder (2003) and technology adoption by Conley and Udry (2003) stress that data quality along with methodological issues are still important qualifiers to the prevailing evidence in favor of high returns from extension or adoption. They then conclude that more evaluative work is needed to better assist policymakers.

In this paper we use an experimental design to evaluate DrumNet. Farmer self-help groups are randomly assigned to either a control group, a group receiving all DrumNet services, or a group receiving all services except credit.

DrumNet has an effective model for encouraging the production of export-oriented crops. More and more farmers are planting these crops, invest more in inputs and as a result are seeing higher net margins and higher gross prices for their produce. In addition, clients seem satisfied with the institution. When we compare members that were offered credit to those that were not, we find that credit is effective in improving yield per acre, but this improvement does not translate into differences in income gains.

The next section provides some background information regarding the DrumNet program, Section 3 describes the design, methodology of the evaluation and the data.

[2] See the work by Feder and Slade (Feder and Slade, 1986; Feder, Lau and Slade, 1987).

Section 4 describes the decision to participate in DrumNet. Section 5 analyzes the impact of DrumNet and finally, Section 6 concludes.

2. Background

DrumNet is a cashless micro-credit program that links commercial banks, smallholder farmers, and retail providers of farm inputs. While encouraging production of export-oriented crops, DrumNet ensures that farmers meet the safety standards. DrumNet members, organized into co-guaranteed solidarity groups, are able to access required farm inputs (seeds, fertilizers, pesticides, etc) at local participating stockists through an established line of credit using their DrumNet transaction card. The stockists, trained in basic DrumNet record keeping, submit receipts to DrumNet and are paid in two-week cycles from a credit account maintained by DrumNet. At harvest time, DrumNet deducts principal and interest payments from farmer net returns, tracks credit history and enforces group guarantees, if required.

In addition to micro-credit services, the DrumNet platform links large-scale buyers, farmers, transporters, and field agents through an integrated marketing and payment system. Before farmers plant crops, DrumNet negotiates contractual arrangements between buyers and farmers, and at harvest time coordinates produce aggregation, grading, and transportation through agreements with local field agents and transporters. Immediately following a successful transaction, data is entered into DrumNet systems, and a set of bank account transfers are triggered to pay the participating farmers, agents, and (if necessary) transporters. Market data and transaction details are made available to participating farmers. Later, generally at monthly intervals, funds from the buyer are transferred into DrumNet accounts to complete the transaction.

The integration of these two processes is the real value of DrumNet. Figure 1 shows the workings of DrumNet. Farmers are able to access both credit and markets through their interactions with DrumNet, paying off loans with their farm produce proceeds. Large-scale buyers are freed from the requirement of managing cumbersome transaction-

intensive credit programs to ensure reliable supplies of produce. Instead they write a single check to DrumNet every month. Stockists can access new customers without the requirement of selling products on short-term credit. Banks are able to tap into a currently inaccessible market for savings and credit while avoiding high transaction costs. In addition, by providing credit to farmers in the context of negotiated contracts for specific crops with large-scale buyers, participating banks are more confident that loans will not default due to poor crop selection or inability to source appropriate markets on the part of the farmer.

From an institutional standpoint, DrumNet works closely with the district government. The Ministry of Agriculture organizes farmers into self help groups (SHG) in the Kirinyaga district through the program SIDA-NALEP. Government extension agents set up Field Farmer's Schools that provide technical assistance in certain crops chosen by the members of the newly created SHG. This method consists of a demonstration plot which is visited several times a month over the course of the cropping season. The SIDA-NALEP program, however, does not provide credit in the form of inputs nor marketing contacts. In this sense, the government work and DrumNet can be seen as complementary.

While DrumNet focuses on all crops of farmers they have identified, they particularly encourage farmers to grow passion fruit, French beans and baby corn, three very profitable export crops. With DrumNet's assistance, smallholder farmers grow and harvest produce that meets the EUREPGAP requirements. In practice, EUREPGAP entails using only pre-approved pesticides and building a shelter with running water and a toilet in its vicinity. The cashless line of credit that farmers have with the stockist only uses inputs certified by EUREPGAP. The shed, to be used to store the produce overnight, should have a door, cemented floor, tin roof and timber or meshed wire walls. The toilet and water tank are to be used for hygiene purposes. DrumNet is actively working with SHGs ensuring that collection points are equipped with this infrastructure as many smallholders without the proper infrastructure will be forced to sell their produce to the local markets, obtaining a lower price.

Because of these new regulations, fresh horticultural produce exporters in Kenya are generally finding it difficult to meet their quotas, and are eager to encourage new growers/producers such as DrumNet's member farmers.

A farmer that wants to be a member of DrumNet has to satisfy the following requirements: (i) be a member of a registered SHG with the Department of Social Services, (ii) express an interest, through the SHG, in growing crops marketed by DrumNet, namely French beans, baby corn or passion fruit, (iii) have irrigated land where to plant DrumNet's produce and (iv) be able to meet the first Transaction Insurance Fund (TIF) commitment (roughly USD 10 or the equivalent of a week's laborer wages).

Members of a SHG that will work with DrumNet first receive a 4-week orientation course in which the DrumNet model is explained. Farmers learn about the need to employ good agricultural practices on their farms to ensure the quality and safety of their produce that will meet EUREGAP requirements, they open a personal savings account with a local commercial bank (Equity Building Society) and they make the first cash contribution to the Transaction Insurance Fund (TIF), that will serve as collateral for their initial line of credit. They also decide on the TIF percentage that DrumNet will automatically deduct from each future marketing transaction. By contributing to the TIF, a farmer gets a loan of up to four times that amount to purchase inputs (seeds and fertilizer) with a local stockist.[3] The initial TIF amount depends on the specific crop the farmer wants to grow and the area under cultivation. For example, growing passion fruit in one quarter of an acre requires an investment of Ksh 5,000 (USD 67) but does not bear fruits for 6 months. The initial TIF for passion fruit is thus Ksh 1,250. French beans and baby corn only require an investment of Ksh 3,000 per one quarter of an acre and

[3] DrumNet has established a partnership with one agro-supply vendor in Kerugoya to supply farmers with program inputs. Thanks to DrumNet, the retailer can reduce the informal credit to his customers, thereby reducing his risk and increasing his ability to keep his shop fully stocked. The retailer also makes sure to stock the inputs for the crops that exporters are requesting. In fact, sometimes the exporters themselves will supply any special seeds or fertilizer to the retailer directly. The retailer also adds value added by re-packaging the seeds or supplies in smaller quantities and by chemically treating seeds before packaging.

harvesting can happen after 3 months only for a period of 3 weeks. In Kirinyaga, both French beans and baby corn can be grown and harvested all year around.

To ensure repayment, DrumNet organizes farmers into FETs (Farmer Enterprise Teams) of 5 members each. Members of a FET are jointly liable for the loans taken out. With the guidance of DrumNet staff, farmers develop a schedule of planting and harvest collection. When harvest time comes, DrumNet negotiates with the exporter a price and will arrange for the produce pick-up at pre-specified collection points. Usually, there is a collection point for every 4 or 5 SHGs. In each collection point, a transaction agent is appointed among the members to serve as liaison between DrumNet and the farmers.[4] At these collection points, farmers grade their produce and package it, although the exporter has the final word on the grading.

Once the produce is delivered to the exporter at the collection points, the exporter pays DrumNet who in turn will deduct any loan repayment, pre-specified TIF percentage and will credit the rest to individual bank accounts that each farmer opened when they registered.[5]

3. Data and Design of Evaluation

The evaluation was integrated into DrumNet's expansion to Gichugu division, also in the Kirinyaga district. We chose Gichugu for two main reasons. First, its agro-climatic

[4] Transaction agents are responsible for coordinating activities within farmer groups. The number of these agents has expanded from approximately 10 in early 2004 to 35 in January 2005. One member of each new farmer group is nominated as the transaction agent, receives additional training, and serves as the main point of contact for DrumNet, facilitating the market transactions. These farmers communicate frequently with the DrumNet staff, both in person in the office and via mobile phones. They have become an important conduit of information about pickup schedules, market prices, approved field practices, and shifting grading standards.

[5] In the beginning, the relationship between DrumNet and export buyers suffered from wholesale rejection of produce, missed pickup agreements, poor communications, poor contractual arrangements, and in some cases outright corruption at the loading dock. However, over the months, by working consistently with the management of the export buyers, and by building trusted relationships with local traders, the flow of produce, payment, and information has now been streamlined. The increased capacity of the buyers has led to more coordination, more efficiency, and higher returns for both the buyer and the farmer.

conditions are similar to the ones DrumNet was already operating in, ensuring that new clients would roughly be equal to current clients. Second, the clustering of participants in a logistically manageable area facilitated operations.

DrumNet reached potential clients by contacting registered self-help groups (SHGs). During our visit to Kirinyaga district in mid-December 2003, we compiled a list of all horticulture SHGs in Gichugu that had registered since 2000. We had in total 96 registered SHGs comprising approximately 3,000 farmers. This data was collected from the official records in the Kirinyaga District offices and thus included inactive or disbanded groups. We therefore administered a "filtering" survey to the leaders of registered SHGs from our master list. The primary goal of this survey was to find out the status and basic group characteristics in order to identify 20-40 SHG whose combined number of members reached our target of 750 individuals (20-40 members in a group) and meet the criteria set by DrumNet.

Figure 2 presents a map of Gichugu with the location of the treatment and control SHGs. As evidenced by the map, both treatment and control groups are randomly scattered throughout the area.[6] In the upper right corner there is a map of Kenya with the location of Gichugu division in black. Gichugu (Kirinyaga District) is located in the Central Province, south of Mount Kenya. It is characterized by fertile soils and favourable climate. A recent collapse in the price of coffee—one of two main cash crops—fostered a switch towards horticulture.

