Interlinked Credit and Farm Intensification: Evidence from Kenya

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Interlinked Credit and its Effects on Farm Intensification in Kenya

Abstract

This paper addresses the potential for interlinked credit/input/output marketing arrangements for particular cash crops to promote food crop intensification. Using panel survey data from Kenya, we estimate a household fixed-effects model of fertilizer use per hectare of food crops. Results indicate that households engaging in interlinked marketing programs for selected cash crops applied considerably greater fertilizer on other crops (primarily cereals) not directly purchased by the cash crop trading firm. These findings suggest that, in addition to the direct stimulus that interlinked cash crop marketing arrangements can have on small farmer incomes, these institutional arrangements may provide spillover benefits for the productivity of the farmers' other activities such as food cropping.

1. Introduction

Meeting the challenge of raising rural incomes in Africa will require some form of transformation out of the semi-subsistence, low-input, low-productivity farming systems that currently characterize much of rural Africa. High-valued cash crops represent one potential avenue of crop intensification. Evidence indicates that, where agro-ecological and infrastructural conditions are favorable, smallholders can raise their agricultural productivity and incomes by engaging in commercialized crops with coordinated input, credit, and output marketing systems (von Braun and Kennedy 1994; Little and Watts, 1994; Kelly *et al.*, 1996; Dorward, Kydd, and Poulton 1998). However, staple food crops continue to account for the bulk of area cultivated in most African countries, and increasing the productivity of these food crops remains a major development priority.

A major research question concerns the effect of engaging in commercialized cash crops on households' food crop productivity. Concerns are often expressed that cash crops compete with food crops for scarce land and may jeopardize households' ability to feed themselves particular when markets fail. However, there is some evidence indicating that participation in cash crop schemes can improve households' access to crop inputs and training that provide "spillover" benefits to their food crops (Goetz, 1993; Govereh and Jayne, 2003). Thus, in addition to the direct effect of cash cropping on household incomes, there may be important indirect effects of cash cropping on the productivity of other household activities such as food cropping. These potential synergies between cash crops and food crops have been generally neglected in food crop research and extension programs, although they may have important implications for programs designed to promote smallholder food crop productivity growth.

This paper measures the potential synergies between interlinked cash cropping schemes and intensification of fertilizer use on food crops. Interlinked schemes are programs where farmers receive inputs on loan from farmers and pay back the loan through sale of the crop at harvest. Credit, input supply, and output sale are "interlinked" in one transaction (Gangopadhyay and Sengupta, 1987; Hayami and Otsuka, 1993). Our analysis focuses on the case of interlinked smallholder crop marketing programs for sugarcane, coffee, and tea in Kenya.

Findings suggest that participation in interlinked cash crop schemes has enabled small farmers in Kenya to acquire key inputs that allow them to substantially increase the level of fertilizer on crops other than the ones featured in commercialized marketing schemes. A better understanding of why and how these synergies occur can help in the design of policy strategies to intensify food crop production in Africa.

2. Data

Analysis is based on a two-year panel of rural household surveys in 1997 and 2000.[1] In April 1997, a total of 1,540 households were randomly selected within the eight provinces of the country, using a sampling frame derived from the Central Bureau of Statistics. In May 2000, 1,422 of these households were located and surveyed (attrition rate was 5.2%).

In Kenya, interlinked credit (ILC) is provided to small farmers mainly by firms purchasing and processing commercialized crops, e.g., coffee, tea, sugarcane, and horticulture. Because of large variations in agro-ecological environments across regions, we restrict our analysis to areas where ILC is available. We selected villages where at least one household received interlinked credit in either survey year. As a result of this procedure, 61 villages containing 825 households were selected (Table 1).

