Finding Missing Markets (and a Disturbing Epilogue): Evidence from an Export Crop Adoption and Marketing Intervention in Kenya

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Farmers may grow crops for local consumption despite more profitable export options. DrumNet, a Kenyan NGO that helps small farmers adopt and market export crops, conducted a randomized trial to evaluate its impact. DrumNet services increased production of export crops and lowered marketing costs, leading to a 32% income gain for new adopters. The services collapsed one year later when the exporter stopped buying from DrumNet because farmers could not meet new EU production requirements. Farmers sold to other middlemen and defaulted on their loans from DrumNet. Such experiences may explain why farmers are less likely to adopt export crops.

Key words: export crop, field experiment, food safety standards.

Why do farmers continue to grow crops for local markets when crops for export markets are thought to be much more profitable? Several answers are possible: missing information about the profitability of these crops, lack of access to the necessary capital to make the switch possible, lack of infrastructure necessary to bring the crops to export outlets, high risk of the export markets (e.g., from holdup problems selling to exporters), lack of human capital necessary to adopt successfully a new agricultural technology, and misperception by researchers and policy makers about the true profit opportunities and risk of crops grown for export markets.

We conduct a clustered randomized control trial with DrumNet, a project of Pride Africa, to evaluate whether a package of services can help farmers adopt, finance, and market export crops, and thus make more income. Therefore, DrumNet resembles a typical out-grower scheme common in horticulture production and other export crops among smallholder farmers but with one key difference. As a third neutral party, DrumNet tries to convince both farmers and exporters that the other party will honor their commitment. The intervention is a package of services. Our research design allows us to distinguish the causal effect from providing agricultural credit along with the package versus simply providing extension and marketing services without credit. Thus, the experimental design includes two treatments, one with credit and one without, and a control group. In addition to evaluating the impact of these packages, we examine whether there are heterogeneous treatment effects on the basis of prior experience growing export crops.

This experiment is motivated by a recent push in development to build sustainable interventions that help complete missing markets (e.g., the initiative launched jointly in 2006 by the Bill and Melinda Gates Foundation and the Rockefeller Foundation). Other similar interventions include the use of mobile phones to obtain real-time prices for fish in markets along the shore by boat owners returning with their catches (Jensen 2007) and an intervention in India to provide internet kiosks in small villages in order to better inform villagers of

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The authors thank the editor and the referee for useful comments. In addition, they thank Jonathan Campaigne, Vince Groh, and Zack Lenawamuro for their work at DrumNet, and their patience and collaboration with this research. They also thank IDS for the data collection efforts and IDRC, SAGA, and the World Bank for funding. Richard Akresh, Steve Boucher, Paul Dower Steve Jaffee, Doug Miller, and Julius Okello provided valuable comments. Sara Nadel from Innovations for Poverty Action, and Guillem Roig and Paola de Baldomero from World Bank provided excellent research assistance. Karlan thanks the National Science Foundation for support. All remaining errors are the authors'.

Amer. J. Agr. Econ. 91(4) (November 2009): 973–990

DOI: 10.1111/j.1467-8276.2009.01319.x

market opportunities (Upton and Fuller 2005; Goyal 2008).

Two approaches seem plausible for measuring impact of such interventions: one infers impact by examining the convergence of market prices (Jensen 2007; Goyal 2008); a second compares the welfare, or change in welfare, of participants and nonparticipants. We employ the second approach. This design requires the assumption that there are no general equilibrium effects as a result of the intervention (e.g., increase of prices of nonexport crops as a result of many farmers taking up export crops), and we present evidence that supports this assumption.

To evaluate such a program, one should be concerned that entrepreneurial and motivated individuals (those with the unobservable "spunk") are most likely to participate; hence a randomized controlled trial seems necessary in order to measure the impact of such interventions convincingly. To the best of our knowledge, no such randomized controlled trial has been completed to date on an export crop adoption and marketing intervention. The literature on agricultural extension services, reviewed by Birkhaeuser, Evenson, and Feder (1991) and Anderson and Feder (2003), and on technology adoption, reviewed by Feder, Just, and Zilberman (1985), stress that both data quality and methodological issues are important qualifiers to the prevailing evidence in favor of high returns from extension or adoption. They conclude that more evaluative work is needed to better assist policy makers.[1]

We find positive but not overwhelming one-year impacts from DrumNet. DrumNet made farmers 19 percentage points more likely to be growing export crops, increasing their production and lowering their marketing costs. While we do not find a statistically significant impact on income for the full sample, we do find a statistically and economically significant (32%) increase for first-time growers of export-oriented crops.

The epilogue to this project is more dismal. One year after the evaluation ended, the export firm that had been buying the horticultural produce stopped because of lack of compliance with European export requirements (EurepGap). This led to the collapse of DrumNet as farmers were forced to undersell to middlemen, leaving sometimes a harvest of unsellable crops to rot and thus defaulting on their loans. Afterward it was reported to us anecdotally that the farmers returned to growing local crops. We discuss the implications (albeit without direct evidence): farmers may not be adopting export crops because of the risk of the export market.

This paper proceeds as follows: first section provides some background information regarding the Kenyan horticultural market and the DrumNet program. Second section describes the research design in more detail. Third section analyzes the decision to participate in DrumNet. Fourth section analyzes the impact of DrumNet. Fifth section discusses the viability of the DrumNet business model. Sixth section documents the EurepGap export requirements and seventh section explains how its implementation affected DrumNet and concludes.

The DrumNet Program and Context

Kenya's horticultural sector[2] has received a great deal of attention over the past decade due to the rapid and sustained growth of its exports to Europe (Jaffee 1994, 1995, 2004; Dolan and Humphrey 2000; Minot and Ngigi 2002; Muendo and Tschirley 2004). In 2004, it exported over 30,000 tons of French beans to European markets. The UK absorbed more than 60% of exports, while France and the Netherlands captured 15 and 12%, respectively. As explained by Markandya, Emerton, and Mwale (1999) and Asfaw, Mithofer, and Waibel (2007), the strength of the Kenyan horticultural export sector can be attributed to (*a*) Nairobi's role as an African hub for air transport, (*b*) preferential treatment under the Lomé Convention between African Caribbean Pacific countries and the EU, and (*c*) a critical mass of export firms with world-class management skills. Despite the lack of consensus on the actual contribution of small landholders to total horticulture exports,[3] there is evidence suggesting that this contribution has declined over time, largely due to the cost and difficulty of complying with the new export production requirements that will be discussed in the last section before the conclusions (Okello and

[1] Foster and Rosenzweig (1995), Bandiera and Rasul (2006), Conley and Udry (2005) and Munshi (2004) also review the literature on agricultural technology adoption but focus on the role of social learning as a driver of adoption.

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

[3] Estimates range from 30% by Dolan and Humphrey (2000) to 70% by the Horticultural Crops Development Authority, a parastatal agency funded by USAID, in Harris et al. (2001). Okello, Narrod, and Roy (2007) report that, while 60% of all French bean production in Kenya in the 1980s was done by smallholders, the share dropped to about 30% by 2003.

Swinton 2007; Okello, Narrod, and Roy 2007; Jaffee 2004).

When designing the DrumNet program, Pride Africa identified several stylized constraints that smallholder farmers in horticulture faced. First, smallholder farmers had little information on pricing and exporting opportunities. Second, they lacked reliable production contracts with large brokers or exporters due to the large presence of middlemen. Farmers feared international price fluctuations or believed that exporters would employ holdup tactics given the perishability of the produce, such as lowering the promised price or grading the crop at a lower quality, while exporters feared that farmers would renege on their promise to sell back the produce or would misuse the inputs, jeopardizing the quality of the crop. Third, farmers did not have relationships with financial institutions, and thus lacked access to credit, and finally, the farmers had difficulty coordinating and financing the use of trucks to transport the crop (see also Axinn 1988; Kimenye 1995; Freeman and Silim 2002). These constraints are not peculiar to the area where DrumNet was to operate but rather are common to regions in sub-Saharan Africa where horticulture is suitable (Jaffee 1994).

DrumNet was therefore designed as a horticultural export and cashless micro-credit program that tried to overcome these barriers by linking smallholder farmers to commercial banks, retail providers of farm inputs, transportation services, and exporters. Indeed, the model resembles an out-grower scheme (Grosh 1994), but with the important difference that, as a third neutral party, DrumNet hoped to bring trust among farmers and the exporter. In addition, with DrumNet there should be higher monitoring and information exchanges, thanks to the frequent interaction between the staff and farmers.

A farmer that wants to be a member of DrumNet has to satisfy the following requirements: (*a*) be a member of a registered farmer group (also known as a self-help group or SHG) with the Department of Social Services; (*b*) express an interest, through the SHG, in growing crops marketed by DrumNet, namely French beans, baby corn, or passion fruit; (*c*) have irrigated land; and (*d*) be able to meet the first Transaction Insurance Fund (TIF) commitment (roughly US$10 or the equivalent of a week's laborer wages).