Once the filtering survey has been completed and entered, we randomly assigned the SHGs into three experimental groups of 250 participants each: 1) control, 2) all DN services, and 3) DN services except credit. This allocation of SHGs into groups was done in such a way that the three groups looked ex-ante alike along several key variables, such as number of members in 2004, SHG age since creation, access to paved road, percentage of members that were already growing export-oriented crops, etc.

[6] Since the area is rather small, potential contamination of the control group is a concern. However, in the follow-up interview less than 15 percent of members in control SHGs had heard about DrumNet.

Table 1.A reports the characteristics of the SHGs involved in the evaluation, separated into those that were offered all DrumNet services including credit (Credit), those that were offered DrumNet services excluding credit (No Credit) and control SHGs (Control). The last two columns report the differences between each treatment group and the controls, along with the significance levels. Although credit SHGs fare a bit worse than control SHGs in terms of infrastructure and remoteness and non-credit SHGs seem to have less social activities as compared to control SHGs, overall the three experimental groups seem rather homogeneous.

In addition to the filter SHG survey, a baseline of 750 farmers from the selected 36 SHGs was conducted in May 2004. At the time of the baseline survey, none of the 36 SHGs had any contact with DrumNet.[7] Table 1.B reports the average characteristics of these SHG members in credit SHGs, no-credit SHGs and control SHGs.

The typical farmer in Gichugu is the household head of a family of 5 members, from the Kikuyu tribe (predominant in the Central Province) and Christian (55 percent are Protestants and the rest are Catholic). Most households live in a wooden home although 27 percent of reported living in mud-walled homes as well. In the survey, only 2 percent of farmers had access to electricity, with 86 percent relying on kerosene lamps for lighting and 11 percent having installed solar panels for lighting and power. Water was available nearby for 62 percent of respondents (29 percent inside the house), while 38 percent are accessing water from distant rivers and streams.

About half of the household income of these farmers came from farm activities, while the rest came from employment (both formal and informal), remittances, or government support. The farmers reported a median income of Ksh 15,000 annually from the sale of

[7] Once the randomization and baseline were completed, the list of SHGs in groups 2 and 3 (the treatment SHGs) was forwarded to the DrumNet operations team in Kerugoya for direct marketing, recruiting, membership, and service provision. This marked the official start of the experiment and that began in June 2004.

crops, and the median of total household income from all sources (including sale of crops) was Ksh 33,000 annually.

Most farmers own the land they cultivate. Landholdings tend to be small as 81 percent of the farmers surveyed operate farms less than three acres in size, while 63 percent operate farms less than two acres. The median farm size was one acre. On these plots, farmers were growing local subsistence crops — such as beans, maize, potatoes, and kale — 51 percent of the time, and were growing cash crops such as coffee, bananas, or tomatoes 34 percent of the time. Interestingly a full 12 percent of the farmers were already growing French beans before contacting DrumNet.

Farm operations are low-tech and so is farm investment as most farmers reported using only manual human labor, with only less than 5 percent utilizing animal labor or machinery to boost productivity. This is not surprising given the small size of the farms. As well, three quarters of those surveyed rely solely on family labor, not requiring hired labor to plant or harvest crops. When asked about the use of agro-chemicals, two-thirds reported either not using fertilizers at all or only using manure to boost yields. And, only 48 percent of farmers in the survey are using pesticides of any kind to improve farm productivity.

Regarding the marketing of their produce, nearly all of the respondents indicated that they use the traditional networks of brokers, resellers, and other intermediaries. A small portion of farmers marketed produce directly to consumers locally, and none of the farmers reported marketing their produce in regional market centers or directly to large-scale end-buyers.[8] Only 6 percent of the farmers reported access to motorized transport (public transport, car, or truck) for hauling their produce; nearly all are forced to transport by foot, bicycle, or animal-drawn cart. Most farmers exercise little choice in which intermediaries they work with – three-quarters reported having relationships with three or fewer brokers and a full 45 percent reported working exclusively with a single broker.

[8] The prime exception was coffee, which in this region is almost exclusively marketed through cooperatives.

Most produce transactions are cash-on-delivery, and most occur at the farm gate. Although these traditional arrangements are convenient for the farmer, they erode any advantages of price comparison, competition among traders, and informed decision making, generally placing the farmer at a disadvantage in the value chain.[9]

The results from the baseline underscore key assumptions within the DrumNet model – there are large opportunities for farmers in this region to boost the productivity of their farms through more informed choices about crop mix, farming techniques, and access to markets.

When comparing among the three groups, we are interested in examining whether the means of these different groups are statistically different from each other. Since the groups were randomly allocated between treatment and controls, we should not expect sizeable differences, but if they exist, they could influence the results. For example, if relatively richer people tend to be in control groups, then we may wrongly infer that DrumNet did not have much impact because control groups could have larger yields (obtained thanks to their larger wealth).

All in all, the three experimental groups look fairly similar. If anything, members in the control group seem to fare better than members in either treatment group. They tend to use more mechanized/animal force than either of the treatment groups and also have higher total income and higher harvest yield per acre than members in the no-credit group. We would thus expect our estimate of impact to be conservative.

The baseline survey also focused on how farmers accessed information related to the business operation of their farms. An overwhelming number of farmers reported that face-to-face conversations with local government extension agents and friends were the primary mode of information transfer. Another 12 percent reported using radio primarily and only 3 percent relied on the newspaper material as their first information source.

[9] Contract farming is not common for little landowners. Only 18 percent of farmers reported having any type of contract for their crops. Export buyers and brokers that engage in contact farming for larger landowners believe that it is too costly to enforce contracts with smaller landholders.

Finally, less than 1 percent used the phone, either fixed line or mobile, as a major means of information access.

Table 2 shows the percentage of households that either own or use mobile phones and their familiarity with SMS technology. Although 26 percent of farmers own a mobile phone, another 37 percent report a desire to acquire one. In 2004, a total of 30 percent used a mobile phone at least once a month. Interestingly, while in 2003 it was mostly used for social purposes, as a tool for staying in touch with family and friends, as Table 3 shows, in 2004 the trend has reversed as households are twice as likely to use mobile phones for business purposes than for personal use.[10] Roughly half of the business calls are placed to inquire about prices. In addition, about a quarter of calls are made to schedule pick-ups with the broker. Interestingly, while members in the control group call more often to inquire about prices than the treatment group, the latter uses relatively more calls to make arrangements with brokers. This suggests that while treatment groups rely on DrumNet for obtaining good prices, they still need to call the DrumNet staff for logistics.

Although SMS has taken off in urban areas, farmers in rural areas largely view the phone as a voice communication device. Indeed, only 16 percent of respondents know how to send an SMS and only 9 percent do so for business purposes (against less than 15 percent for personal purposes). There are several reasons for the lag in SMS adoption. First, SMS is more complicated than simply placing a call (even if the cost is much lower). Second, the lower-end phones typically owned by farmers have very small displays and less functional user interfaces, making SMS (and other advanced features) more difficult to take advantage of. Third, many farmers are illiterate and would be challenged to write or read an SMS message, regardless of the language. In every rural community in Kenya there are "community phones", landlines for hire, at the cost of Ksh 20 per minute. Table 3 indicates that landlines were on average less used than the mobile phones, probably due to the fact that mobile phones are far more convenient.

[10] In Kirinyaga, the typical family is scattered, with husbands often working in Nairobi, children attending school or working jobs in other parts of the country.

All in all, however, mobile phone usage is still low in rural areas, and the main reason is its cost. Besides the phone itself and the connectivity kit, recharging the phone is costly as very few households have access to electricity. The most popular plan is a pre-paid, dual-rate plan charging Ksh 32 during business hours and Ksh 10 during off-peak periods, generally after 8pm. Under this plan, text messages are available at Ksh 5 each. To put these numbers into context, the official poverty line in Kenya is Ksh 1,239 per individual per month, which roughly equals one hour of air time. Table 3 shows that the 30 percent of SHG members that do use the mobile phone, respond somewhat to prices by using it relatively more during off-peak hours. On average, however, they talk a total of 30 minutes a month.

Respondents were asked about their willingness to pay in order to avoid a trip to the main town, Kerugoya.[11] Table 2 shows that while the average direct cost of going to Kerugoya by matatu (mini-van) is reported to be Ksh 118 (excluding the opportunity cost of time), they declared an average of Ksh 70.[12] At current rates, this amounts to roughly 2 minutes of phone time during office hours, about 40 percent of the time involved in an average business mobile phone conversation.

The DrumNet office in Kerugoya does engage in mobile phone communication with those Transaction Agents who own mobile phones. Through phone calls or SMSs, these TAs learn about market prices, collection days, and grading standards and communicate them to farmers during their normal interactions in their farm communities. As discussed in Section 2, these TA's are paid 3 percent of the groups' earnings and are responsible for coordinating pick-ups with DrumNet, and in some cases bringing records of farmer's produce sales to the office and collecting labels to mark the product. Some of these transaction agents reported having to visit or call the DrumNet office multiple times a week to make any special arrangements. Often these visits are combined with other

[11] The actual wording of the question was: "Suppose that you want to check the balance in your bank account and that this could be resolved with a phone call. How much would you be willing to pay to avoid going to town?"

[12] Since roughly half of trips to Kerugoya are solely for business reasons, these numbers imply that they would be willing to pay a little more than the direct cost of traveling for business purposes only.

errands in Kerugoya, but occasionally they make trips to Kerugoya exclusively to come to DrumNet.