3. Spillover Effects of Interlinked Credit on Fertilizer Use on Other Crops

Pathways for Spill Over Effects

A purchasing or processing firm provides fertilizer on credit under an understanding that producers will sell their produce to the same firm after a harvest. Then, the firm takes out the cost of fertilizer and implicit interest rates from the sales of the produce, often together with other associated costs such as processing and marketing costs. There is a possibility that producers strategically default by selling their produce to firms that did not provide fertilizer to them. Typical examples, such as cotton production in Pakistan, are illustrated in Dorward, Kydd, and Poulton (1998). To avoid such strategic default problems, firms in Kenya use past sales records to set the credit limits for the future. For instance, coffee cooperatives set the credit limit to a producer at the average sales of the past three years. This incentive scheme gives producers an incentive to keep selling their produce to the same firm if they want to obtain in-kind credit in the future. This

[1] These surveys were designed and implemented under the Kenya Agricultural Marketing and Policy Analysis Project (KAMPAP), implemented primarily by Egerton University/Tegemeo Institute.

scheme could be more effective to prevent strategic defaults among coffee and tea producers who need to maintain a log-term contract with local purchasing and processing firms than among producers who are looking for myopic profits.

When fertilizer is provided on credit, how does such credit on commercialized crops have spill over effects to non-ILC crops? We consider the following pathways: (a) the direct physical diversion pathway, (b) the budget expansion pathway, and (c) the learning-by-doing pathway, and (d) the input-market development pathway. In Table 2, we summarize the following discussions on pathways. The first pathway, the direct physical pathway, takes place when types of fertilizer provided via ILC are appropriate for non-ILC crop production. For instance, UREA and DAP provided by coffee cooperatives, sugarcane firms, and horticulture traders can directly be applied on many non-ILC crops, such as maize. In contrast, tea firms provide NPK, which is not appropriate to use on most non-ILC crops. The direct physical diversion of fertilizer will be limited, however, because producers need to maintain the ILC crop production at a high level to obtain a high level of credit in the future. Note, however, that this physical diversion will increase fertilizer use on non-ILC crops only when producers are facing the credit constraint and when costs of fertilizer on credit are higher than market prices of fertilizer, i.e., a positive interest rate on fertilizer on credit. Recently, many firms provide fertilizer on credit not just for the ILC crop, but for food crops as well. The rationale is that participating farmers may increase their area to cash crops if they can satisfy their basic food requirements by using less land (Nyoro 2001).

The second pathway, the budget expansion pathway, will also have positive impacts on fertilizer use on non-ILC crops when ILC-producers are facing the credit constraint. When produces are facing the credit constraint, then producers no longer need to allocate limited resources between fertilizers on ILC and non-ILC crops. Thus, they can devote more resources to purchase fertilizer on non-ILC crops when they receive ILC.

The third pathway, the learning-by-doing pathway, also plays a larger role when types of fertilizers applied on ILC crops are appropriate for non-ILC crops. By applying fertilizer on ILC crops, producers become familiar with the particular fertilizers and start applying them on other crops.

The last pathway, the input market development pathway, which is first illustrated by Goetz (1993), is that in areas with high values crops such as all ILC crops, the input markets for those high value crops develop over time. Because of a high demand for fertilizer by high value crop producers, traders can bring in large amounts of fertilizer to rural areas with a low unit cost. Thus, low fertilizer prices encourage farmers to apply fertilizer on non-ILC crops. This pathway, however, is a long-term development and this paper, which uses a three-year panel, is not suitable to analyze it. Thus, we focus on the first three pathways in the following analysis.

Descriptive Analysis

To examine these potential pathways, we first stratified the sample into two groups, poor and non-poor, based on their 1997 asset values. Assuming that poor households are more likely to face the credit constraint, this stratification is intended to explore the first and second pathways. To examine the impacts of ILC on these two groups, we further stratified the sample into four groups based on credit status in 1997 and 2000. The first group received credit neither in 1997 or 2000. The second group received ILC in 2000 only, while the third group received credit in 1997 only. The last group received credit both in 1997 and 2000. We name these four groups "Neither," "Enter", "Exit" and "Both", respectively. Changes in households' use of ILC between the two periods provide an opportunity to estimate the effects of credit.

The Kenya national level data indeed support an increase in total fertilizer use in Kenya from 1997 to 2000. Indeed, we find an increase in fertilizer use from 1997 to 2000 among our sample households. Table 3 shows how sample households used fertilizer on crops other than the four crops (coffee, tea, sugarcane, and vegetables) for which interlinked credit could be given. We measure fertilizer use as kilograms of nutrients. Nutrient use is a better indicator of soil enhancement than the quantity of fertilizer because nutrient-to-weight ratios differ between fertilizer types.