DrumNet clients first receive a four-week orientation course in which the process is explained. During this course, farmers learn about the need to employ Good Agricultural Practices on their farms to ensure the quality and safety of their produce. After the course, participants open a personal savings account with a local commercial bank and, for those in the credit treatment group, they make the first cash contribution to the TIF that will serve as partial collateral for their initial line of credit. They also decide on the TIF percentage that DrumNet will automatically deduct from each future marketing transaction. Maximum loan size is four times their balance in the TIF. The initial TIF amount depends on the specific crop the farmer wants to grow and the area under cultivation.[4]

To ensure repayment, DrumNet organizes farmers into groups of five members each who are jointly liable for the individual loans taken out. The seeds and other inputs are distributed and the planting is monitored by DrumNet staff. At harvest time, DrumNet negotiates price with the exporter and arranges the produce pickup at prespecified collection points. Usually, there is a collection point for every four or five SHGs. In each collection point, a transaction agent is appointed among the members to serve as liaison between DrumNet and the farmers.[5] At these collection points, farmers grade their produce and package it, although the exporter has the final word on the grading.[6]

In the credit treatment group, DrumNet also works with local agricultural retail stores to coordinate the in-kind loans. The retailers are trained in basic DrumNet record keeping and submit receipts to DrumNet to receive payment.

Once the produce is delivered to the exporter at the collection points, the exporter pays DrumNet who in turn will deduct any loan

[4] For example, passion fruit in one quarter of an acre requires an investment of Ksh 5,000 (US$67) but does not bear fruit for six months. The initial TIF for passion fruit is Ksh 1,250. French beans and baby corn only require an investment of Ksh 3,000 per one quarter of an acre and harvesting takes place after three months. In Kirinyaga, both French beans and baby corn can be grown and harvested all year.

[5] Transaction agents are responsible for coordinating activities within farmer groups. The number of these agents has expanded from approximately ten in early 2004 to thirty-five 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 are an important conduit of information about pickup schedules, market prices, approved field practices, and shifting grading standards.

[6] Anecdotal evidence suggests that some export buyers arbitrarily change the rejection rate, especially in periods of oversupply (Okello and Swinton 2007), but we have no evidence that the buyer from DrumNet engaged in such practices.

repayment, prespecified TIF percentage, and credits the remainder to individual bank savings accounts that each farmer opened when they registered. 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. Beginning in 2004, the DrumNet team also began to 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 this, very few SHG members that participated in DrumNet decided to grow passion fruit. Instead, they focused on French beans and, to a lesser extent, baby corn. The type of French beans chosen by DrumNet is the extra fine from the Amy variety, exported as fresh produce and preferred by the UK supermarkets. Due to its higher labor requirements, it is better suited for smallholder farms than the bobby type from the paulista variety, mainly produced for canning by larger plantations.

Data and Design of Evaluation

The evaluation was conducted in the Gichugu division of the Kirinyaga district of Kenya. First, in December 2003, we collected a list of all horticulture SHGs from the Ministry of Agriculture in Gichugu that had been registered since 2000. There were ninety-six registered SHGs comprising approximately 3,000 farmers, although many of these ninety-six SHGs were inactive or disbanded groups. After screening out the inactive or disbanded groups (via a brief filter survey to the SHG leader), we were left with thirty-six viable SHGs for the evaluation.

We randomly assigned the thirty-six SHGs into three experimental groups of twelve SHGs each: (*a*) *treatment credit*: all DrumNet services, totaling 373 individuals; (*b*) *treatment no credit*: all DrumNet services except credit, totaling 377 individuals; and (*c*) *control*: no DrumNet services, totaling 367 individuals. Figure 1 in Ashraf, Giné, and Karlan (2009) presents a map of Gichugu with the location of the treatment and control SHGs.[7]

After the randomization was done, we verified that the three groups were similar statistically on the limited variables available from the filter survey (i.e., number of members in 2004, SHG age since creation, access to paved road, percentage of members that were already growing export-oriented crops, etc.). Table 1 reports these orthogonality checks. Column 4 reports the p-value of the t-test of the differences between the treatment group and the controls. Columns 5 and 6 then show the breakdown for each of the two treatment groups, and column 7 reports the p-value of the F-test that neither coefficient for the two treatment groups is equal to zero. Although credit SHGs start off slightly worse than control SHGs in terms of infrastructure and remoteness, overall the three experimental groups seem quite similar. Note that in the analysis, since we have baseline data, we will include SHG fixed effects and all baseline controls of table 2. Thus, any remaining differences in levels of fixed characteristics (but not trends in time-varying characteristics) that occurred due to the small sample will be controlled for through the SHG fixed effects and individual-level baseline control variables.

In April 2004, immediately after the filter survey was completed, we conducted a baseline of 726 farmers from the selected 36 SHGs.[8] At the time of the baseline survey, DrumNet had not yet started operations or marketing, and thus no one had heard of it. During the follow-up survey in May 2005, we expanded the sample to include 391 additional SHG members registered at the time of the baseline but not included in the baseline survey. See figure 2 in Ashraf, Giné, and Karlan (2009) for a Timeline of Events.

Table 2 compares the baseline characteristics across treatment and control groups. Table 1 in Ashraf, Giné, and Karlan (2009) details how the variables used were created. All members used in the analysis were registered SHG members at the time of the baseline data collection. Table 2 in Ashraf, Giné, and Karlan (2009) reports the number of observations per variables at baseline and at follow-up. Some variables have at most 726 nonmissing observations if the information was only elicited in April 2004 or 1,117 if we also asked the question retrospectively at follow-up for the

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

[8] The 391 were not included initially because of budgetary constraints, but were drawn randomly from the same sample frame used to draw the original baseline sample frame of 726.

Table 1. Preintervention Self-Help Group Characteristics from Filter Survey Means and Standard Deviations

		Means				Means		
	Number of Observations	All (1)	Control (2)	Treatment (3)	*p*-Value (4)	Credit (5)	No Credit (6)	*p*-Value (7)
Current number of members	36	28.7 (17.5)	31.4 (19.6)	27.3 (16.6)	0.51	24.2 (11.3)	31.0 (21.3)	0.52
Age of SHG (months)	36	4.77 (4.89)	4.99 (3.9)	4.66 (5.39)	0.85	5.24 (6.24)	3.97 (4.37)	0.81
SHG has social activities (1 = yes)	36	0.53 (0.51)	0.75 (0.45)	0.42 (0.5)	0.06*	0.46 (0.52)	0.36 (0.5)	0.16
Fee contribution to the SHG per member	36	103 (106)	87.5 (56.9)	111 (124)	0.55	111 (128)	110 (126)	0.83
SHG has an account in the bank (1 = yes)	36	0.64 (0.49)	0.67 (0.49)	0.63 (0.49)	0.81	0.62 (0.51)	0.64 (0.5)	0.97
Main road paved (1 = yes)	36	0.86 (0.35)	1.00 (0)	0.79 (0.41)	0.09*	0.69 (0.48)	0.91 (0.3)	0.07*
Distance to main market (km)	36	5.82 (3.6)	5.08 (3.2)	6.19 (3.79)	0.39	5.42 (3.09)	7.09 (4.46)	0.37
Time to the main market (minutes)	36	41.5 (47.1)	22.5 (16)	51.0 (54.6)	0.09*	65.0 (68.6)	34.5 (25.3)	0.06*

Note: Data come from the SHG filter survey conducted in February 2004, prior to the start of the intervention. Column 3 includes all SHGs that received DrumNet services including both the credit and no credit treatment groups. Column 4 reports the *p*-value for the *t*-test on the mean comparison between treatment (Column 3) and control (Column 2) SHGs. Column 7 reports the regression analog to column 4, except now with two indicator variables, one for each treatment group. Specifically, we regress the group characteristic in each row on two indicator variables, and report the *p*-value for the *F*-test that neither coefficient for the two treatment groups is equal to zero. The single asterisk (*) represents significance at the 10% level.

additional sample of 391 members that were included in the follow-up. We reached 86% of the baseline individuals in the follow-up survey. Table 3 in Ashraf, Giné, and Karlan (2009) compares the baseline characteristics of those reached in the follow-up to those not reached. Although there are a few variables that predict attrition, we take comfort in the fact that there is no differential attrition between treatment and control groups.

Farmers in our sample are comparable to other smallholder farmers engaged in horticulture in the region (e.g., see Asfaw, Mithofer, and Waibel 2007; Okello and Swinton 2007). About half the household income of these farmers came from farm activities, while the rest came from employment (both formal and informal), remittances, or pensions and gifts. Most farmers own the land they cultivate, and the median farm size was 1 acre. Farmers grew subsistence crops (beans, maize, potatoes, and kale) half the time and cash crops such as coffee, bananas, or tomatoes 34% of the time.[9] Only 12% of the farmers were already growing French beans, and nobody baby corn, the main horticulture crops promoted by DrumNet.