Otherwise, farmers have to rely on informal networks, but they are based on rumor and often times the information is provided by the brokers themselves, who have no interest in revealing the true price prevailing in the local or district market. Besides interactions with TAs, DrumNet also provides accurate, real-time pricing data through a whiteboard installed at the entrance of the office in Kerugoya. Originally intended as a reference tool for the staff, this whiteboard has become a central meeting place for farmers. Table 4 reports that farmers in the credit group visit the office twice a month, nearly once a month more than members of the no-credit group. This results in an average of about 25 farmers per day visiting the DrumNet office to check on prices paid by exporters or local markets, transportation charges, rejection rates, and net prices.[13] For DrumNet, this is an opportunity to address concerns of farmers, distribute other materials, or encourage the participation of farmers in other crop programs. As well, this whiteboard has played a role in trust-building with farmers, as it ensures complete transparency with DrumNet transactions. In addition, most DrumNet farmers access specific account details from the computers in the Kerugoya office, especially the status of payments. Assisted by a DrumNet staff member, the database application can provide figures such as the net proceeds earned from a particular transaction, the total savings balance for a farmer, a price history on a particular crop, or the amount of produce credited to a farmer on a particular day.

4. Participation in DrumNet

We turn our attention to the issue of take-up of DrumNet. We use the sample of 437 treatment SHG members (216 from credit SHGs and 221 from no-credit SHGs). While almost 40 percent of the members from credit groups joined DrumNet, only 20 percent did so when credit was not included as a DrumNet service. If we look at SHGs rather

[13] These personal visits to the DrumNet office are not, half of the times, special trips to the office, but simply part of regular trips to Kerugoya town for banking, shopping, or other reasons.

than members, 10 out of 12 SHGs in the credit group are now actively working with DrumNet, but only 5 out of 12 signed up from the treatment group without credit. Since SHGs were allocated randomly in the different treatment groups, one can conclude that credit is important in encouraging farmers to start growing new crops and that the decision to join DrumNet has to be analyzed separately for those that could access credit and those that could not.

The individual characteristics that we use to predict take-up are the following. First we use farmer's personal characteristics, such as their age, level of literacy[14], household size, whether they were SHG officers when DrumNet was introduced to the SHG, length as a SHG member and total income per household member. We also control for whether the household has any deposit in a formal bank and if any member of the household participated in a Merry-Go-Round[15]. Finally, we use land characteristics and production patterns such as percentage of irrigated land, total land holdings per household member, whether the household grows export-oriented crops, whether the household uses hired labor and machinery/animal force, the harvest yield per acre and whether the household sells in the market.

In addition, for each SHG member we compute four "network variables".[16] These are simply the number of SHG members who also participate in DrumNet and relate to the particular SHG member as follows: (i) being a relative, (ii) having been asked for advice by the SHG member, (iii) having lent money to the SHG member. In addition, we construct the number of officers in each SHG that participated in DrumNet. These variables are included to capture the possible network effects that were alluded to in the introduction. For example, SHG members may not be convinced that signing up with

[14] Since education attainment is highly correlated with literacy (0.53) we only use literacy.

[15] A merry-go-round or ROSCA is a voluntary grouping of individuals who agree to contribute financially at given dates towards the pot, which will then be allotted to each member of the group in turn in accordance with some prearranged principle.

[16] As part of the baseline and follow-up surveys, we collected a complete social mapping in each SHG. Each member was asked several questions regarding other SHG members. The surveyor had a SHG roster of all members and was instructed to record the ID of all members reported by the member in a given question. These questions included: "Which SHG members are you related to by blood? What is the relationship to you?", "Which SHG members did you ask for advice in farming during the last six months?" and "Which SHG members have you borrowed from in the last 5 years?"

DrumNet is a good idea, but the fact that most of the SHG officers are doing so may lend credibility to DrumNet and so the member may feel compelled to sign up too.

Finally we include three measures of popularity constructed from three different social mapping questions from the baseline. The measure of popularity used is known as "in-degrees" and is widely used in the social network literature.[17]

Table 5 shows the regression results of DrumNet participation. Under "All" we use all SHG in the treatment group, irrespective of whether they were offered credit or not. Under "Credit" we only use SHG's in the treatment group that were offered credit. Among the individual characteristics, it seems that literacy, household size, and being a SHG officer contribute significantly to the probability of participating in DrumNet. Length as a SHG member is positive and significant only when considering the credit treatment group but negative and significant when considering the no-credit group. Thus, those in the credit group that have been a member for a longer time are more likely to join DrumNet than their relatively newer peers, but the opposite happens in the no-credit group. Participation in a merry-go-round and having a deposit in a bank do not influence significantly the decision to take part in DrumNet. In the no-credit group, however, having a deposit has the expected sign. Since cash is required to make the upfront TIF payment, the larger the savings, the easier it is to come up with the funds to participate.

Moving to the land characteristics and production patters we find a somewhat surprising result. In three of the four specifications, members in the credit group who have a relatively high harvest yield per acre are less likely to participate in DrumNet. This can be explained by the fact that those farmers with high yields are satisfied with what they grow and do not want to try out the varieties offered by DrumNet. Less surprisingly, households with larger landholdings per member are more likely to join DrumNet, and in three of the four specifications, a larger percentage of irrigated land contributes too. However, farmers who sell directly to the market, use hired labor and machines or animal

[17] The in-degrees measure the tendency to be "named" by others. As an example, member X's in-degrees for the question "ask for advice" would simply be the number members in the SHG that asked member X for advice.

traction, are less likely to join DrumNet. The reason may be that they have less to benefit from joining because they are already successful at producing and marketing their crops. Finally, households belonging to the no-credit group are more likely to join DrumNet if they are already growing export crops, possibly suggesting that if credit is not offered, farmers need certainty of the returns to the crops before deciding to cultivate them. So far, DrumNet participants seem entrepreneurial; they are willing to try other crop varieties but they face input purchasing and marketing constraints.

We now explore how members are influenced by their peers or network. There exists a non-linear, decreasing returns-to-scale relationship between the likelihood of members joining DrumNet and the number of their relatives who are already part of the network—the probability of joining increases with the number of relatives at a decreasing rate. However, the type of network differs between the no credit and credit groups: the relevant network for the no-credit group is who they obtain information from while for the credit group what matters is who they borrow money from. Finally, members that do not have a responsibility in the SHG are more likely to participate the more officers participate. Therefore, the buy-in from focal members may be important to spur participation. These results indicate that members are positively influenced by the actions and decisions of their peers.

The last set of regressors examine whether member popularity in the SHG is a trait that affects the probability of signing up with DrumNet. We find that for the credit group, those members that are more frequently asked for advice are also more likely to sign up. Interestingly, those members from whom other members tend to borrow are less likely to participate, while members that tend to borrow from other members are more likely to participate. If we assume that members from whom other members tend to borrow are wealthier (as they have the means to lend money) this result can be interpreted to indicate that DrumNet is most appealing to poorer farmers, who are more likely to borrow.

This evidence complements the findings of the analysis with individual characteristics only. It seems that it is not the wealthier farmers or those that use the most efficient

techniques the ones that sign up for DrumNet. Indeed, it is those members that face severe constraints and that see DrumNet as their hope to mitigating some of them.

5. Impact of Drumnet

Since commencement in October 2003, DrumNet has facilitated over 7,000 marketing transactions on behalf of the now currently 647 member farmers participating in the study and has provided credit to 485 individual farmers of the value of Ksh 1.3M (US$16,705), generating gross revenue of Ksh 2,231,250 (US$ 27,890). [18,19] In total, this represents over 75 metric tons of produce moved between smallholder farms and advantageous markets.[20] Initially, DrumNet focused on passion fruit, a profitable but challenging crop sold both in export and local markets. The favorable climate and small farms in Kirinyaga favors this fruit crop, and DrumNet farmers have seen strong results. Beginning in 2004, the DrumNet team began to also support the production of two other crops in high demand with Kenyan exporters, French beans and baby corn. These crops have additional advantages over passion fruit — they are less capital intensive, simpler to grow, and have shorter growing periods leading to faster economic returns.

Because of these advantages, very few SHG members that participated in DrumNet decided to grow passion fruit. Instead, they focused on French beans and baby corn. Table 6 reports the average number of transactions and the total amount earned per member. It is clear that members in the credit treatment group have transacted more with DrumNet, earning larger incomes. One cannot conclude *a priori* that the no-credit group is producing less of these crops, because they could be selling the produce to local traders rather than DrumNet. However, because the prices offered by DrumNet are competitive,

[18] Recall that these credit funds were not disbursed directly to member farmers as cash, but were used to reimburse local agro-supply vendors that had distributed seeds and fertilizers to our farmers.
[19] Two thirds of the farmers surveyed who obtained credit had loan sizes of over Ksh 10,000, while DrumNet's initial loan is between Ksh 3,000 and Ksh 5,000.
[20] Besides the sale of produce to exporters directly, depending on the price DrumNet sells to the Nairobi's central Wakulima market, Nairobi's Export Processing Zone near Jomo Kenyatta International Airport, and Karatina's central produce market.

one can assume that the production is indeed lower for members of the no-credit group. This fact provides further evidence that DrumNet customers may be credit constrained.

DrumNet's policy with credit is that a new loan is availed only when the previous one has been fully repaid. Despite the fact that horticulture can be planted and harvested all year round in Gichugu, this policy de facto means that the frequency of planting and harvesting is lower than if credit were given continuously at planting time, every two weeks. Figure 3 plots the percentage of all registered members that transact with DrumNet on a given week. Under the current scheme, Figure 3 shows that farmers are idle for some weeks and may look for other seeds and inputs, of lower quality and yield, usually from local traders. Figure 3 suggests that credit was given in July-September and in January after the first credit had been repaid. Instead, credit should have been phased out so that a steady flow of harvesting and planting is achieved. The end result for DrumNet is that the full potential of its clients is not exploited and that brokers may reap the benefits from having trained these farmers although they have not invested in them at all.