Table 3 shows that the nutrient use has increased from 1997 to 2000 among all four credit-status groups of poor and non-poor households. The comparison between the “Enter” and “Never” groups among the poor households indicates that the fertilizer use on non-ILC crops increased more by 8.79 kg per acre among “Enter” group than “Never” group. This difference-in-differences indicator is statistically significantly different from zero according to a *t*-test. Among non-poor households, we also find a higher increase in the fertilizer use on non-ILC crops, by 5.13 kg per acre, among “Enter” group than “Never” group, but the difference is not statistically significant. These results suggest that poor households are credit constrained and that the access to credit helps them to expand their fertilizer use on non-ILC crops; consistent with the physical diversion or budget expansion pathway hypotheses.

Between the “Both” and “Exit” groups, we do not find significant differences in increases in fertilizer use on non-ILC crops from 1997 and 2000. This could be because households who received ILC-credit in 1997 are not credit constrained and can finance fertilizer use on non-ILC crops on their own.

4. Estimation Strategies and Variables

The main purpose of this paper is to measure the effects of interlinked credit on fertilizer use on other crops (non-ILC crops) that are not part of interlinked credit contracts.[2] The main

[2] Feder, et al. (1990) and Kochar (1997) have studied on effects of credit on farm productivity in general. They did not study a potential spillover from interlinked credit to non-interlinked credit crops (or food crops).

problem of estimating the effects of interlinked credit is the selection problem at household and village level. Households who are provided interlinked credit by traders and who agree to participate in such arrangements may have unobservable characteristics that are correlated with fertilizer use on Non-ILC crops. Or villages in which traders operate may have good soil quality or infrastructure that encourage high fertilizer use on Non-ILC crops. This selection problem can be written as an omitted variables problem.

The conditional demand equation for fertilizer use on Non-ILC crops is

$$Y_{ijt} = Z_{ijt}\,\beta_B + X_{ijt}\,\beta_X + \alpha_{ij} + v_j + e_{ijt} \qquad (1)$$

where Y_{ijt} is the fertilizer nutrient use on Non-ILC crops of household *i* in village *j* at time t; Z_{ijt} is a dummy variable which is one if household *i* has received interlinked credit at time t; X_{ijt} is a vector of household and village characteristics. The time-invariant unobservable household characteristics is α_{ij}, while the time-invariant village characteristics is v_j. The participation of interlinked credit, Z_{ijt}, is most likely to be correlated with some of unobservable household and village characteristics that are also correlated with the fertilizer use on Non-ILC crops.

By taking an advantage of panel data, we take the first difference of equation (1)

$$Y_{ijt+1} - Y_{ijt} = (Z_{ijt+1} - Z_{ijt})\,\beta_B + (X_{ijt+1} - X_{ijt})\,\beta_X + e_{ijt+1} - e_{ijt}. \qquad (2)$$

The time-invariant unobservable household and village characteristics are now purged from this model. We first estimate the equation (2) for all sample households and then separately for poor and non-poor households to be consistent with descriptive analysis in the previous section. We further stratify the samples by credit status so that we can compare “Neither” against “Enter” and “Exit” against “Both.” These separations may create sample selection biases, but still provide important policy implications.

Variables

The dependent variable is a change in the fertilizer nutrient use per acre on non-ILC crops from 1997 to 2000. The ILC variable is the change in the dummy variable that takes one if a household received ILC credit in a survey year. This variable is zero among “Neither” and “Both” groups, one among “Enter” group, and minus one among “Exit” group. Two sets of household level variables are included in estimations. The first group represents households’ human resources: the maximum years of schooling of male and female adults, a dummy for female-headed households, and demographic attributes. The second group represents households’ financial resources: a dummy for households with land title deed, land owned in acres, total value of agricultural assets (e.g., ploughs, ox-carts, bicycles) and animal assets. Land owned is defined as the sum of land that a household claims its ownership with or without title deed. In the estimation models, we use first-differences of these variables from 1997 to 2000.