Farm operations are typically done using only manual human labor, with fewer than 5% utilizing animal labor or machinery to boost productivity. This is not surprising given the small size of the farms. In addition, three-quarters of those surveyed rely solely on family labor, not requiring hired labor to plant or harvest crops.

To market their produce, nearly all used the traditional networks of brokers, resellers, and other intermediaries (see also Harris et al. 2001). A few marketed produce directly to consumers locally, and none reported marketing their produce in regional market centers

[9] Coffee is also an export crop, but it is exclusively marketed through cooperatives and is auctioned at the Kenya Coffee Auction owned by the Coffee Board of Kenya.

Table 2. Preintervention Individual and Household Characteristics from Baseline Survey Means and Standard Deviations

	Means			*p*-Value on *t*-Test of Difference	Means		*p*-Value on *F*-Test for (5) and (6)
	All (1)	Control (2)	Treatment (3)	(2)–(3) (4)	Credit (5)	No Credit (6)	(7)
Member							
Age of member	41.2	39.3	42.2	0.17	42.3	42.0	0.37
	(12.2)	(11.9)	(12.2)		(12.3)	(12.2)	
Literacy	0.90	0.89	0.90	0.79	0.92	0.88	0.55
	(0.30)	(0.30)	(0.29)		(0.27)	(0.32)	
Risk tolerance	0.38	0.39	0.38	0.89	0.36	0.39	0.81
	(0.42)	(0.42)	(0.42)		(0.42)	(0.42)	
Months as member in SHG	52.51	57.2	49.8	0.51	49.0	50.6	0.76
	(39.7)	(44.4)	(36.5)		(33.2)	(39.2)	
Member of SHG is an officer (1 = yes)	0.16	0.16	0.16	0.92	0.14	0.18	0.54
	(0.37)	(0.36)	(0.37)		(0.35)	(0.38)	
Deposit in a formal bank (1 = yes)	0.69	0.70	0.69	0.77	0.71	0.66	0.66
	(0.46)	(0.46)	(0.46)		(0.45)	(0.47)	
Loan from formal institutions (1 = yes)	0.04	0.06	0.03	0.03**	0.05	0.01	0.00***
	(0.19)	(0.23)	(0.17)		(0.22)	(0.09)	
Logarithm of total annual household income	3.49	3.59	3.44	0.30	3.67	3.23	0.02**
	(1.20)	(1.19)	(1.20)		(1.17)	(1.20)	
Number of household members	4.59	4.55	4.61	0.79	4.71	4.52	0.73
	(2.09)	(2.12)	(2.08)		(2.23)	(1.94)	
Land							
Harvest yield per acre (in Ksh 100,000)	0.29	0.33	0.27	0.30	0.26	0.28	0.41
	(0.62)	(0.65)	(0.60)		(0.41)	(0.72)	
Proportion of land that is irrigated	0.40	0.39	0.40	0.87	0.43	0.37	0.45
	(0.31)	(0.29)	(0.32)		(0.32)	(0.32)	
Total land holdings (acres)	1.80	1.90	1.75	0.56	1.77	1.74	0.83
	(2.05)	(2.36)	(1.89)		(1.81)	(1.96)	
Proportion of land devoted to cash crops	0.58	0.59	0.57	0.54	0.58	0.55	0.68
	(0.25)	(0.24)	(0.26)		(0.24)	(0.28)	
Production							
Grows export crops (1 = yes)	0.46	0.55	0.41	0.15	0.48	0.35	0.16
	(0.50)	(0.50)	(0.49)		(0.50)	(0.48)	
Sells to market (1 = yes)	0.39	0.41	0.38	0.54	0.36	0.40	0.66
	(0.49)	(0.49)	(0.49)		(0.48)	(0.49)	
Uses hired labor (1 = yes)	0.34	0.34	0.34	0.99	0.36	0.31	0.56
	(0.45)	(0.44)	(0.46)		(0.47)	(0.45)	
Uses machinery and/or animal force (1 = yes)	0.06	0.09	0.04	0.06*	0.04	0.04	0.12
	(0.23)	(0.28)	(0.19)		(0.18)	(0.20)	
Value of harvested produce (in Ksh 1,000)	44.27	48.1	42.1	0.37	47.1	37.7	0.27
	(72.7)	(73.1)	(72.6)		(77.9)	(67.4)	
Production of French beans (in 1,000 kg)	3.40	2.89	3.65	0.61	4.54	2.76	0.56
	(14.3)	(13.1)	(14.9)		(17.0)	(12.5)	
Production of baby corn (in kg)	13.3	21.0	9.48	0.34	11.9	7.06	0.40
	(114.1)	(162.1)	(80.6)		(107.8)	(38.1)	
Total spent in marketing (in Ksh 1,000)	1.00	0.36	1.36	0.06*	2.02	0.78	0.11
	(8.18)	(2.13)	(10.1)		(13.8)	(4.91)	
Use of inputs	0.95	0.95	0.95	0.89	0.95	0.94	0.64
	(0.23)	(0.22)	(0.23)		(0.21)	(0.24)	

Note: Column 3 includes all SHGs that received DrumNet services including both the credit and no credit treatment groups. Column 4 reports the *p*-value from the *t*-test comparing the treatment group's mean value of different characteristics to the control group. Column 7 reports the regression analog to column 4, except now with two indicator variables, one for each treatment group. Specifically, we regress the group characteristic in each row on two indicator variables, and report the *p*-value for the *F*-test that neither coefficient for the two treatment groups is equal to zero. The asterisks (*), (**), and (***) represent significance at 10, 5, and 1%, respectively. Number of observations is either 726 or 1,117 depending on whether the information came from the baseline survey, or from the baseline and the retrospective portion of the follow-up survey. See Table 1 in Ashraf, Gine and Karlan (2009) for a definition of the variables.

or directly to large-scale end buyers. Only 6% of the farmers reported access to motorized transport (public transport, car, or truck) for hauling their produce; nearly all transport by foot, bicycle, or animal-drawn cart. Most farmers have little control over which intermediaries they work with—three-quarters reported having relationships with three or fewer brokers and 45% reported working exclusively with a single broker. 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 and informed decision making, generally placing the farmer at a disadvantage.

Participation Decision

Using the baseline data from the 463 members in the twenty-four SHGs offered to participate in DrumNet, we now examine their decision to participate in the program. We do so for two reasons. First, we want to examine potential distributional implications of this program. Are the better-off farmers more likely to join, or does the program succeed in achieving its goal of reaching the poor? Second, by examining the program participation decision, we hope to learn something about *why* this intervention was potentially needed in the first place.

While 41% of the members from credit groups joined DrumNet, only 27% did so when credit was not included as a DrumNet service. If we look at SHGs rather than individuals, ten out of twelve SHGs in the treatment credit group joined DrumNet, compared to only five out of twelve from the treatment group without credit. This provides some suggestive evidence that, at a minimum for increasing program participation, credit is perceived by farmers as an important factor for cultivation of export-oriented crops.

Table 3 shows the determinants of participation in DrumNet, using both ordinary least squares (OLS) and Probit specifications with very similar results.[10] Column 1 examines both treatment groups and includes an indicator variable for the credit treatment. Columns 2 and 3 show the determinants of program participation for the credit and no credit groups separately. Since the results in columns 2 and 3 do not differ much, we focus here on the results from column 1.

We examine a few hypotheses regarding the program participation decision. First, is offering credit an important determinant? We find that the credit indicator is positive but not significant statistically. Thus, once other household characteristics are included, the offer of formal credit seems to play less of a role. Second, are farmers who join more educated? If education is required to understand the potential benefits of DrumNet, we would expect a positive correlation. On the other hand, if educated farmers are already more advanced, accessing export markets, they may see no additional value in the DrumNet services and refuse the offer to join. We find that literacy, as defined by the self-reported ability to read and write, is positively correlated with joining DrumNet.

Third, does household income predict program participation? This is particularly important to examine for the treatment groups separately, to examine whether DrumNet without credit only reaches those with higher income. We find no statistically significant linear correlation between household income and participation.

Fourth, how does yield per acre in the previous season and landholdings correlate with program participation? We find that members in the credit group with relatively high harvest yield per acre are *less* likely to participate in DrumNet (p-value is 0.106). This perhaps is due to farmers with high yields being satisfied with what they grow and not wanting to change crop varieties. In addition, households with larger total landholdings are more likely to join DrumNet and the same is true for households of larger size (both are statistically significant).

Fifth, we look at whether those who participate used more or less advanced prior farming practices. We may expect that more advanced farming techniques (e.g., accessing markets directly, hiring labor, and using machinery) are indications of farmers willing and eager to take on new ideas to increase profits, or on the other hand may indicate farmers less in need of the services of DrumNet, hence less likely to participate. We find that those who sell directly to the market (i.e., do not use brokers) are less likely to join DrumNet. Those who use machinery and/or animals rather than just human labor are also less likely to join DrumNet, and using hired labor is also negatively correlated,

[10] Because the mean of the dependent variable is close to 0.50, both the linear (OLS) and the nonlinear (probit or logit) estimates should be similar.