A direct way to measure DrumNet's impact is to ask client's about their satisfaction and the perceived changes in their behavior as a result of DrumNet. The follow-up survey of June 2005 devoted a whole section to these questions, and Table 7 reports the results. Before we turn to changes in behavior, it is interesting how relatively more people in the no-credit group had to borrow to afford the membership fee or TIF.

In terms of changes in behavior, most people report increases in the inputs used, land cultivated, both self and family farm work as well as in savings. Of these variables, only inputs and own farm work seem to increase significantly more for the credit than for the no-credit group.[21] Interestingly, the no-credit group reports increases in own and family labor supplied off-farm. Finally, the credit group seems to be able to borrow more from formal sources as compared to the no-credit group. This may be explained by the fact that

[21] Notice that the question is only asked to treatment farmers and refers to changes in behaviour in 2005 relative to 2004, before the introduction of DrumNet.

15 percent of the no-credit group members are already borrowing to afford the TIF. Table 7 also reports the overall level of satisfaction with DrumNet. This measure is constructed by adding the responses to several questions and then classifying respondents into one of three categories: Dissatisfied, Neutral or Satisfied.[22] Although the vast majority of clients seem satisfied with DrumNet, there is more dissatisfaction among members of the credit group. This apparent dissatisfaction can be attributed to fairly long delays in depositing the value of sales into their bank account.

All in all, by opening a personal savings account with a local bank, DrumNet has also had an impact through the provision of several micro-finance services. Those DrumNet members without a savings account in a formal institution can now save and start building a financial history. In addition, thanks to the TIF contributions, the members not only build up their stock of savings but also are able to access larger loans. At this point, DrumNet is holding a total of just over Ksh 400,000 in member contributions. Interestingly, about 65 percent of these contributions have come from the automatic deductions taken from marketing transactions, as opposed to cash contributions made when members register. In other words, the program seems to have broken through the traditional problem of collecting cash contributions from members to guarantee credit — in essence, the farmers are guaranteeing future credit through passive, deferred payments on produce marketing.

While Table 7 reported perceptions about their changes in behavior, Tables 8 and 9 show the actual changes in behavior comparing the outcomes of all members in treatment SHGs to those of all members in control SHGs. To be clear, we are taking an average of both participants and non-participants in treatment groups compared to everyone in the control group. In Table 8 both treatment groups (credit and no credit) are taken as one, while in Table 9 they are separated to explore the differential effect of offering credit. In both tables, Panel A looks at production outcomes and Panel B reports impact or well-

[22] The specific questions used to measure satisfaction concerned the usefulness of the orientation and extension services, punctuality, prices, whether repayments were made on time, availability of credit and helpfulness of the DrumNet staff.

being outcomes. For each outcome variable we run two specifications. The first column without controls and the second with some baseline controls reported in the tables.

The variable "Post" captures the difference between 2005, the follow-up year, and 2004, the baseline year. A negative sign indicates that on average, 2005 was a worse year than 2004. In Table 8, the "Treatment" coefficient would capture initial differences between the treatment group and the control group. Analogously in Table 9, the "Credit" and "No Credit" coefficients capture, in turn, initial differences relative to the control group. For example, the negative and significant coefficient for No Credit in the first column of Table 9.A suggests that members of the no-credit group were initially less likely to group export crops relative to members in the control group.

The key variable to determine whether DrumNet has had an impact is "Post x Treatment" in Table 8 and "Post x Credit" and "Post x No Credit" in Table 9. When both treatment groups are taken together, we find a significant increase in the percentage of members in the treatment group that grow export-oriented crops. In addition, these members tend to use relatively more mechanical or animal draft power. The rest of production outcomes do not appear significant in Table 8. But this increase in export crops is responsible for the increase in income and yield per acre that we see in the fist four columns of Table 8.B. It is likely that this increased income was used to make improvements in the house, since this variable also increased significantly as a result of DrumNet. Finally, DrumNet's policy discussed earlier of creating a savings account with a formal institution also shows in Table 8.B.

Table 9 reports the same outcome variables but differentiating the impacts to credit and no-credit treatment groups. In terms of production outcomes, the credit SHGs seem to have increased the production of exports crops more dramatically. There are, however no statistically significant differences between both treatment groups. This can be seen in the bottom rows in each panel where the P-value of an equal coefficient test in year 2004 and

year 2005 is performed.[23] In addition, when controls are used it seems that the credit group uses more pesticides than the control group, and without control, it is also the credit group that uses more mechanical and animal draft force. To sum up the changes in production patterns, it seems that it was the credit group which switched more heavily towards export crops, used more pesticides and also used more mechanical and animal traction. There are however no significant differences in the impact of DrumNet on credit versus no-credit groups.

Turning to impact variables, we find surprisingly that it is the no-credit group that has significantly improved relative to the control. Although there are no statistical differences between the credit and no-credit group, only the no-credit group is statistically different from the control group. It turns out that on average, 2005 was a worse year compared to 2004, as evidenced by the negative coefficient on "Post". In addition, the negative and significant coefficient for "No Credit" suggests that members of the no-credit group initially had lower incomes than those in the control group. Therefore, although 2005 was overall a worse year than 2004, treatment members benefited from DrumNet and experienced improvements in their total income. In the case of yield per acre, we find that it is the credit group that experienced the highest increase in yield, possibly a consequence of using better inputs as Panel A shows. Notice that in this case there is a significant difference between credit and no credit at the 10 percent confidence level. In other words, the yield per acre for the credit group is significantly higher than that of the no-credit group, which in turn is indistinguishable from that of the control group.

The finding that the treatment group that was not offered credit may fare equally well in terms of income is somewhat puzzling and deserves further investigation. One possibility is that the crop prices that members in the no-credit group receive are actually higher than those of the credit group. Although DrumNet negotiates prices with exporters in an attempt to beat intermediaries, members of the no-credit group can in principle sell to whoever offers the best price, while members of the credit group are forced to sell to

[23] If DrumNet affected both treatment groups differently, then we would reject the hypothesis that the coefficients "Post x Credit" and "Post x No Credit" are equal. Since the P-value is 0.13, we cannot reject the hypothesis that they are equal at the 5 or 10 percent level (although we would at the 15 percent).

DrumNet in order to repay the loan. To explore the possibility of different prices, Table 8 reports the results of a price regression with the same regressors as Table 8 and 9. One can therefore decompose differences in prices before and after DrumNet and by treatment and control groups. There are two specifications, one when we use the average price using all the transactions conducted by the SHG member, regardless of the buyer, and another that only includes transactions at the farm gate. In the first specification, where all crops are included, we find that there are no significant differences between both treatment groups, although the no-credit group receives significantly larger prices at farm gate than the control. In the crop-by-crop analysis, we find that except for French beans, the no-credit group gets higher prices than the control group, but these differences are not significant. In the case of the French beans, it is interesting to note that there is a significant difference between the average price received by members in the credit group and the average price received in the no-credit group. Since we documented earlier that credit group members transact more with DrumNet, this result suggests that DrumNet is effective at securing higher prices to French bean growers, and that no-credit group members possibly do not sell their production to DrumNet or miss pick-up appointments, in which case they are then forced to sell the perishable produce to the first trader that comes along.

6. Conclusions

The results of the evaluation show that DrumNet is an effective model for encouraging the production of export-oriented crops. More and more farmers are planting these crops, invest more in inputs and as a result are seeing higher net margins and higher gross prices for their produce. In addition, clients seem satisfied with the institution. When we compare members that were offered credit to those that were not, we find that credit is effective in improving yield per acre, but this improvement does not translate into differential income gains.

A key to profit and long-term sustainability of DrumNet is the volume of farmers, volume of farm produce, and a successful portfolio of credit products. The main challenge in the implementation and expansion is the need to establish a close

relationship with farmers through transaction agents while minimizing costs. This relationship with TAs should accomplish two objectives. First, the produce is sold to DrumNet. If pick-up appointments are missed, farmers are forced to sell their produce elsewhere, with the resulting loss in revenue to DrumNet, as less transactions take place and to the farmers as the perceived price will be lower. A way to improve this relationship would be to provide TAs with mobile phones to ease in communications with the office. If airtime costs are still high, TAs could be trained in SMS technology to lower these costs. Second, enough credit should be extended to farmers to ensure a year-round production. If a new loan is only available when the previous credit is repaid, the frequency of planting and thus of harvesting will be lower than if credit was given at planting every two weeks. Innovative ways for credit delivery should be explored, in particular those focusing on enforcing repayment during harvest.

References

Anderson, J and Feder, G. (2003) "Rural Extension Services", World Bank Policy Research Paper 2970, World Bank, Washington, DC.

Axinn, G. (1988), *Guide on Alternative Extension Approaches*, FAO, Rome.

Bandiera, O and I. Rasul (2003), "Complementarities, Social Networks and Technology Adoption in Mozambique", mimeo LSE.

Bawden, R., P. A. Sterns, S. Harris and J Berdegue (2002). Increasing Rural Household Incomes in Kenya Through Horticulture. A Design Proposal. A Report Prepared for USAID Kenya.

Birkhaeuser, D., Evenson, R.E. and Feder, G. (1991), "The Economic Impact of Agricultural Extension: A Review", *Economic Development and Cultural Change* 39(3), 607-50.

Conley, T. and C. Udry (2003), "Learning about a New Technology: Pineapple in Ghana" mimeo Yale University.

Dolan, C., and J.Humphrey (2001). "Governance and Trade in Fresh vegetables. The Impact of UK Supermarkets on the African Horticultural Industry." In Globalization and Trade: *Implications for Exports from Marginalized Economies*, edited by O. Morrissey and I. Filatotchev. London:Frank Cass, 2001.

Evenson, R. (1997), "The Economic Contributions of Agricultural Extension to Agricultural and Rural Development", In B. Swanson, R. Bentz and A. Sofranko (eds.), *Improving Agricultural Extension: A Reference Manual*. FAO, Rome, pp. 27-36.