5. Results

Spillover Effects

Table 5 shows results from the first-differenced models. The result using the all samples indicates that the ILC has a positive but insignificant impact on fertilizer use on non-ILC crops. When we stratify the sample into poor and non-poor households based on the 1997 asset level, we find a large positive and significant impact on fertilizer nutrient use on non-ILC crops. The result indicates that the ILC increases fertilizer nutrient use by 5.6 kgs per acre on non-ILC crops. Because the average fertilizer nutrient use on non-ILC crops is 16.1 kgs per acer among the poor households, the result suggest a 35 percent

In contrast,, however, the ILC does not have a significant impact. These results are consistent with earlier descriptive results and indicate the importance of ILC among the poor households.

Among the a

The results indicate that the ILC positively affects fertilizer use on Non-ILC crops. Farmers receiving ILC used 15.05 kgs more fertilizer nutrient on non-ILC crops than similar households receiving no credit, but this effect is significant only at the 10% significance level (Table 3). The average level of fertilizer use on non-ILC crops is 18.6 kgs among non-borrowers. Thus the estimated coefficient suggests a 81 percent increase in the fertilizer nutrient use on non-ILC crops. The contribution of ILC to fertilizer use on non-ILC crops is also twice as large as the naive estimate from Table 1.

Although the main focus of this paper is on the effects of interlinked credit on non-ILC crops through household level credit reception, interlinked credit and other associated factors may have impacts on fertilizer use on Non-ILC crops. For instance, Dione (1991) found that the introduction of cotton to Southern Mali increased the demand for fertilizer, which subsequently stimulated private investment from input manufacturers, distributors, and retailers. These investments made fertilizer and other inputs more accessible and profitable not only for use on cotton (which was the primary impetus for the expansion of input supply in these areas) but also for farmers who only produced staple food crops. This description is consistent with our finding in Table 3 that the estimated coefficient of the interaction term between the ILC-village dummy for coffee&tea villages and the 2000 year dummy is significantly positive. The interpretation of this coefficient is that fertilizer use on Non-ILC crops increased by 18.7 kgs from 29.6 kgs in 1997 in villages well-served by both the Kenya Tea Development Authority and coffee cooperatives (these are the agents providing ILC for these two crops in Kenya).

6. Conclusions

This paper addresses the potential for interlinked credit/input/output marketing arrangements for cash crops to promote food crop productivity. Findings from Kenya suggest that, in addition to the direct stimulus that such institutional arrangements can have on household incomes, interlinked input/credit/marketing arrangements may have spillover benefits on the productivity of other household activities such as food cropping. Specifically, our econometric panel model results indicate that households engaging in interlinked marketing programs for selected cash crops tended to apply considerably greater fertilizer on other crops (primarily cereals) not directly purchased by the trading firm providing the ILC. Especially where there are market failures in credit and input markets (which frequently occur in many areas of Africa where credit repayment is hindered by firms' inability to control the output market), farmers' ability to obtain inputs on credit from food crop traders is very constrained. Participation in cash cropping programs may, at least in some cases, allow farmers to overcome such market failures facing food crop input and credit supply. However, whether these complementarities actually materialize depends on whether cash cropping firms are able to continue to recoup their up-front costs and support farmers through purchase of the cash crop. A useful analysis of the strategic interactions between smallholders and cash crop trading firms is contained in Dorward, Kydd, and Poulton (1998). Along these lines, there is a need for future research to help identify policies and strategic partnerships between cash crop firms and governments that might better exploit the potential for high-valued cash crops to serve as vehicles to promote food crop productivity.

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Table 1. Interlinked Credit by Region in 2000

Zone	Sample Households (A)	Interlinked Credit		Changes in ILC		
		1997 (B)	2000 (C)	1997 only (D)	2000 only (E)	Both (F)
Eastern Lowlands	76	16	6	12	2	4
Western Lowlands	51	7	6	6	5	1
Western Transitional	135	46	83	3	40	43
High Potential Maize Zone	161	32	51	4	23	28
Western Highlands	145	51	57	24	30	27
Central Highlands	257	163	183	20	40	143
Total	825	315	386	69	140	246

Note: *a*) Villages where at least one household received interlinked credit from either coffee cooperatives, KTDA, or sugar companies.