Table 3. Individual Determinants of Participation in DrumNet

	OLS				Probit			
	All (1)	Credit (2)	No Credit (3)	All (4)	All (5)	Credit (6)	No Credit (7)	All (8)
Treatment group included credit	0.108 (0.084)			0.110 (0.084)	0.120 (0.088)			0.121 (0.088)
Member								
Age of member	0.002 (0.002)	0.002 (0.003)	0.002 (0.001)	0.002 (0.002)	0.002 (0.002)	0.002 (0.003)	0.002 (0.001)	0.002 (0.002)
Literacy	0.151 (0.064)**	0.202 (0.111)*	0.106 (0.074)	0.148 (0.065)**	0.182 (0.079)**	0.238 (0.137)*	0.121 (0.087)	0.182 (0.081)**
Risk tolerance	−0.038 (0.050)	−0.037 (0.075)	−0.043 (0.064)	−0.040 (0.049)	−0.052 (0.054)	−0.048 (0.088)	−0.057 (0.066)	−0.055 (0.054)
Months as member in SHG	0.001 (0.001)	0.002 (0.001)	0.000 (0.002)	0.001 (0.001)	0.001 (0.001)	0.002 (0.001)	0 (0.002)	0.001 (0.001)
Member of SHG is an officer (1 = yes)	0.291 (0.057)***	0.396 (0.076)***	0.175 (0.064)**	0.296 (0.057)***	0.314 (0.056)***	0.429 (0.077)***	0.19 (0.064)***	0.322 (0.055)***
Deposit in a formal bank (1 = yes)	0.003 (0.041)	0.036 (0.074)	−0.018 (0.031)	0.000 (0.042)	0.009 (0.045)	0.045 (0.085)	−0.014 (0.038)	0.008 (0.047)
Log of total annual household income	0.003 (0.024)	−0.004 (0.045)	0.013 (0.023)	0.103 (0.053)*	0.004 (0.026)	−0.011 (0.051)	0.016 (0.024)	0.125 (0.064)*
Log of total annual household income squared				−0.015 (0.007)**				−0.018 (0.008)**
Number of household members	0.030 (0.008)***	0.026 −0.014	0.035 (0.007)***	0.031 (0.008)***	0.035 (0.009)***	0.032 (0.017)*	0.04 (0.008)***	0.037 (0.010)***
Land								
Harvest yield per acre (in Ksh 100,000)	−0.006 (0.047)	−0.091 (0.056)	0.019 (0.042)	−0.004 (0.044)	0.003 (0.043)	−0.129 (0.106)	0.021 (0.035)	0.005 (0.040)
Proportion of land that is irrigated	0.074 (0.072)	0.070 (0.130)	0.091 (0.077)	0.081 (0.068)	0.087 (0.080)	0.072 (0.156)	0.102 (0.077)	0.094 (0.077)
Total landholdings (acres)	0.027 (0.014)*	0.021 (0.023)	0.035 (0.017)*	0.029 (0.014)*	0.029 (0.015)*	0.023 (0.027)	0.033 (0.016)**	0.031 (0.015)**
Production								
Grows export crops (1 = yes)	0.069 (0.058)	0.053 (0.121)	0.095 (0.029)***	0.058 (0.058)	0.074 (0.062)	0.067 (0.132)	0.092 (0.026)***	0.062 (0.062)
Sells to market (1 = yes)	−0.133 (0.043)***	−0.168 (0.071)**	−0.105 (0.045)**	−0.138 (0.043)***	−0.15 (0.044)***	−0.192 (0.078)**	−0.113 (0.045)**	−0.156 (0.044)***
Uses hired labor (1 = yes)	−0.065 (0.059)	−0.089 (0.070)	−0.013 (0.103)	−0.067 (0.058)	−0.07 (0.063)	−0.103 (0.079)	−0.017 (0.103)	−0.075 (0.063)
Uses machinery and/or animal force (1 = yes)	−0.166 (0.091)*	−0.168 (0.130)	−0.097 (0.099)	−0.166 (0.090)*	−0.193 (0.114)*	−0.164 (0.167)	−0.126 (0.131)	−0.199 (0.113)*
Mean dependent variable	0.340	0.415	0.273	0.340	0.340	0.415	0.273	0.340
Number of observations	450	212	238	450	450	212	238	450
R^2	0.16	0.2	0.13	0.16				

Note: The binary dependent variable is DrumNet membership. The column "All" uses the whole sample of registered SHG members surveyed at the time of the baseline in treatment SHGs (i.e., not the members added to the sample for the follow-up), and column "Credit" ("No Credit") uses the subsample of registered SHG members at the time of the baseline in credit (no credit) SHGs. Data come from the baseline survey conducted in 2004 before DrumNet was introduced to the treatment SHGs. Standard errors clustered at the SHG are reported in parenthesis below the coefficient. The asterisks (*), (**), and (***) represent significance at 10, 5, and 1%, respectively. Regressions in columns 1–4 are estimated using linear probability model. Regressions in columns 5–8 are estimated using a probit. Marginal effects are reported. See Table 1 in Ashraf, Gine and Karlan (2009) for a definition of the variables.

but not significant statistically, with participation in DrumNet.

Finally, we examine whether risk tolerance, as measured through hypothetical choice questions on the survey instrument, are predictive of program participation. We find that it is uncorrelated with program participation.

Overall, it seems that neither the wealthiest farmers nor those that use the most efficient techniques sign up for DrumNet. In addition, the poorest in the SHG are also less likely to sign up for DrumNet, given the positive correlations of literacy and leadership in the SHG and program participation. This evidence points toward an inverted U-shape relationship between income and program participation, indicating that the wealthiest and poorest are least likely to join. Column 4 includes a quadratic term in log income. As expected, both the linear and quadratic terms

Table 4. Impact of DrumNet, OLS, and IV

	Export Crop (1)	Proportion of Land Devoted to Cash Crops (2)	Use of Inputs (3)	Production of French Beans (l,000 kg) (4)	Production of Baby Corn (kg) (5)	Value of Harvested Produce (in Ksh 1,000) (6)	Total Spent in Marketing (in Ksh 1,000) (7)	Logarithm of Household Income (8)	Loan from Formal Institutions (9)	Deposit in Formal Institutions (10)
Panel A: intent-to-treat estimates, OLS										
Post	−0.004	−0.078	0.049	0.664	11,133	−7,062	3,567	−0.107	−0.057	0.117
	[0.059]	[0.019]***	[0.018]***	[0.768]	[34.775]	[5.139]	[2.113]	[0.097]	[0.012]***	[0.033]***
Post ×	0.192	0.043	−0.004	1,611	396,735	4,829	−3,528	0.089	0.048	0.078
treatment	[0.067]***	[0.024]*	[0.019]	[1.270]	[99.607]***	[6.269]	[1.781]*	[0.110]	[0.016]***	[0.040]*
Number of observations	1,983	1,779	1,822	1,981	1,981	1,603	1,653	1,566	1,672	1,672
R^2	0.27	0.13	0.07	0.21	0.07	0.26	0.02	0.16	0.05	0.17
Panel B: Treatment-on-the-treated estimates, IV (requires assuming no within-group spillovers)										
Post	−0.003	−0.078	0.049	0.672	13,016	−6,916	3,445	−0.105	−0.055	0.119
	[0.059]	[0.019]***	[0.018]***	[0.772]	[34.534]	[5.066]	[2.077]	[0.095]	[0.012]***	[0.032]***
Post ×	0.466	0.099	−0.010	3,932	968,183	11,689	−8,696	0.212	0.119	0.192
treatment	[0.165]***	[0.056]*	[0.046]	[3.016]	[253.923]***	[15.235]	[4.432]*	[0.268]	[0.043]***	[0.103]*
Number of observations	1,983	1,779	1,822	1,981	1,981	1,603	1,653	1,566	1,672	1,672
Mean dependent variable	0.526	0.568	0.961	4.546	144.6	40.1	1.4	3.495	0.033	0.800

Note: The variable "post" takes value 1 in year 2005, when follow-up was conducted. The variable "treatment" is an indicator variable equal to one if the member is in a treatment SHG. Panel A shows the results of OLS regressions with SHG fixed effects. Panel B shows the results of IV regressions with assignment to treatment group as an instrument for DrumNet take-up. Robust standard errors are clustered at the SHG level and reported in brackets below the coefficient. The asterisks (*), (**), and (***) represent significance at 10, 5, and 1%, respectively. Only SHG members at the time of the baseline are included in the regression. All regressions include the following controls: age of member, literacy, member of SHG is an officer (1 = yes), proportion of land that is irrigated, total landholdings (acres), uses hired labor (1 = yes) and uses machinery and/or animal force (1 = yes), and indicator variables for any missing values for each of the controls.

are significant and have the expected sign. The coefficients on the log income terms imply a maximum at the median log income: the further above and the further below median log income, the less likely an individual is to participate in DrumNet. This pattern is the same in both credit and no credit groups (not shown), thus we conclude that including credit in the package of DrumNet services does not change the composition of participants with respect to income.