Evenson, R. and L. Westphal (1994) "Technological Change and Technological Strategy", in T.N. Srinivasan and J. Behrman (eds.) *Handbook of Development Economics* Vol. 3, New York: North Holland.

Feder, G., R. Just and D. Zilberman (1985) "Adoptions of Agricultural Innovations in Developing Countries: A Survey", *Economic Development and Cultural Change* 33:255-298.

Feder, G., Lau, L.J. and Slade, R.H. (1987), "Does Agricultural Extension Pay: The Training and Visit System in Northwest India", *American Journal of Agricultural Economics* 69(3), 677-86.

Feder, G. and Slade, R.H. (1986), "Methodological Issues in the Evaluation of Extension", In G.E. Jones (ed.), *Investing in Rural Extension: Strategies and Goals*, Elsevier Applied Science, London, pp. 255-66.

Foster and Rosenzweig (1995) "Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture", *Journal of Political Economy* 103: 1176:1209.

Freeman, H. and S. Silim (2002) "Commercialization of smallholder irrigation: The case of horticultural crops in semi-arid areas of eastern Kenya" in *Private Irrigation in sub-Saharan Africa*, edited by Sally, H. and C. Abernethy. Colombo, Sri Lanka: International Groh, V. (2004) "DrumNet Project: Technical Report to IDRC", mimeo.

Jaffee, S. (1994). "Contract Farming in the Shadow of Competitive Markets: The Experience of Kenyan Horticulture." In Little , P. and M. Watts. *Living Under Contract: Contract Farming and Agrarian Transformation in Sub-Saharan Africa*. University of Wisconsin Press. Madison, Wisconsin.

Jaffee, S. (1995). "The Many Faces of Success: The Development of Kenyan Horticultural Exports." In Jaffee, S and J. Morton (eds) *Marketing Africa's High Value Foods*. The World Bank . Washington, D.C.

Kenya, GoK, (2004). Kirinyaga District Development Plan, 2002-2008. Government Pinter. Nairobi.

Kenya, GoK, (2003). Central Province Annual Report 2003. Provincial Director of Agriculture. Nyeri, Kenya.

Minot, N. and M. Ngigi, (2002). “Horticulture Development in Kenya and Ivory Coast”. A Paper Prepared for the IFRI Workshop on “Successes in African Agriculture”, Lusaka, June 10th –12th, 2002.

Munshi, K. (2003) “Social Learning in a Heterogeneous Population: Social Learning in the Indian Green Revolution”, forthcoming *Journal of Development Economics*.

Rivera, W (1991) “Agricultural Extension Worldwide: A Critical Turning Point”, in Rivera, W and Gustafson, D. (eds.) Agricultural Extension: Worldwide Institutional Evolution and Forces for Change. London: Elsevier.

Water Management Institute, Food and Agriculture Organization of the United Nations and ACP-EU Technical Center for Agriculture and Rural Cooperation.

Figure 1. Value Chain of DrumNet Services

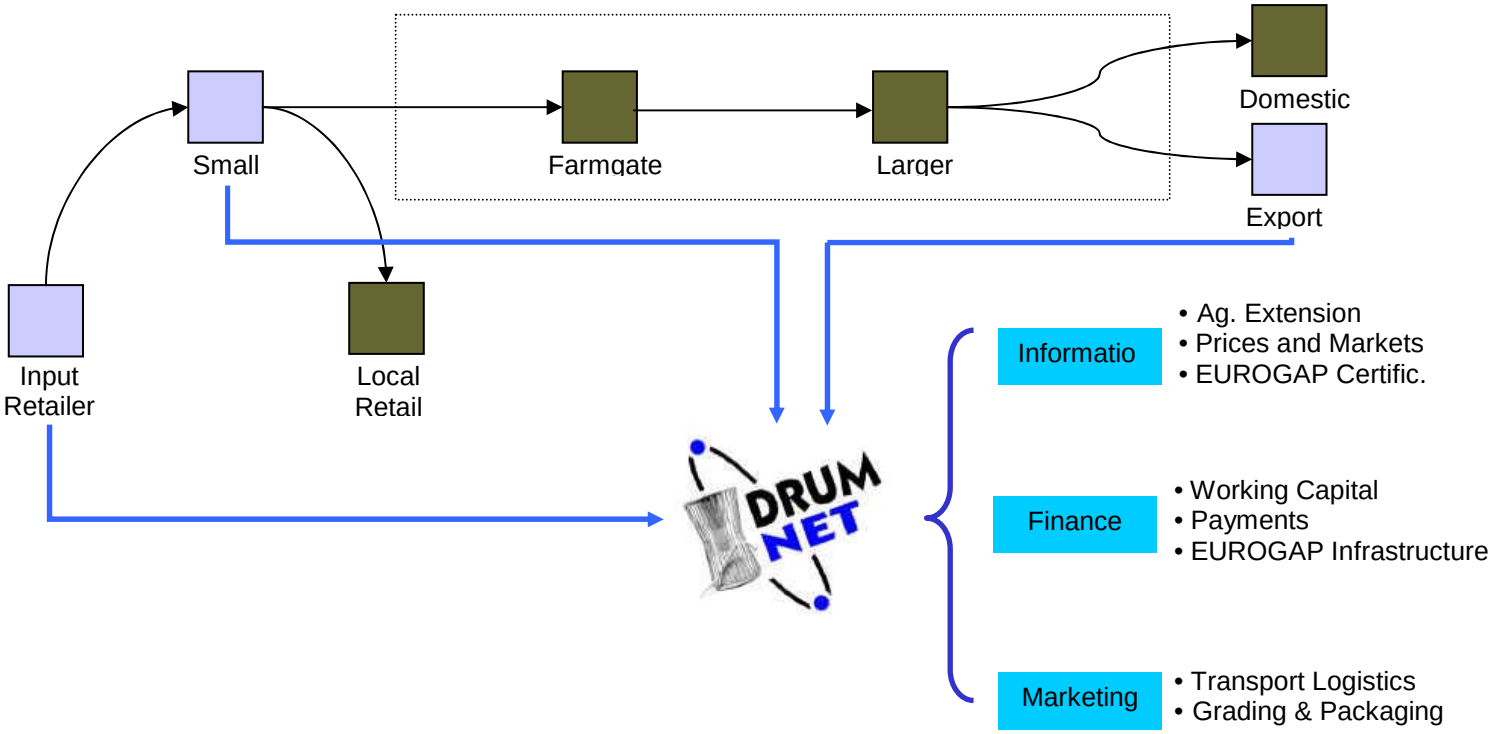

Figure 2: Location of SHGs in Gichugu Division: Treatment (black), Control (white).