Table 2. Pathways for Spill-over Effects

	Possible Pathways for Spill-over Effects			
	Direct physical diversions (A)	Budget Expansion (B)	Learning-by-Doing (C)	Input-market development (D)
Level of Effects	Household	Household	Household	Village
Among who?	Credit-constrained households only (as long as implicit interest rates are positive)	Credit-constrained households only	All Households	All Households
By ILC-Crops				
Sugarcane	Likely	Likely	Likely	Likely
Coffee	Likely	Likely	Likely	Less likely
Tea	Not likely (Tea requires NPK which is not appropriate for food crops)	Likely	Not likely (Tea requires NPK which is not appropriate for food crops)	Less likely
Horticulture	Likely	Likely	Likely	Likely

Note: *a*) Villages where at least one household received interlinked credit from coffee cooperatives, KTDA, sugar companies, or horticulture traders.

Table 3. Fertilizer Nutrient Use on Non-Credit Crops by Changes in ILC Reception

ILC Status	Number of households		Poor[a]				Non-Poor[a]			
	Poor	Non-Poor	1997 (D)	2000 (E)	Difference (D) - (E)	Dif-in-Dif	1997 (D)	2000 (E)	Difference (D) - (E)	Dif-in-Dif
	- Number -		*- Kgs/acre -*				*- Kgs/acre -*			
Neither	177	192	9.6	13.8	+4.3	+8.79	19.4	24.4	+5.0	+5.13
Enter	73	68	14.8	27.9	+13.1	[2.45]**	26.8	36.9	+10.1	[1.16]
Exit	35	35	11.9	15.2	+3.3	+7.85	18.7	30.8	+12.1	+0.74
Both	106	139	13.8	25.0	+11.2	[1.13]	23.6	34.9	+12.3	[0.11]
ALL	391	434								

Note: Total number of households is 1,650 (825 households *2 rounds). Numbers in brackets are absolute t-ratios.
a) “Poor” households had less than the median asset values in 1997 among all sampled households, while “Non-poor” households had more than the median. * indicates 10% significance; ** indicates 5 % significance.

Table 4. Fertilizer Nutrient Use on Non-ILC Crops by ILC Reception (Pooled)

ILC Status	Poor				Non-Poor			
	1997	2000	Dif	Dif-in-Dif	1997	2000	Dif	Dif-in-Dif
Sugarcane Villages								
Neither	0.2	2.0	+1.8	+6.95	4.5	12.5	+7.9	+0.61
Enter	4.4	13.1	+8.7	[2.09]**	13.9	22.4	+8.6	[0.10]
Exit	1.0	0.6	-0.4	+8.18	19.3	7.8	-11.4	+29.9
Ever	2.6	10.2	+7.8	[0.84]	24.1	42.5	+18.4	[1.57]
Coffee Villages								
Neither	9.6	14.1	+4.5	+18.4	23.9	43.4	+19.5	+2.56
Enter	15.5	38.4	+22.9	[2.24]**	28.0	44.9	+16.9	[0.27]
Exit	15,8	24.2	+8.4	-2.48	11.7	29.3	+17.6	+6.71
Ever	15.0	20.9	+5.9	[0.22]	23.5	34.4	+10.9	[0.48]
Tea Villages								
Neither	15.8	22.0	+6.2	+7.22	20.4	24.7	+4.2	+3.95
Enter	25.2	38.6	+13.4	[0.96]	50.5	58.2	+8.2	[0.25]
Exit	10.6	10.6	0.0	+11.5	19.7	30.0	+10.2	+0.66
Ever	20.5	36.0	+15.4	[1.30]	23.4	34.2	+10.9	[0.07]
Horticulture Villages[A]								
Neither	6.8	9.4	+2.6		19.7	20.0	0.3	-0.7
Enter	n.a.	n.a.			25.1	24.7	-0.4	[0.18]
Exit	n.a.	n.a.			n.a.	n.a.		
Ever	n.a.	n.a.			n.a.	n.a.		

Note: Total number of households is 1,650 (825 households *2 rounds). Numbers in brackets are absolute t-ratios. * indicates 10% significance. ** indicates 5% significance. *A*) ILC credit was not available from horticulture traders in 1997 among the sample households.