Impact of DrumNet

Table 4 presents the basic impact analysis.[11] We use both baseline and follow-up data to construct the intent-to-treat (ITT) estimate of impact, which measures the average effect of being randomly offered the DrumNet program across those who took up and those who did not, and the treatment-on-the-treated (TOT-IV) impact, which measures the actual treatment impact on those who took up, purged of selection bias by using random assignment to treatment as an instrument for program participation, based on certain assumptions that we discuss below. We include fixed effects for each SHG and all individual-level baseline controls of table 2.[12] In table 4, panel A, we report the intent-to-treat results for the pooled treatment groups, and in panel B we report the treatment-on-the-treated estimates for the pooled treatment groups. The coefficient of "post × treatment" in panel A identifies the impact of the DrumNet *offer* on farmer outcomes, while in panel B it identifies, assuming no spillovers within cluster, the impact of DrumNet *participation* among those that took up the program when offered because no individuals that were assigned to the control group received the treatment (Angrist 2004). In table 5, we then separately estimate the ITT (panel A) and TOT (panel B) estimates of the impact of DrumNet with and without credit. The econometric specification for the ITT is as follows:

$$(1) \quad Y_{ijt} = \alpha_j + \beta Post_t + \delta Post_t \times Treatment_j + X'_{ij}\gamma + \varepsilon_{ijt}$$

and

$$(2) \quad Y_{ij} = \alpha_j + \beta Post_t + \delta_C Post_t \times Credit_j + \delta_{NC} Post_t \times No\ Credit_j + X'_{ij}\gamma + \varepsilon_{ijt}$$

[11] We report OLS estimates of impact in the text; in tables 4 and 5 in Ashraf, Giné, and Karlan (2009), we report impact estimates using conditional logit models for all dependent variables that are binary (such as whether the farmer has switched to an export crop). Results across specifications are similar. However, it is not clear that a nonlinear model is preferred in this case due to the imposition of stricter functional form assumptions. See Angrist (2001) for exposition of this issue and Chattopaydhyay and Duflo (2004) for an example of similar empirical design and strategy.

[12] We also estimated a specification where we include the interaction of Post with all the baseline controls. The results do not differ from those of Tables 4 and 5 and are therefore not reported.

Table 5. Impact of DrumNet: Credit Versus No Credit, OLS, and IV

	Export Crop	Proportion of Land Devoted to Cash Crops	Use of Inputs	Production of French Beans (in 1,000 kg)	Production of Baby Corn (kg)	Value of Harvested Produce (in Ksh 1,000)	Total Spent in Marketing (in Ksh 1,000)	Logarithm of Household Income	Loan from Formal Institutions	Deposit in Formal Institutions
Panel A: Intent-to-treat estimates, OLS										
Post	−0.004	−0.078	0.049	0.666	11,318	−7,117	3,557	−0.108	−0.057	0.117
	[0.059]	[0.019]***	[0.018]***	[0.769]	[34.785]	[5.138]	[2.114]	[0.097]	[0.012]***	[0.033]***
Post × credit	0.226	0.046	−0.009	2,331	460,980	2,042	4,014	0.014	0.033	0.088
	[0.077]***	[0.028]	[0.022]	[1.759]	[148.600]***	[9.084]	[2.016]*	[0.118]	[0.022]	[0.048]*
Post × no credit	0.158	0.039	0.001	0.917	334,709	7,345	−3,103	0.163	0.061	0.070
	[0.071]**	[0.029]	[0.020]	[1.455]	[125.341]**	[6.183]	[1.784]*	[0.119]	[0.014]***	[0.041]*
Number of observations	1.983	1,779	1,822	1,981	1,981	1,603	1,653	1,566	1,672	1,672
R^2	0.27	0.13	0.07	0.21	0.07	0.26	0.02	0.16	0.05	0.17
p-value of F-test post × credit = post × no credit										
	0.291	0.812	0.533	0.481	0.507	0.557	0.485	0.119	0.173	0.625
Panel B: Treatment-on-the-treated estimates, IV (requires assuming no within-group spillovers)										
Post	−0.003	−0.078	0.049	0.672	13,016	−6,926	3,446	−0.105	−0.055	0.119
	[0.059]	[0.019]**	[0.018]***	[0.772]	[34.546]	[5.074]	[2.078]	[0.095]	[0.012]***	[0.032]***
Post × credit	0.475	0.092	−0.019	4,900	968,940	4,388	−8,476	0.032	0.071	0.185
	[0.170]***	[0.056]	[0.045]	[3.722]	[284.230]***	[19.020]	[4.230]*	[0.248]	[0.047]	[0.108]*
Post × no credit	0.454	0.109	0.003	2,654	967,183	20,872	−8,967	0.446	0.177	0.200
	[0.200]**	[0.083]	[0.057]	[3.948]	[433.997]**	[16.616]	[5.378]	[0.376]	[0.062]***	[0.124]
Number of observations	1.983	1,779	1,822	1,981	1,981	1,603	1,653	1,566	1,672	1,672
Mean dependent variable	0.526	0.568	0.961	4.546	144.614	40.113	1.379	3.495	0.033	0.800
p-value of F-test post × credit = post × no credit										
	0.899	0.822	0.588	0.632	0.997	0.407	0.892	3.495	0.105	0.887

Note: The variable "post" takes value 1 in year 2005, when follow-up was conducted. The variables "credit" and "no credit" are indicator variables for each treatment group. Panel A shows the results of OLS regressions with SHG fixed effects. Panel B shows the results of IV regressions with assignment to each treatment group as an instrument for DrumNet take-up. Robust standard errors are clustered at the SHG level and reported in brackets below the coefficient. The asterisks (*), (**), and (***) represent significance at 10, 5, and 1%, respectively. Only SHG members at the time of the baseline are included in the regression. All regressions include the following controls: age of member, literacy, member of SHG is an officer (1 = yes), proportion of land that is irrigated, total landholdings (acres), uses hired labor (1 = yes) and uses machinery and/or animal force (1 = yes), and indicator variables for any missing values for each of the controls.

where Y_{ij} is the outcome measure, α_j is a SHG fixed effect, $Post_t$ is a dummy that takes value 0 in 2004 and 1 in year 2005, $Treatment_j$ is a dummy that takes value 1 if the SHG j is a treatment SHG, X_{ij} is the set of baseline controls reported in table 2 and ε_{ij} is the error term, clustered within SHG. In specification (2), the dummies $Credit_j$ and $No\ Credit_j$ are defined analogously. We include the set of baseline controls because, despite the random assignment, assignment to treatment was correlated with certain observable characteristics.[13]

The interpretation of panel B treatment-on-the-treated (TOT) estimates will be valid as long as certain assumptions are satisfied (Angrist, Imbens, and Rubin 1996; Angrist and Pischke 2009). First, that the offer to participate in DrumNet be random. Second, that the offer actually increases the probability of participating in DrumNet. Third, that control groups do not participate in DrumNet, and finally, the most questionable in this setting, that the offer of DrumNet does not have an independent effect on the outcome variables—such as crop choice and yields—except through actually joining the program (i.e., the exclusion restriction). This assumption cannot actually be tested in this setting, but it is violated if there are within-group externalities. In particular, if the behavior of nonparticipants is affected by that of participants then the exclusion restriction is violated. If we knew who would not participate in DrumNet when offered among members in control groups, we could test for the degree of spillovers by comparing the outcomes of nonparticipants in treatment groups with nonparticipants in control groups, but unfortunately we lack the ability to conduct such a test.[14] Given the nature of the groups that they are designed to facilitate communication and cooperation in agriculture, we are concerned that this assumption is not valid. Therefore, whereas we present both TOT and ITT estimates, we consider the ITT estimates the preferred results for interpretation.

Average Treatment Effects

When describing the outcome measures, we will walk through the agricultural process in order to examine at what steps DrumNet causes change. We examine, in chronological order, whether export crops are grown, the percentage of area devoted to cash crops, use of

[13] If no controls or fixed effects were included in specifications (1) and (2), then the treatment on the treated (TOT) estimate would be identical to the intent-to-treat (ITT) estimate divided by the proportion of individuals that participated in DrumNet.

[14] See Miguel and Kremer (2004) for such an analysis in a very different context.

inputs, production of export crops, value of harvest, marketing expenditures, and household income. We also examine use of lending or savings services from other formal financial institutions.

First, we find the immediate effect on growing an export crop is strong and significant: treatment individuals are 19.2 percentage points more likely to be growing an export crop than control individuals, and likewise a greater proportion of their land is dedicated to cash crops (table 4, panel A, columns 1 and 2). We do not find any increase in expenditure on inputs (panel A, column 3).