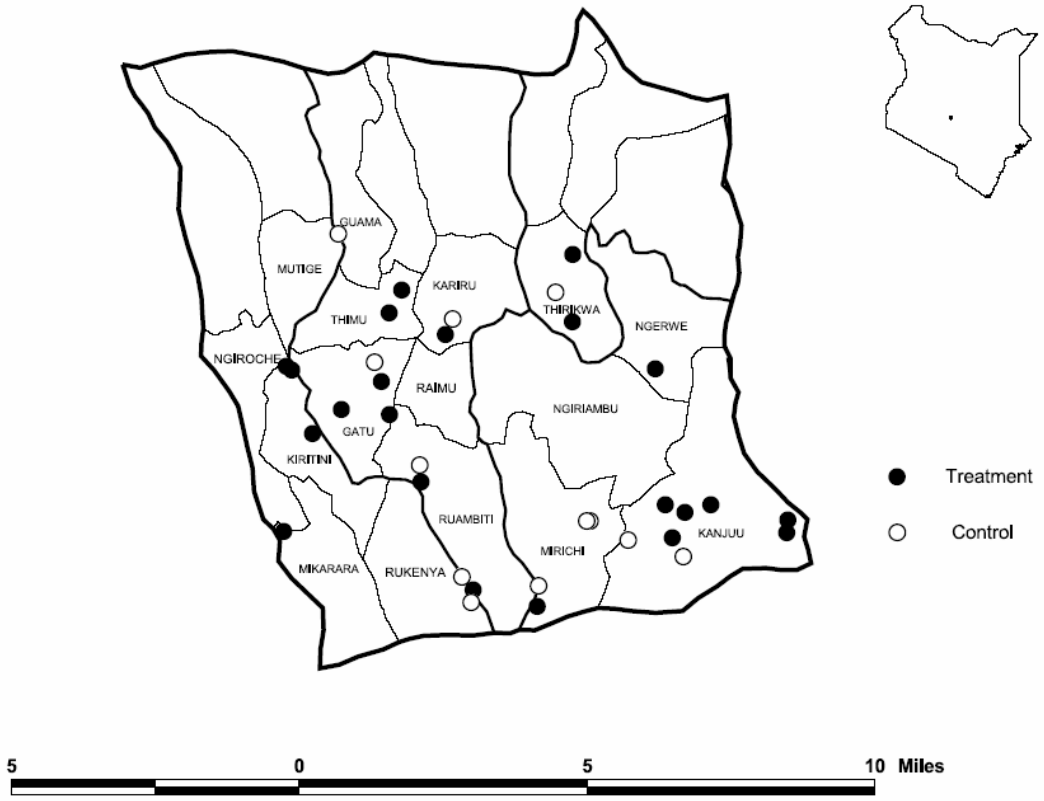

Figure 3. Percentage of DN Members Transacting over time

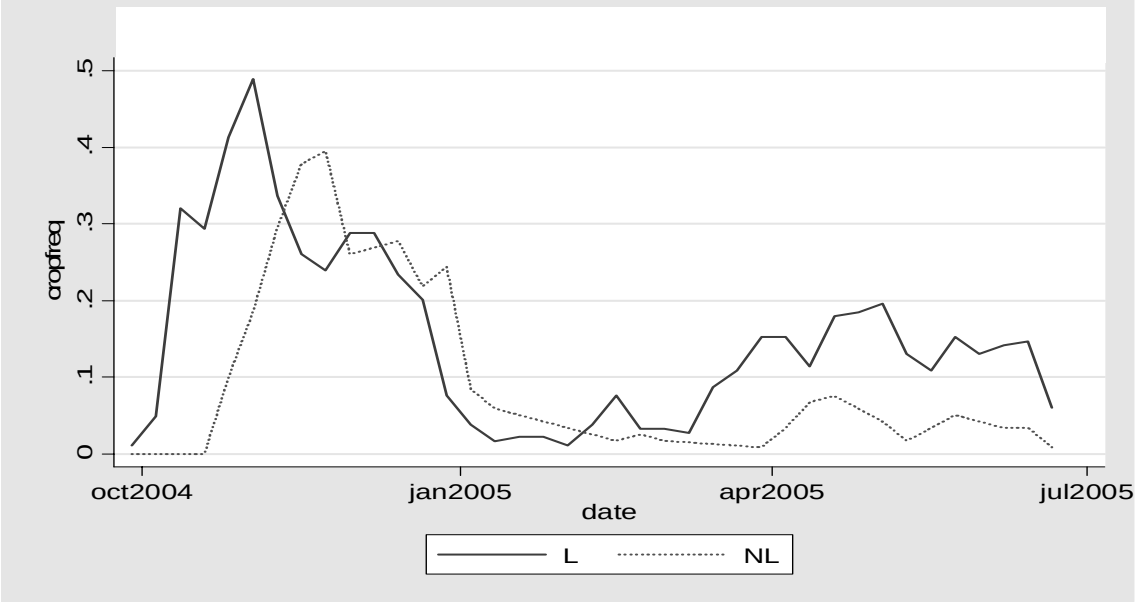

Table 1. Baseline Characteristics

Column 1 includes SHGs that received all DrumNet services including credit, Column 2 SHGs that were offered DrumNet services excluding credit and Column 3 control SHGs. Column 4 (Column 5) reports the difference between Credit (No credit) SHGs and Control SHGs. The symbols *, **, and *** indicate significance at the 10, 5 and 1 percent level, respectively. Data from Panel A comes from the SHG filter survey conducted in February 2004. Data from Panel B come from the baseline, conducted in May 2004.

Panel A: Group characteristics					
	Credit	No credit	Control	Credit	No credit
		Means		Differences	
Total population in village	828	785	460	**368***	325
Current number of members	24.2	31.0	31.4	-7.3	-0.4
Age of SHG (months)	62.8	47.7	59.8	3.0	-12.2
SHG has social activities (1 = yes)	0.46	0.36	0.75	-0.29	**-0.39***
Members that grow export crops (Pct)	0.69	0.818	0.66	0.03	0.15
Main road paved (1 = yes)	0.69	0.91	1.00	**-0.31****	-0.09
Km to main market	5.42	7.09	5.08	0.34	2.01
Time to the main market (minutes)	65.0	34.5	22.5	**42.5****	12.1
Number of Observations	13	11	12		
Panel B: Household characteristics					
	Credit	No credit	Control	Credit	No credit
		Means		Differences	
Member					
Age of member	41.0	41.1	40.7	0.31	0.34
Member is literate (1 = yes)	0.92	0.84	0.88	0.04	-0.04
Religion of the member (1 = Protestant)	0.55	0.54	0.76	**-0.21*****	**-0.22*****
Household size	4.71	4.46	4.54	0.17	-0.08
Months as member of SHG	49.7	47.3	57.8	-8.2	-10.6
House with wood walls (1=Yes)	0.48	0.41	0.47	0.01	-0.06
House has piped water (1 = Yes)	0.21	0.38	0.25	-0.04	0.13
Member is an officer (1 = yes)	0.22	0.25	0.21	0.01	0.04
Total income per household member (1,000 Ksh)	17.0	11.3	18.5	-1.5	**-7.2****
Farming Income (Pct of Total Income)	0.49	0.54	0.55	-0.06	-0.01
Land					
Harvest yield per acre (1,000 Ksh)	30.6	25.7	36.9	-6.3	**-11.3***
Land in cash crops (Pct)	0.63	0.53	0.60	0.03	-0.07
Irrigated land (Pct)	0.39	0.32	0.37	0.02	-0.05
Total land per household member (Acres)	0.49	0.45	0.49	0.00	-0.04
Land with pesticides (Pct)	0.55	0.53	0.55	0.00	-0.02
Production					
Household grows export crops (1=yes)	0.64	0.40	0.64	0.00	-0.24
Household uses manure (1 = yes)	0.90	0.80	0.83	**0.07***	-0.03
Household Sells to market (1 = yes)	0.36	0.38	0.41	-0.05	-0.03
Household hires labor (1 = yes)	0.33	0.24	0.30	0.03	-0.06
Household uses mechanical and/or animal force	0.05	0.06	0.12	**-0.07****	**-0.06***
Number of Observations	210	221	266		

Table 2. Use of ICT

Data come from the Follow-up survey conducted in June 2005.			
	Treatment	Control	Difference
Mobile phone			
Mobile phone ownership (1=Yes)	0.26	0.26	0.01
Plans to buy a mobile phone (1=Yes)	0.36	0.37	-0.01
Ever used a mobile phone (1=Yes)	0.29	0.31	-0.03
Typical business calls using mobile phone			
Inquire about prices	0.40	0.55	**-0.15***
Make arrangments with broker	0.28	0.19	**0.10***
Contact supplies	0.13	0.08	0.05
Ask for farming advice	0.18	0.17	0.01
Internet and SMS			
Use internet (1=Yes)	0.008	0.003	0.005
Member Knows how to send SMS (1=Yes)	0.17	0.17	0.00
Uses SMS for personal use (1=Yes)	0.15	0.14	0.00
Uses SMS for business (1=Yes)	0.09	0.05	**0.36***
Kerugoya visits			
Avg. Times to Kerugoya per month	1.89	1.61	0.28
Avg. Times to Kerugoya for business	1.09	0.86	0.23
Travels to Kerugoya by matatu (1=Yes)	0.93	0.99	**-0.06****
Avg. Cost per trip (to and fro)	120.69	116.81	3.88
Avg. Time per trip (to and fro)	76.49	89.16	-12.67
Avg. Trips avoided if phone calls affordable	1.84	0.68	**1.16****
Avg. Ksh willing to pay not to go to town	71.61	67.66	3.96
Number of Observations	596	300	

Table 3. Mobile and Landline phone usage

	Personal			Business		
	Treatment	Control	Difference	Treatment	Control	Difference
Mobile phone off-peak (after 8pm)						
Avg. Number	2.58	2.71	-0.13	3.74	4.17	-0.43
Avg. Length in minutes	3.31	3.58	-0.27	4.67	6.43	**-1.76****
Mobile phone peak (before 8pm)						
Avg. Number	2.2	2.42	-0.21	3.59	3.74	-0.15
Avg. Length in minutes	3.6	4.54	-0.94	6.27	4.9	1.36
Landline phone						
Avg. Number	1.48	1.81	-0.32	1.64	2.05	-0.41
Avg. Length in minutes	3.87	4.1	-0.23	4.04	4.41	-0.37

Table 4. Visits to DrumNet Office

	Credit	No credit	Difference
Visit to the DN			
Number of visits to DN office per month	2.08	1.20	**0.88****
Trip to Kerugoya only to visit DN office (1=Yes)	0.57	0.46	0.10
Main purpose for visit to DN office			
Inquire about prices	0.18	0.20	-0.01
Check payments	0.54	0.46	0.09
Ask for advice	0.28	0.34	-0.08
Number of Observations	103	66	

Table 5. Determinants of DrumNet participation

The dependent variable is DrumNet membership. The column "All" uses the whole sample, column "Credit" uses the subsample of members in credit SHGs and "No credit" the subsample of no-credit SHGs. In the last specification (last 3 columns) SHG officials are not included. Data come from the baseline survey conducted in 2004 before DrumNet was introduced to the SHGs. Robust standard errors are reported in brackets below the coefficient. The symbol *,**,*** represent significance at the 10, 5 and 1 percent, respectively. All regressions are estimated using Probit clustering at the SHG level.