Table 5. The Spillover Effects of ILC: First-Differenced Models

	All (A)	Poor (B)	Non-Poor (C)
ILC Credit			
Δ ILC Received (1/0)	2.704	5.601	1.585
	(1.20)	(1.91)*	(0.52)
Household Human Resources			
Δ Male Max Schooling Years	-0.107	-0.563	-0.095
	(0.19)	(0.63)	(0.14)
Δ Female Max Schooling Years	0.081	1.806	-0.146
	(0.17)	(2.21)**	(0.24)
Δ Female Headed Household (0/1)	1.178	-1.198	3.626
	(0.35)	(0.30)	(0.71)
Δ Number of male adults	-1.098	-1.223	-0.862
	(1.30)	(0.94)	(0.80)
Δ Number of female adults	0.443	1.118	0.231
	(0.49)	(0.87)	(0.19)
Δ Number of Boys age 7-14	-0.221	0.422	0.175
	(0.21)	(0.30)	(0.13)
Δ Number of Girls age 7-14	-0.445	2.127	-1.448
	(0.42)	(1.49)	(1.03)
Household Resources			
Δ Land Tenure (0/1)	0.063	-0.024	0.105
	(0.61)	(0.17)	(0.79)
Δ Land Owned (acres)	3.004	3.248	2.645
	(1.50)	(1.27)	(0.95)
Δ Value of assets (›000 Ksh)	0.000	0.008	-0.000
	(0.02)	(0.17)	(0.01)
Constant (Year 2000)	7.206	7.016	7.304
	(5.12)**	(3.67)**	(3.82)**
R-squared	0.01	0.04	0.01
# of observations	825	394	547

Table 6. The Spillover Effects of ILC- Household Fixed Effects Models

	All		Poor		Non-Poor	
	Neither/Enter	Exit/Ever	Neither/Enter	Exit/Ever	Neither/Enter	Exit/Ever
	(A)	(B)	(C)	(D)	(E)	(F)
ILC Credit						
Δ ILC Received (1/0)	7.270	4.761	9.566	8.025	4.796	1.312
	(2.51)*	(0.94)	(2.60)**	(1.12)	(1.04)	(0.18)
Household Human Resources						
Δ Male Max Schooling Years	0.101	-0.427	-0.422	-1.054	0.423	-0.229
	(0.16)	(0.41)	(0.41)	(0.61)	(0.49)	(0.17)
Δ Female Max Schooling Years	-0.225	0.308	-0.185	2.767	-0.106	-1.817
	(0.37)	(0.37)	(0.17)	(2.08)*	(0.13)	(1.67)+
Δ Female Headed Household	1.803	-0.454	-1.330	-1.469	6.308	9.939
	(0.47)	(0.07)	(0.30)	(0.19)	(0.94)	(0.89)
Δ Number of male adults	-1.018	-1.187	-1.556	-1.100	-0.649	-1.525
	(1.00)	(0.79)	(1.02)	(0.46)	(0.45)	(0.78)
Δ Number of female adults	0.058	1.741	1.328	1.407	-0.622	-0.042
	(0.05)	(1.04)	(0.86)	(0.59)	(0.40)	(0.02)
Δ Number of Boys age 7-14	-1.638	2.787	-1.481	4.327	-1.999	-0.048
	(1.42)	(1.34)	(0.98)	(1.43)	(1.12)	(0.02)
Δ Number of Girls age 7-14	0.561	-1.504	2.293	2.915	-0.732	-7.040
	(0.46)	(0.75)	(1.41)	(1.01)	(0.40)	(2.41)*
Household Resources						
Δ Land Tenure (0/1)	0.023	0.044	-0.088	0.063	0.076	0.382
	(0.20)	(0.21)	(0.48)	(0.27)	(0.48)	(0.70)
Δ Land Owned (acres)	1.721	5.224	0.711	7.982	3.114	0.399
	(0.73)	(1.44)	(0.24)	(1.60)	(0.82)	(0.08)
Δ Value of assets (›000 Ksh)	0.003	-0.007	-0.025	0.010	0.001	-0.018
	(0.30)	(0.37)	(0.32)	(0.14)	(0.13)	(0.87)
Constant (Year 2000)	3.930	11.499	4.602	11.867	3.422	9.868
	(2.20)*	(4.00)**	(1.99)*	(2.73)**	(1.19)	(2.47)*
R-squared	0.02	0.03	0.04	0.11	0.02	0.07
# of observations	508	313	249	141	259	172