Next we examine production of export crops in kilograms and find large increases for baby corn but insignificant increases for French beans (panel A, columns 4 and 5). Most farmers that were already growing export crops were only growing French beans, not baby corn. Thus, the increased production of baby corn can be attributed to DrumNet entirely. The more difficult to measure outcomes of the value of the produce was positive but statistically insignificant (panel A, column 6). Marketing expenditures were lower for treatment members compared to control members (panel A, column 7).

For the log of household income (panel A, column 8), we find on the full sample a positive but statistically insignificant result.

Finally, members in treatment SHGs seem to be obtaining loans for formal sources (other than DrumNet) and are also more likely to have a deposit with a formal institution (panel A, columns 9 and 10). The finding on increased borrowing from formal sources is explained below. The finding on the increased number of members with a savings account in a formal institution is not surprising because DrumNet opened an account with all SHG members that did not have one previously to facilitate transactions.

In table 5, panel A, we estimate the intent-to-treat effect for the credit and no credit groups separately. Surprisingly, despite the differential program participation rates, we do not find many significant differences between the credit and no credit groups even on the intent-to-treat specification employed. This may be because the offer of credit may have changed the type of farmer who agreed to participate, and this "type" may be correlated with unobservables that affect success of the program. Note from the earlier discussion that we do not observe many differences in selection on observables between the credit and no credit groups, but we also are only able to explain about one-third of the variation in the program participation decision.

Heterogeneous Treatment Effects

In table 6, we examine important heterogeneous treatment effects for those who were already growing DrumNet export crops versus those that were not. For each outcome variable we employ the above specifications (1) and (2), also presented in tables 4 and 5.

We find that those who benefit the most are precisely first-time growers of export crops. Prior growers do not devote more land to cash crops nor do they increase production of French beans, but first-time adopters do both. Both prior growers and new adopters increase their production of baby corn since, as mentioned before, baby corn was introduced by DrumNet. Interestingly, only prior growers perceive a reduction in marketing costs. This could be explained by the fact that first-time adopters were only selling at the farm gate, while old adopters were hauling their produce to be exported to markets.

Most importantly, we find here that income is significantly larger for first-time exporters, an increase of 31.9% for the pooled treatment group. Table 7 shows this broken down for the credit and no credit groups, but the difference between these two groups is not significant statistically (although the point estimate is higher for the no credit group).

General Equilibrium Effects

Using the marketing transaction data also collected at the time of the survey, we also tested whether treatment SHGs benefited from an access to higher prices than they would otherwise (note that whereas a large intervention of this sort may actually shift market prices, DrumNet, relative to the market as a whole, was too small to realistically cause general equilibrium shift in overall market prices). To examine prices available to farmers in the study, we use all transaction data available, including those conducted at farm gate as well as at a local or distant market. The dependent variable is the price per relevant unit of the crop: kilogram for French beans and coffee, 90-kg bag for maize and beans and bunches bananas. We run a pooled regression, which includes crop fixed effects and a crop-by-crop for

Table 6. Impact of DrumNet (Prior Exporters Versus New Adopters) OL and IV

Grows Export Crops at Baseline	Proportion Land Devoted to Cash Crops		Use of Inputs		Production of French Beans (1,000 kg)		Production of Baby Corn (kg)		Value of Harvested Produce (in Ksh 1,000)		Total Spent in Marketing (in Ksh 1,000)		Logarithm of Household Income		Loan from Formal Institutions		Deposit in Formal Institutions	
	Yes (1)	No (2)	Yes (3)	No (4)	Yes (5)	No (6)	Yes (7)	No (8)	Yes (9)	No (10)	Yes (11)	No (12)	Yes (13)	No (14)	Yes (15)	No (16)	Yes (17)	No (18)
Panel A: Intent-to-treat estimates, OLS																		
Post	−0.102	−0.052	0.007	0.106	0.664	1,878	−18,175	64,590	−13,294	3,394	4,974	2,535	−0.127	−0.132	−0.074	−0.030	0.090	0.149
	[0.017]***	[0.034]	[0.005]	[0.042]***	[1.544]	[0.875]**	[31.051]	[48.654]	[10.011]	[5.047]	[3.344]	[2.153]	[0.094]	[0.176]	[0.014]***	[0.017]*	[0.029]***	[0.041]***
Post × treatment	−0.019	0.086	−0.007	−0.033	−3,904	4,885	489,112	338,607	5,059	4,162	−6,488	−1,494	−0.028	0.319	0.061	0.025	0.077	0.075
	[0.031]	[0.041]***	[0.007]	[0.044]	[2.053]*	[2.085]**	[128.097]**	[104.410]**	[12.668]	[6.633]	[3.319]*	[1.913]	[0.119]	[0.182]*	[0.021]***	[0.022]	[0.048]	[0.051]
Number of observations	818	909	822	947	894	1,027	894	1,027	774	770	800	793	764	744	802	799	802	799
R^2	0.19	0.14	0.03	0.11	0.45	0.19	0.10	0.08	0.37	0.23	0.03	0.10	0.20	0.19	0.08	0.07	0.17	0.23
Panel B: Treatment-on-the-treated estimates, IV (requires assuming no within-group spillovers)																		
Post	−0.102	−0.050	0.007	0.106	0.636	1,919	−14,689	67,396	−13,090	3,676	4,699	2,423	−0.128	−0.107	−0.071	−0.028	0.093	0.154
	[0.017]***	[0.034]	[0.005]	[0.043]**	[1.544]	[0.874]**	[29.915]	[49.529]	[9.859]	[4.930]	[3.332]	[2.060]	[0.093]	[0.168]	[0.014]***	[0.016]*	[0.029]***	[0.039]***
Post × treatment	−0.036	0.222	−0.013	−0.085	−7,724	12,942	967,746	897,034	9,775	12,288	−12,742	−4,524	−0.053	0.926	0.119	0.076	0.149	0.224
	[0.059]	[0.103]***	[0.014]	[0.117]	[4.305]*	[4.868]**	[250.706]**	[313.445]**	[24.836]	[19.948]	[6.666]*	[5.999]	[0.232]	[0.576]	[0.044]***	[0.072]	[0.098]	[0.152]
Number of observations	818	909	822	947	894	1,027	894	1,027	774	770	800	793	764	744	802	799	802	799
Mean dependent variable	0.653	0.496	0.996	0.930	6.861	2.751	147.642	156.560	49.923	30,085	1.979	0.768	3.641	3.354	0.036	0.029	0.813	0.782

Note: The variable "post" takes value 1 in year 2005, when follow-up was conducted. The variable "treatment" is an indicator variable equal to one if the member is in a treatment SHG. Panel A shows the results of OLS regressions with SHG fixed effects. Panel B shows the results of IV regressions with assignment to treatment group as an instrument for DrumNet take-up. Robust standard errors are clustered at the SHG level and reported in brackets below the coefficient. The asterisks (*), (**), and (***) represent significance at 10, 5, and 1%, respectively. Only SHG members at the time of the baseline are included in the regression. All regressions include the following controls: age of member, literacy, member of SHG is an officer (1 = yes), proportion of land that is irrigated, total landholdings (acres), uses hired labor (1 = yes) and uses machinery and/or animal force (1 = yes), and indicator variables for any missing values for each of the controls.