	All	Credit	No credit	All	Credit	No credit	All	Credit	No credit	All	Credit	No credit
Age	0.0066	0.0081	-0.0004	0.0049	0.0031	-0.0023	0.0042	-0.0036	-0.0014	0.0040	0.0170	-0.0017
	[0.0081]	[0.0128]	[0.0073]	[0.0073]	[0.0111]	[0.0078]	[0.0072]	[0.0126]	[0.0081]	[0.0073]	[0.0122]	[0.0082]
Literacy	0.3700	0.5962	0.1248	0.4077	0.8847	-0.0187	0.3940	1.2038	-0.0170	0.8780	1.2396	0.5400
	[0.2135]*	[0.5410]	[0.2496]	[0.2286]*	[0.5054]*	[0.1837]	[0.2331]*	[0.5277]**	[0.1845]	[0.2810]***	[0.5358]**	[0.3119]*
Months in SHG	-0.001	0.014	-0.004	-0.003	0.016	-0.007	-0.003	0.021	-0.007	-0.000	0.009	-0.005
	[0.005]	[0.005]**	[0.005]	[0.004]	[0.005]***	[0.004]*	[0.004]	[0.005]***	[0.004]*	[0.004]	[0.008]	[0.005]
Deposit in a formal bank (1=yes)	0.067	0.078	0.214	0.076	-0.062	0.107	0.070	0.071	0.088	0.036	-0.224	0.153
	[0.139]	[0.272]	[0.190]	[0.155]	[0.311]	[0.227]	[0.160]	[0.282]	[0.238]	[0.188]	[0.348]	[0.310]
Participates in a Merry-Go-Round (1=yes)	0.190	0.215	0.288	0.196	0.260	0.389	0.226	0.388	0.381	0.406	0.438	0.335
	[0.174]	[0.306]	[0.267]	[0.170]	[0.256]	[0.264]	[0.166]	[0.253]	[0.252]	[0.193]**	[0.297]	[0.349]
Total income per household member (in Ksh M)	-0.121	-0.956	-1.069	-0.857	1.308	-2.243	-0.470	4.296	-1.497	8.439	-4.313	16.406
	[0.869]	[0.980]	[1.017]	[4.473]	[6.855]	[4.366]	[4.407]	[8.011]	[4.191]	[5.483]	[8.552]	[7.760]**
Number HH members	0.062	0.078	0.054	0.116	0.220	0.076	0.122	0.295	0.081	0.169	0.298	0.113
	[0.029]**	[0.057]	[0.027]**	[0.050]**	[0.060]***	[0.063]	[0.049]**	[0.076]***	[0.062]	[0.047]***	[0.086]***	[0.077]
Officer of SHG (1=yes)	0.689	0.913	0.513	0.764	1.101	0.692	0.699	0.722	0.655			
	[0.164]***	[0.294]***	[0.148]***	[0.190]***	[0.307]***	[0.173]***	[0.207]***	[0.344]**	[0.196]***			
Harvest yield per acre (in Ksh M)	-2.584	-17.332	0.471	-2.495	-17.374	-0.528	-2.577	-20.234	-0.703	-6.958	-9.503	-5.944
	[1.683]	[3.144]***	[1.294]	[1.561]	[3.528]***	[1.577]	[1.447]*	[4.372]***	[1.550]	[4.195]*	[7.810]	[3.703]
Pct of irrigated land	0.476	0.637	0.514	0.428	0.957	0.136	0.410	1.084	0.133	0.358	1.406	0.123
	[0.223]**	[0.428]	[0.243]**	[0.259]*	[0.469]**	[0.328]	[0.260]	[0.473]**	[0.319]	[0.266]	[0.394]***	[0.385]
Total land per household member (Acres)	0.082	0.124	0.131	0.581	1.050	0.754	0.588	1.409	0.710	0.371	1.133	0.345
	[0.053]	[0.095]	[0.079]*	[0.248]**	[0.322]***	[0.345]**	[0.249]**	[0.387]***	[0.338]**	[0.187]**	[0.387]***	[0.187]*
Sells to market (1=yes)	-0.439	-0.424	-0.506	-0.445	-0.314	-0.641	-0.460	-0.562	-0.631	-0.431	-0.697	-0.288
	[0.145]***	[0.224]*	[0.172]***	[0.149]***	[0.233]	[0.158]***	[0.149]***	[0.238]**	[0.154]***	[0.165]***	[0.298]**	[0.207]
Uses hired labor (1=yes)	-0.152	-0.539	0.086	-0.214	-0.762	0.136	-0.262	-0.940	0.072	-0.630	-0.921	-0.720
	[0.186]	[0.288]*	[0.325]	[0.201]	[0.245]***	[0.272]	[0.194]	[0.293]***	[0.238]	[0.166]***	[0.338]***	[0.193]***
Uses Machinery and/or animal force (1=yes)	-0.717	-0.459	-1.039	-0.794	-0.508	-0.975	-0.810	-0.558	-0.903	-0.631	-0.626	-1.055
	[0.326]**	[0.534]	[0.579]*	[0.336]**	[0.617]	[0.639]	[0.319]**	[0.604]	[0.598]	[0.438]	[0.663]	[0.926]
Grows export crops (1=yes)	0.639	0.603	0.750	0.657	0.496	0.771	0.666	0.551	0.747	0.496	0.203	0.937
	[0.191]***	[0.428]	[0.149]***	[0.201]***	[0.409]	[0.172]***	[0.200]***	[0.399]	[0.202]***	[0.213]**	[0.335]	[0.298]***
Number of relatives who participate in DN				0.519	0.484	0.594	0.544	0.489	0.574	0.593	0.653	0.084
				[0.220]**	[0.279]*	[0.635]	[0.224]**	[0.348]	[0.631]	[0.331]*	[0.578]	[0.485]
Square of number of relatives who participate in DN				-0.090	-0.109	-0.075	-0.097	-0.115	-0.058	-0.217	-0.257	0.046
				[0.073]	[0.058]*	[0.295]	[0.071]	[0.059]**	[0.295]	[0.135]	[0.207]	[0.209]
Number of advising members who participate in DN				0.550	0.125	1.071	0.527	-0.097	1.103	0.485	0.055	1.061
				[0.253]**	[0.349]	[0.483]**	[0.275]*	[0.471]	[0.499]**	[0.316]	[0.390]	[0.574]*
Square of number of advising members who participate in DN				-0.131	-0.123	-0.221	-0.112	-0.007	-0.228	-0.153	0.145	-0.344
				[0.082]	[0.212]	[0.149]	[0.089]	[0.155]	[0.152]	[0.089]*	[0.124]	[0.159]**
Number of lending members who participate in DN				0.406	4.320	0.571	0.427	6.366	0.508	0.255	4.099	-0.228
				[0.308]	[0.431]***	[0.508]	[0.319]	[0.486]***	[0.559]	[0.306]	[0.452]***	[0.474]
Squared number of lending members who participate in DN				-0.076	-4.163	-0.124	-0.083	-5.977	-0.109	-0.032	-3.657	0.191
				[0.136]	[0.000]	[0.201]	[0.137]	[0.000]	[0.211]	[0.119]	[0.000]	[0.165]
Number of SHG officers who participate in DN										0.531	0.849	0.534
										[0.230]**	[0.902]	[0.710]
Squared number of officers who participate in DN										-0.045	-0.100	-0.050
										[0.018]**	[0.112]	[0.053]
In-degrees of being asked for advice							1.104	3.554	0.719			
							[0.846]	[1.696]**	[1.173]			
In-degrees of having lent							-4.742	-30.173	0.048			
							[2.542]*	[7.336]***	[1.724]			
In-degrees of having borrowed							1.781	21.120	1.037			
							[2.007]	[8.607]**	[2.467]			
Constant	-1.835	-2.331	-1.658	-2.440	-3.704	-2.027	-2.429	-4.576	-2.092	-4.030	-6.324	-3.314
	[0.509]***	[0.792]***	[0.556]***	[0.568]***	[0.661]***	[0.696]***	[0.584]***	[0.708]***	[0.680]***	[0.791]***	[1.932]***	[1.934]*
Observations	310	121	189	309	121	188	309	121	188	251	118	133
R squared	0.139	21.07	0.167	0.219	0.289	0.316	0.225	0.346	0.319	0.188	0.262	0.238

Table 6. Transactions with DrumNet

Data come from the DrumNet administrative records.			
	Credit	No credit	
	Means		Difference
French beans			
Num. Transactions	4.69	2.27	**2.423****
Total earned (Shillings)	2,707.35	121.29	**1,496.1***
Baby corn			
Num. Transactions	6.33	4.06	2.27
Total earned (Shillings)	4,285.50	2,702.25	1,583.30
Total			
Num. Transactions	8.91	4.39	**4.52***
Total earned (Shillings)	5,971.08	2,668.95	3,302.10
N. of observations	188	125	

Table 7. Perceived Impact and Satisfaction

	Credit	No credit	Difference
DN membership entry			
DrumNet Membership in days	134	118	16
TIF financing			
Own funds (1=Yes)	0.91	0.85	0.06
Borrowed (1=Yes)	0.05	0.11	-0.06
Change in behavior as a result of DrumNet. More…			
Inputs purhased	0.86	0.69	**.17*****
Land cultivated	0.77	0.65	0.12
Land leased	0.48	0.56	-0.08
Land devoted to cash crops	0.46	0.48	-0.03
Own work on the farm	0.88	0.82	**0.06***
Own work off the farm	0.26	0.47	**-0.21***
Family work on the farm	0.89	0.88	0.00
Family work off the farm	0.24	0.59	**-0.35*****
Borrowing from banks	0.79	0.45	**0.34****
Transfers/remittances given out	0.51	0.44	0.06
Savings	0.78	0.69	0.09
Satisfaction with DrumNet			
Dissatisfied	0.13	0.06	0.07
Neutral	0.17	0.12	0.05
Satisfied	0.69	0.82	0.13
N. of observations	134	84	

Table 8. Changes in Production and Impact due to DrumNet (Treatment)

The variable Post takes value 1 in year 2005. The variable Treatment is a dummy variable that takes 1 if the member is in a treatment SHG. For each dependent variable, the second column uses the following controls: Age, Duration as SHG member, Literacy, Participation in Rosca and Officer in SHG. All regressions are estimated using probits with clustering at the SHG level. Robust standard errors are in parentheses. The symbols *, ** and *** represent significance at the 10, 5 and 1 percent, respectively.

Panel A: Production

	Export Crop		Use of Manure		Use of Pesticides		Hired Labor		Mech/Animal Traction	
Post	0.029	-0.048	-0.030	-0.013	0.081	0.065	0.226	0.323	-0.061	-0.103
	(0.054)	(0.081)	(0.030)	(0.047)	(0.027)***	(0.053)	(0.051)***	(0.064)***	(0.018)***	(0.025)***
Treatment	-0.151	-0.132	0.031	0.000	0.000	-0.059	0.002	-0.006	-0.042	-0.067
	(0.090)	(0.125)	(0.041)	(0.044)	(0.030)	(0.041)	(0.038)	(0.046)	(0.026)	(0.033)*
Post x Treatment	0.188	0.076	0.025	-0.049	0.012	0.091	-0.003	-0.033	0.037	0.043
	(0.065)***	(0.089)	(0.035)	(0.064)	(0.034)	(0.066)	(0.058)	(0.078)	(0.021)*	(0.032)
Constant	0.531	0.527	0.771	0.630	0.581	0.473	0.336	-0.090	0.082	0.063
	(0.078)***	(0.211)**	(0.034)***	(0.115)***	(0.021)***	(0.088)***	(0.027)***	(0.100)	(0.021)***	(0.041)
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Num. Observations	1,894	936	1,757	827	1,715	826	1,757	827	1,757	827
R-squared	0.04	0.04	0.00	0.02	0.02	0.05	0.05	0.16	0.01	0.04

Panel B: Impact

	Income per member		Yield per Acre		Livestock		House Quality		Deposit in Formal Inst.	
Post	-3.892	-4.834	-3.473	-5.410	0.806	-0.314	-0.105	-0.116	0.110	0.127
	(1.714)**	(2.005)**	(5.257)	(5.926)	(0.545)	(0.991)	(0.060)*	(0.085)	(0.031)***	(0.028)***
Treatment	-3.945	-4.556	-11.744	-14.600	3.927	0.194	0.011	-0.027	-0.068	-0.053
	(2.434)	(2.798)	(7.178)	(7.583)*	(2.745)	(2.302)	(0.153)	(0.156)	(0.064)	(0.066)
Post x Treatment	4.506	5.102	40.928	46.551	-1.421	1.469	0.160	0.171	0.074	0.047
	(2.070)**	(2.427)**	(15.315)**	(16.984)***	(2.110)	(1.188)	(0.088)*	(0.111)	(0.039)*	(0.036)
Constant	18.339	14.826	39.231	53.970	16.720	-0.102	-0.071	-0.594	0.741	0.199
	(1.812)***	(4.938)***	(6.689)***	(20.024)**	(1.481)***	(5.147)	(0.122)	(0.241)**	(0.051)***	(0.175)
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Num. Observations	1,013	887	939	824	1,874	936	1,058	929	1,075	945
R-squared	0.01	0.02	0.02	0.03	0.00	0.06	0.00	0.04	0.04	0.10

Table 9. Changes in Production and Impact due to DrumNet (Credit vs. No Credit)

The variable Post takes value 1 in year 2005. The variables Credit and No Credit are dummy variables for each treatment group. For each dependent variable, the second column uses the following controls: Age, Duration as SHG member, Literacy, Participation in Rosca and Officer in SHG. All regressions are estimated using probits with clustering at the SHG level. Robust standard errors are in parentheses. The symbols *, ** and *** represent significance at the 10, 5 and 1 percent, respectively.

Panel A: Production										
	Export Crop		Use of Manure		Use of Pesticides		Hired Labor		Mech/Animal Traction	
Post	0.029	-0.048	-0.030	-0.013	0.081	0.065	0.226	0.323	-0.061	-0.103
	(0.054)	(0.081)	(0.030)	(0.048)	(0.027)***	(0.053)	(0.051)***	(0.064)***	(0.018)***	(0.025)***
Credit	-0.121	-0.015	0.062	0.068	-0.019	-0.073	0.029	0.037	-0.053	-0.069
	(0.098)	(0.130)	(0.040)	(0.043)	(0.033)	(0.043)	(0.038)	(0.052)	(0.023)**	(0.036)*
No credit	-0.187	-0.226	-0.005	-0.055	0.022	-0.048	-0.028	-0.043	-0.029	-0.065
	(0.102)*	(0.145)	(0.054)	(0.050)	(0.042)	(0.051)	(0.051)	(0.050)	(0.038)	(0.041)
Post x Credit	0.239	0.115	0.021	-0.085	0.023	0.124	-0.000	0.014	0.038	0.039
	(0.074)***	(0.102)	(0.036)	(0.069)	(0.035)	(0.067)*	(0.065)	(0.089)	(0.020)*	(0.035)
Post x No credit	0.129	0.042	0.021	-0.030	0.002	0.058	-0.015	-0.103	0.039	0.048
	(0.074)*	(0.095)	(0.043)	(0.084)	(0.048)	(0.083)	(0.061)	(0.087)	(0.028)	(0.043)
Constant	0.531	0.577	0.771	0.648	0.581	0.472	0.336	-0.072	0.082	0.062
	(0.078)***	(0.185)***	(0.034)***	(0.108)***	(0.021)***	(0.091)***	(0.027)***	(0.088)	(0.021)***	(0.042)
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Number of Observations	1,894	936	1,757	827	1,715	826	1,757	827	1,757	827
R-squared	0.05	0.08	0.01	0.03	0.02	0.06	0.05	0.17	0.02	0.04
P-value of Tests										
Credit = No credit	0.46	0.14	0.16	0.01	0.36	0.62	0.28	0.13	0.45	0.91
Post x Credit = Post x No credit	0.13	0.36	0.98	0.52	0.66	0.38	0.78	0.18	0.96	0.84
Panel B: Impact										
	Income per HH member		Yield per Acre		Livestock		House Quality		Deposit in Formal Inst.	
Post	-3.892	-4.835	-3.473	-5.422	0.806	-0.314	-0.105	-0.116	0.110	0.127
	(1.716)**	(2.009)**	(5.263)	(5.923)	(0.546)	(0.992)	(0.060)*	(0.085)	(0.031)***	(0.028)***
Credit	-0.965	-1.222	-10.878	-13.772	7.508	3.673	0.016	-0.003	-0.025	-0.011
	(2.803)	(3.296)	(8.367)	(8.486)	(3.621)**	(3.355)	(0.174)	(0.182)	(0.067)	(0.072)
No credit	-6.425	-7.228	-12.467	-15.391	-0.122	-2.645	0.007	-0.046	-0.103	-0.087
	(2.448)**	(2.649)**	(7.134)*	(7.560)*	(2.291)	(2.121)	(0.181)	(0.178)	(0.073)	(0.069)
Post x Credit	4.158	4.370	58.515	66.697	-3.748	1.162	0.126	0.133	0.078	0.050
	(2.769)	(3.299)	(21.292)***	(23.710)***	(3.497)	(1.394)	(0.082)	(0.105)	(0.053)	(0.051)
Post x No credit	4.143	5.099	18.796	22.112	1.211	1.715	0.188	0.201	0.070	0.042
	(2.078)*	(2.428)**	(13.947)	(14.926)	(1.043)	(1.342)	(0.119)	(0.142)	(0.040)*	(0.037)
Constant	18.339	15.731	39.231	56.274	16.720	1.156	-0.071	-0.592	0.741	0.216
	(1.813)***	(4.290)***	(6.696)***	(19.171)***	(1.482)***	(4.714)	(0.122)	(0.241)**	(0.051)***	(0.168)
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Number of Observations	1,013	887	939	824	1,874	936	1,058	929	1,075	945
R-squared	0.02	0.03	0.03	0.04	0.01	0.07	0.00	0.04	0.04	0.10
P-value of Tests										
Credit = No credit	0.05	0.04	0.78	0.77	0.05	0.09	0.96	0.81	0.25	0.16
Post x Credit = Post x No credit	0.99	0.81	0.11	0.1	0.17	0.68	0.59	0.6	0.88	0.87

Table 10. Changes in the Price of Main Crops

The dependent variable is price per unit of weight depending on the crop. The first specification uses all crops and includes a crop fixed effect. The variable Post takes value 1 in year 2005. The variables Credit and No Credit are dummy variables for each treatment group. All regressions are estimated using OLS with clustering at the SHG level. Robust standard errors are in parentheses. The symbols *, ** and *** represent significance at the 10, 5 and 1 percent, respectively.

	All crops		Maize dry		Beans		Bananas		French Beans	
	All	Farmgate	All	Farmgate	All	Farmgate	All	Farmgate	All	Farmgate
Post	-8.12	-9.48	7.43	11.84	-108.12	-79.91	0.16	1.20	-0.04	-0.84
	(6.15)	(12.44)	(11.92)	(17.86)	(75.27)	(84.46)	(2.70)	(2.81)	(0.60)	(1.35)
Credit	-3.71	-5.70	27.22	19.27	-144.08	-143.20	15.85	11.35	-0.06	-1.57
	(12.06)	(23.17)	(38.03)	(47.25)	(163.57)	(204.37)	(12.26)	(11.70)	(1.71)	(1.86)
No Credit	3.97	24.94	72.16	112.44	-90.33	4.87	5.04	2.35	0.46	0.89
	(13.29)	(27.36)	(39.09)*	(54.07)**	(154.76)	(207.65)	(11.88)	(12.23)	(1.54)	(2.54)
Post x Credit	7.68	5.72	-24.46	-39.94	140.39	88.94	-4.37	-1.63	1.16	0.74
	(8.78)	(18.49)	(30.68)	(33.18)	(102.42)	(132.84)	(5.21)	(3.64)	(0.73)	(1.82)
Post x No credit	8.02	26.47	-6.59	15.58	93.26	143.46	2.92	4.96	-0.42	-0.04
	(9.21)	(14.96)*	(15.52)	(25.71)	(95.24)	(117.97)	(3.86)	(4.06)	(0.86)	(2.23)
Constant	326.63	494.30	1,042.37	1,047.87	1,897.52	1,798.47	106.32	104.65	21.62	19.59
	(7.35)***	(17.28)***	(32.82)***	(40.96)***	(101.93)***	(136.28)***	(8.48)***	(8.53)***	(1.33)***	(1.60)***
Number of Observations	2,397	1,022	325	204	190	129	614	532	594	151
R-squared	0.88	0.86	0.02	0.06	0.01	0.01	0.01	0.01	0.00	0.02
P-value of Tests										
Credit = No credit	0.6	0.22	0.12	0.04	0.75	0.5	0.38	0.45	0.69	0.27
Post x Credit = Post x No credit	0.97	0.21	0.55	0.11	0.61	0.69	0.17	0.09	0.04	0.72