Table 7. Impact of DrumNet (Prior Exporters Versus New Adopters) OLS and IV

	Proportion Land Devoted to Cash Crops		Use of Inputs		Production of French Beans (1,000 kg)		Production of Baby Corn (kg)		Value of Harvested Produce (in Ksh 1,000)		Total Spent in Marketing (in Ksh 1,000)		Logarithm of Household Income		Loan from Formal Institutions		Deposit in Formal Institutions	
Grows Export Crops at Baseline	Yes (1)	No (2)	Yes (3)	No (4)	Yes (5)	No (6)	Yes (7)	No (8)	Yes (9)	No (10)	Yes (11)	No (12)	Yes (13)	No (14)	Yes (15)	No (16)	Yes (17)	No (18)
Panel A: Intent-to-treat estimates, OLS																		
Post	−0.102	−0.052	0.007	0.106	0.662	1,877	−17,820	64,584	−13,307	3,549	4,964	2,561	−0.127	−0.134	−0.074	−0.031	0.090	0.150
	[0.0171]***	[0.034]	[0.005]	[0.042]**	[1.545]	[0.876]**	[31.004]	[48.669]	[10.013]	[5.030]	[3.347]	[2.158]	[0.094]	[0.176]	[0.014]***	[0.017]*	[0.0291]***	[0.041]***
Post × credit	−0.027	0.118	−0.014	−0.032	−4,728	8,075	619,801	351,978	3,291	12,032	−7,539	−0.386	−0.006	0.219	0.064	−0.019	0.067	0.134
	[0.034]	[0.046]**	[0.008]*	[0.048]	[2.312]**	[2.604]***	[200.553]*	[136.257]*	[15.781]	[5.043]**	[3.564]**	[2.127]	[0.139]	[0.188]	[0.030]**	[0.025]	[0.065]	[0.049]***
Post × no credit	−0.008	0.056	0.004	−0.034	−2,859	2,405	323,490	328,213	7,348	−0.434	−5,159	−2,119	−0.059	0.384	0.057	0.049	0.089	0.042
	[0.048]	[0.044]	[0.010]	[0.045]	[2.432]	[2.569]	[114.607]*	[144.762]*	[13.844]	[7.642]	[3.256]	[1.894]	[0.140]	[0.195]*	[0.019]***	[0.022]**	[0.049]*	[0.059]
Number of observations	818	909	822	947	894	1,027	894	1,027	774	770	800	793	764	744	802	799	802	799
R^2	0.19	0.14	0.03	0.11	0.46	0.20	0.10	0.08	0.37	0.23	0.03	0.10	0.20	0.19	0.08	0.08	0.17	0.23
p-value of F-test post × credit = post × no credit																		
	0.722	0.143	0.144	0.945	0.455	0.108	0.205	0.901	0.804	0.052	0.191	0.166	0.718	0.150	0.823	0.009	0.743	0.096
Panel B: Treatment-on-the-treated estimates, IV (requires assuming no within-group spillovers)																		
Post	−0.102	−0.050	0.007	0.105	0.633	1,906	−14,040	67,788	−13,123	3,455	4,687	2,369	−0.128	−0.099	−0.071	−0.026	0.093	0.153
	[0.017]***	[0.034]	[0.005]	[0.042]**	[1.546]	[0.873]**	[29.897]	[49.472]	[9.867]	[4.976]	[3.337]	[2.031]	[0.093]	[0.168]	[0.014]**	[0.016]	[0.029]***	[0.039]***
Post × credit	−0.046	0.250	−0.025	−0.068	−8,682	17,457	1,138,116	757,232	5,967	27,982	−13,981	−1,031	−0.011	0.519	0.119	−0.040	0.125	0.309
	[0.061]	[0.095]**	[0.016]	[0.104]	[4.743]*	[5.550]***	[345.239]*	[304.560]	[28.894]	[14.399]*	[6.780]**	[5.129]	[0.261]	[0.458]	[0.060]*	[0.061]	[0.128]	[0.130]**
Post × no credit	−0.017	0.182	0.008	−0.108	−6,278	7,754	710,707	1,057,668	15,529	−1,660	−10,965	−7,695	−0.114	1,348	0.119	0.180	0.184	0.147
	[0.104]	[0.141]	[0.022]	[0.153]	[5.640]	[7.479]	[281.214]*	[538.6781]	[28.735]	[27.200]	[7.010]	[7.110]	[0.272]	[0.824]	[0.046]**	[0.099]*	[0.105]*	[0.214]
Number of observations	818	909	822	947	894	1.027	894	1.027	774	770	800	793	764	744	802	799	802	799
Mean dependent variable	0.653	0.496	0.996	0.930	6.861	2.751	147.642	156.560	49.923	30,085	1.979	0.768	3.641	3.354	0.036	0.029	0.813	0.782
p-value of F-test post × credit = post × no credit																		
	0.792	0.546	0.203	0.683	0.679	0.275	0.339	0.620	0.756	0.216	0.396	0.129	0.710	0.171	0.996	0.021	0.674	0.4028

Note: The variable "post" takes value 1 in year 2005, when follow-up was conducted. The variables "credit" and "no credit" are indicator variables for each treatment group. Panel A shows the results of OLS regressions with SHG fixed effects. Panel B shows the results of IV regressions with assignment to each treatment group as an instrument for DrumNet take-up. Robust standard errors are clustered at the SHG level and reported in brackets below the coefficient. The asterisks (*), (**), and (***) represent significance at 10, 5, and 1%, respectively. Only SHG members at the time of the baseline are included in the regression. All regressions include the following controls: age of member, literacy, member of SHG is an officer (1 = yes), proportion of land that is irrigated, total landholdings (acres), uses hired labor (1 = yes) and uses machinery and/or animal force (1 = yes), and indicator variables for any missing values for each of the controls.

specification for the main crops grown. Analogous to the impact tables 4–7, all regressions include SHG fixed effects and all household baseline controls of table 2. Standard errors are also clustered at the SHG level, our unit of randomization. Table 8 reports the results.

All coefficients of interest, but one (no credit × post in the maize regression), are insignificant, thus, we conclude that there are no differences between unit prices perceived by members of treatment and control SHGs even if treatment group is split into credit and no credit groups. The point estimates of treatment × post in column 3 and credit × post and no credit × post in column 4 are all negative and insignificant, indicating that treatment groups did not receive on average higher prices for French beans. The DrumNet administrative data show an average net transaction price in 2005 of US$0.33 per kg,[15] compared to a lower mean transaction price for French beans in 2005 of US$0.26 per kg. Thus, while transactions with DrumNet were possibly more profitable than with middlemen, the average price of French beans in the treatment group, which includes the transaction prices of nonmembers as well as members selling to middlemen, fails to show it. Notice in contrast that the post coefficient of French beans, maize, and coffee is positive and significant, indicating that, on average, the price of these crops was higher in 2005 than in 2004. Figure 3 plots the Kenya-wide price index of the same crops, taking year 2001 as the base year.[16] Consistent with the post coefficient of table 8, figure 3 shows an increase in prices from 2004 to 2005 for the same crops.

Finally, we interviewed the few local input suppliers that serve Gichugu and we found anecdotally that the price of inputs (fertilizer, pesticides, and seeds) was not affected either by the presence of DrumNet. This is not surprising, since in aggregate DrumNet was fairly small compared to the market as a whole.

Business Viability

In this section we assess whether DrumNet was profitable from a business standpoint. The monthly cost of the DrumNet main regional office in Kerugoya for an average month during the study was US$1,200 and included the rental, salaries, transportation, utilities, marketing, and communication expenses. In addition, the Kerugoya office benefited from two "market intelligence" offices in the nearby markets of Karatina and Wakulima where the staff would check on local prices and report to Kerugoya. These offices were fully staffed from January until June 2004 and were closed in December 2004. The monthly cost for these two offices during the study period was US$50. These monthly costs include neither a motor vehicle owned by the Kerugoya office nor expenses from the Pride Africa Nairobi national office, even though DrumNet was a project of Pride Africa.

At the time of the study, DrumNet was already operating with some SHGs that were growing passion fruit, French beans, and baby corn. By the end of the study, they were working with forty-three collection points, fourteen of which were established for the study. In order to calculate the cost of the study to DrumNet, we calculate a monthly cost per collection point and multiply it by the number of study collection points.

To compute the sustainability of DrumNet as a business, we compute the annualized cost of running DrumNet per member and compare it to the income generated from the commission that DrumNet charged in each transaction. DrumNet registered 294 farmers in the month of June 2004 for the study, although they did not start generating revenues until September 2004. Unfortunately, we only have administrative data from DrumNet for 2004, so we can only assess business profitability from June to December. Assuming a conservative 10% cost of funds, DrumNet made a net loss of US$12 per client in the experimental SHG. One explanation for this loss is that the horizon we are considering is too short. In 2005, clients in the experimental SHG were already producing and marketing with DrumNet, although we lack the data to assess whether DrumNet made a profit over the one-year horizon. Needless to say, DrumNet was making a profit in 2004 with farmers in nonexperimental groups that started before the evaluation, in other geographic areas of Kenya. DrumNet's goals were to become a sustainable organization, one that could finance its continued operations itself while serving the goal of agricultural development in the region.

[15] At the time of the study 1 Kenyan shilling = US$0.01314 (http://www.oanda.com/convert/classic).

[16] Price data for French beans and bananas come from the Horticultural Crops Development Authority (HCDA), prices for maize and beans come from the Regional Agricultural Trade Intelligence Network (RATIN), and finally prices for coffee come from the Nairobi Coffee Exchange.

Table 8. Impact on Prices, OLS, and IV

	All Crops		French Beans		Bananas		Maize (Dry)		Beans		Coffee	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Intent-to-treat estimates, OLS												
Post	21.92	21.89	5.54	5.55	6.81	6.81	364.82	364.09	−276.23	−276.75	3.85	3.83
	[16.41]	[16.41]	[1.47]***	[1.47]***	[8.37]	[8.37]	[98.99]***	[99.02]***	[251.64]	[252.49]	[0.56]***	[0.56]***
Treatment × post	−3.67		−1.61		−11.20		−181.50		308.93		−0.09	
	[19.26]		[1.77]		[9.76]		[113.48]		[290.40]		[0.65]	
Credit × post		−0.30		−2.60		−16.43		−129.93		274.63		0.91
		[21.91]		[1.97]		[11.15]		[126.06]		[331.18]		[0.76]
No credit × post		−7.44		−0.15		−5.63		−24,327		343.36		−1.05
		[22.55]		[2.19]		[11.33]		[131.15]*		[331.47]		[0.75]
Number of observations	2,850	2,850	760	760	713	713	295	295	190	190	892	892
R^2	0.86	0.86	0.37	0.37	0.35	0.35	0.34	0.34	0.40	0.40	0.44	0.44
p-value of test post × credit = post × no credit												
		0.796		0.332		0.308		0.438		0.8422		0.012
Panel B: Treatment-on-the-treated estimates, IV (requires assuming no within-group spillovers)												
Post	21.32	21.34	5.43	5.39	7.06	7.07	363.93	361.77	−278.66	−271.84	3.82	3.80
	[15.91]	[15.93]	[1.37]***	[1.37]***	[8.47]	[8.46]	[98.51]***	[100.21]***	[269.97]	[269.59]	[0.54]***	[0.54]***
Treatment × post	−5.36		−2.96		−26.78		−506.12		1,003.41		−0.15	
	[43.24]		[3.21]		[23.13]		[316.32]		[1,004.44]		[1.49]	
Credit × post		0.66		−4.43		−33.94		−28,225		708.56		1.91
		[42.51]		[329]		[22.74]		[264.91]		[898.46]		[1.52]
No credit × post		−15.14		−0.30		−15.62		−1,206.84		1,464.26		−2.77
		[62.51]		[4.65]		[33.53]		[665.58]*		[1,495.61]		[1.98]
Number of observations	2,850	2,850	760	760	713	713	295	295	190	190	892	892
Mean dependent variable	265.516	265.516	19.457	19.457	96.559	96.559	1,115.813	1,115.813	1,782.217	1,782.217	5.942	5.942
p-value of test post × take up credit = post × take up no credit												
		0.778		0.437		0.513		0.150		0.523		0.013

Note: The dependent variable is the transacted price per relevant unit of a crop: kilogram for French beans and Coffee, 90-kg bag for maize (dry) and beans and bunches for bananas. All transaction data are used, including those at farm gate as well as at a local or distant market. The variable "post" takes value 1 in year 2005, when follow-up was conducted. The variable "treatment" in odd-numbered columns is an indicator variable equal to one if the member is in a treatment SHG. The variables "credit" and "no credit" in even-numbered columns are indicator variables for each treatment group. Panel A shows the results of OLS regressions with SHG fixed effects. Panel B shows the results of IV regressions with assignment to treatment in odd-numbered columns and to each treatment group in even-numbered columns as an instrument for DrumNet take-up. Robust standard errors are clustered at the SHG level and reported in brackets below the coefficient. The asterisks (*), (**), and (***) represent significance at 10, 5, and 1%, respectively. Only SHG members at the time of the baseline are included in the regression. All regressions include the following member controls: age of member, literacy, member of SHG is an officer (1 = yes), proportion of land that is irrigated, total landholdings (acres), uses hired labor (1 = yes) and uses machinery and/or animal force (1 = yes), and indicator variables for any missing values for each of the controls.

International Food Safety Standards: The EurepGap Requirements

In this section we describe the requirements that the few Kenyan smallholders who have succeeded over the years in producing for the export market face since the implementation of the EurepGap in January 2005. These requirements are established in the protocol for Good Agricultural Practices (GAP) of the retailer members (mostly supermarkets) of Euro-Retailer Produce Working Group (EUREP) and are a response to rising litigation from European consumers following several food safety scandals (Jaffee 2004; Mungai 2004; Okello, Narrod, and Roy 2007). These requirements aim to ensure the production of safe, high-quality food using practices that reduce the impact of farming on the environment. Exporters must be able to trace production back to the specific farm from which it came in order to ensure safe pesticide use, handling procedures, and hygiene standards.

Export growers have to be certified, either individually or as a group. Certification is obtained during an on-farm inspection and has to be renewed every year. An SHG that seeks certification has to be registered with the Ministry of Culture and Social Services. SHG members have to draft a group constitution and sign a resolution stating their desire to develop a quality management system and to seek EurepGap certification. The quality management system involves the construction of a grading shed and a chemical storage facility with concrete floors, doors and lock, and proper ventilation as well as latrines with running water. In addition, they need to keep written records for two years of all their farming activities, both at the group and individual level, including the variety of seeds used, where they were purchased, the planting date, agrochemicals used, exact quantities, and date of application. Spraying equipment must be in good working condition and the person doing the spraying must wear protective gear. Farm chemicals must be carefully stored under lock in a proper storage facility and in their original containers. The water used for irrigation must be periodically checked. Finally, every grower's produce needs to be properly labeled.

Asfaw, Mithofer, and Waibel (2007) estimate that the cost of compliance with EurepGap standards per farmer under the group

certification option is US$581,[17] including US$446 investment in infrastructure (e.g., toilet, grading shed, fertilizer and chemical stores, waste disposal pit, pesticide disposal, charcoal cooler, protective clothing, and sprayer) with an average life of 7.8 years and US$134 in recurrent yearly expenses (e.g., application for SHG and water permit, record keeping, audits, water, and soil analysis).[18,19] Most SHGs that have been certified have not typically covered these expenses on their own. Donors have helped farmers make the investments in infrastructure while exporters pay for part of the recurring expenses. But if help from donors and exporters is not forthcoming, smallholder farmers may find it difficult to obtain certification. Given our results, the costs of compliance during the first year are more than twice the net gain of first-time adopters, although, of course, the costs can be recouped over several years.

As a result and as predicted by several authors and the Kenyan press (cf., Farina and Reardon 2000; Mungai 2004), most Kenyan exporters reduced their involvement with small-scale growers after the introduction of EurepGap (Graffman, Karehu, and MacGregor 2007).

According to an independent survey fielded by International Development Research Center (IDRC) in November 2004 in the same region where DrumNet operates, farmers reported having heard about the EurepGap requirements although they were unable to give specific details. Regardless, they seemed overconfident about their ability to obtain certification. Although EurepGap compliance was made mandatory in January 2005, it was not until mid 2006 that the exporter in partnership with DrumNet ceased to purchase the produce from DrumNet SHGs since they lacked certification. In the next section we describe the fate of DrumNet SHG after European export markets became inaccessible.

Conclusion and Epilogue

We examine whether an intervention to help smallholder farmers access export markets can change farmer practices and improve household income. We find that the program succeeds in getting farmers to switch crops, and that the middle-income farmers were the most likely to participate in the program (relative to low-income and high-income).

Comparing members that were offered credit to those that were not, we find that credit increases participation in DrumNet but does *not* translate into higher income gains relative to the no credit treatment group. This suggests that either access to credit is *not necessarily* the primary explanation for why farmers are not accessing these markets on their own or those who were able to access markets already had some ability to do so, such that increasing credit did not change their income.

We find a significant increase in household income but only for farmers who were not previously accessing export markets. This implies that, in order to generate positive economic returns at the household level, such interventions should focus intensely on deepening outreach to new farmers, not merely facilitating transactions for farmers already exporting crops.

As with any empirical research, external validity is of utmost concern. These results are encouraging; profitable solutions exist to improve horticultural choices by farmers and increase household income. However, as with any program, many local conditions and organizational characteristics may have been necessary conditions for finding these positive impacts. Furthermore, the heterogeneous results regarding credit and no credit require further research to understand more fully. With further carefully designed evaluations, we can learn more about *why* these interventions are necessary in the first place, and such information can then be used for designing even better interventions that focus directly on the source of the problem.

The epilogue to this project is not good. One year after the follow-up data were collected, the exporter refused to continue buying the crops from DrumNet farmers since none of the SHGs had obtained EurepGap certification. DrumNet lost money on its loan to the farmers and collapsed, but equally importantly farmers were forced to sell to middlemen, sometimes leaving a harvest to rot. As reported to us by DrumNet, the farmers were upset but powerless, and most of them subsequently returned

[17] In 2007, 1 Kenyan shilling = US$0.0129.

[18] These costs do not include the pesticide residue analysis to check maximum residue level (MRL) compliance. Because it has to be done in every farm and is fairly expensive (Ksh 8,000–20,000 or US$200 per farm), some exporters do not test the produce they buy for residue content but their European buyers will occasionally test random sample and will notify them if there are problems (Okello and Swinton 2007).

[19] Okello, Narrod, and Roy (2007) present alternative group certification costs gathered from records and informal interviews with farmers, group leaders, and certification companies. The costs are Ksh 439,000 (roughly US$6,000) for the group, which amounts to Ksh 29,264 (roughly US$400) per farmer assuming groups of fifteen members.

to growing what they had been growing before (e.g., local crops such as maize). In 2007, the exporter told us that it was working again with two of the treatment SHGs after they had built a grading shed with a charcoal cooler. The exporter provided the seeds, first in exchange for cash and later on credit, but did not provide any additional training.

Two lessons can be drawn from the DrumNet experience. First, on the positive side, DrumNet succeeded in building trust in the horticultural markets by convincing farmers to make specific investments even when some feared holdup problems with the export buyers, and by convincing buyers to trust farmers and purchase their produce. The second lesson, however, was that because DrumNet's success depended on their farmers being certified, it should have secured the resources to cover the substantial infrastructure and maintenance costs to achieve it. The eventual collapse of the transactions thus may have generated a *loss* of trust, the exact problem DrumNet was designed to solve.

[Received September 2008; accepted March 2009.]

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