Feed the Future Innovation Lab for Food Security Policy

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Africa Great Lakes Region Coffee Support Program

THE ROLE OF COOPERATIVES ON ADOPTION OF BEST MANAGEMENT PRACTICES AND PRODUCTIVITY IN RWANDA'S COFFEE SECTOR

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EXECUTIVE SUMMARY

Agricultural cooperatives operate under the notion that smallholder farmers are better off working collectively. Rwanda's coffee sector has experienced a significant transformation over the past two decades, which includes farmers coming together to establish cooperative coffee washing stations (CWSs). Our data and analysis show that these collectives provide farmers with a myriad of services that include economic, agronomic and social benefits. We find that cooperative membership affects adoption of specific practices, most notably pesticide application. This finding, however cannot be generalized to all best management practices as we find that membership is not associated with uptake of some practices (like fertilizer use) and in some instances it can contribute to a lower likelihood of adoption. Among other differences, we find that cooperative members attain higher levels of productivity, however our analysis cannot confirm this to be a causal relationship. We note that collective action in Rwanda's coffee sector needs additional research attention, as these types of farmer associations don't always thrive or provide the same level of services that their members expect. We derive implications of our findings and identify areas in need of further inquiry.

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1. Introduction

Rwandan coffee is increasingly recognized as a high quality product, sought after by specialty coffee buyers and consumers world-wide. The coffee sector in Rwanda is made up of over 355,000 farmers, mostly smallholders, and is a major source of export revenue for the country (NAEB Census 2015). Despite impressive growth and a rapid transformation of the sector over the past two decades, coffee productivity in Rwanda, at 385kg/ha, is among the lowest in East Africa (ICO). In the late 1990s the Rwandan government began a process of liberalization and privatization of the coffee sector, dismantling barriers to trade, and creating incentives for groups and organizations to invest in coffee production (Boudreaux, 2011). These reforms led to private-sector investments in coffee-washing stations (CWS) and incentivized smallholder farmers to shift some production from semi-washed (ordinary) to fully-washed (specialty) coffee. Consequently, the number of coffee washings stations increased from a single one in 2002 to 245 in 2015 (NAEB Census 2015). During this time, farmers also began forming cooperatives, often building their own washing stations to process coffee cherry. As such, the processing sector is comprised of both private and cooperative-owned CWSs. Despite this transformation, the coffee sector in Rwanda continues to struggle with high production costs, low productivity, and low producer cherry prices (AGLC, 2016). Rwanda's coffee cooperatives are farmer organizations established to improve smallholder income and livelihoods mainly by providing technical assistance and inputs for production, processing fully-washed coffee, increasing farmers' bargaining power and market entry opportunities as well as providing non-technical services (OCIR, 2005; Bizoza, 2012). Many of these cooperatives have emerged as a result of government and NGO support (Loevinsohn et al., 1994). In 2006, the government of Rwanda issued a legal and statutory framework to support the establishment of cooperatives and to contribute to their functioning and proliferation (MINICOM, 2006; Mujawamariya et al., 2013). Additionally, NGOs and development programs such as the Partnership for Enhancing Agriculture in Rwanda (PEARL) implemented by Michigan State University and partners have helped farmers establish cooperatives and have trained members in various aspects of coffee production, processing and marketing. At present, 14% of coffee farmers are members of a cooperative or smallholder association (NAEB Census 2015).

The viability and future growth of the coffee sector depends on CWSs ability to improve technical capacities, operate profitably, and to create incentives for more farmers to supply the fully-washed channel rather than processing cherries themselves for the semi-washed market (Boudreaux, 2011). This research report draws on recent quantitative and qualitative evidence from the AGLC project to identify the key factors influencing adoption of coffee best management practice and to assess the effects of cooperative membership on coffee productivity. The remainder of the report is structured as follows. In the next section, we describe our methodological approach and sampling frame. We then present a series of working hypothesis regarding the effects of cooperatives on various coffee production indicators and describe our data. Following, we test our hypothesis and present results from our analysis that estimates the effects of cooperative membership on adoption of best practices and productivity.

The concluding section focuses on the policy implications of our empirical findings and informs current developments in Rwanda's coffee sector.

2. Approach and Sampling Frame

The data used in this paper were collected in 2016 as a component of the Africa Great Lakes Region Coffee Support Program (AGLC), funded by USAID. The study draws upon a broad mix of quantitative and qualitative data collection methods, notably: 1) a coffee farmer/household survey, 2) a broad set of targeted Key Informant Interviews (KIIs), and 3) a program of Focus Group Discussions (FGDs) with coffee sector stakeholder groups. Each of these three methods is summarized below.

3.1 Coffee farmer/household surveys

A baseline survey of coffee growers was conducted in four major coffee-growing districts representing Rwanda's four agricultural provinces. The selected districts are Rutsiro (Western Province), Huye (Southern Province), Kirehe (Eastern Province), and Gakanke (Northern Province). From each district, and with the assistance of NAEB collaborators, the team purposively selected four high volume coffee-producing sectors and one coffee washing station (CWS) from each sector. The guiding objective of the sector/CWS selection was to maximize geographic dispersion of the four CWSs in each district and also to ensure that the four would include two that are cooperatively owned and operated and two that are privately owned and operated. From the farmer listings at each of the CWSs 64 farmers were randomly sampled for study, totaling 1,024 (16 CWS x 64 HH) coffee producing households (Figure 1).

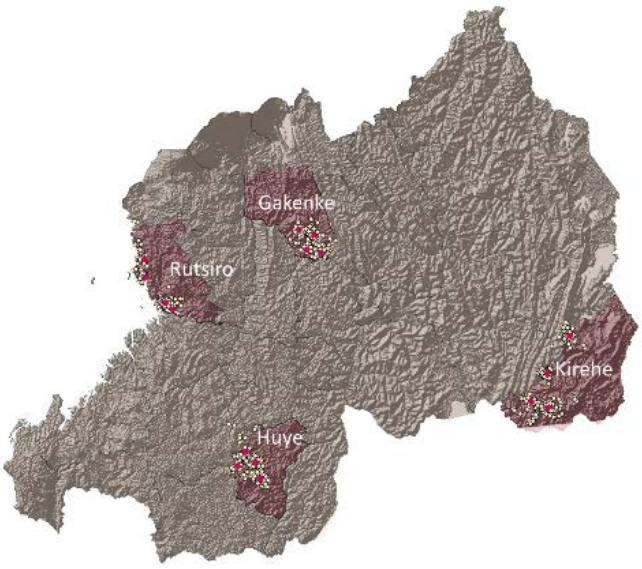

Figure 1. Map of Sampled Districts, Washing Stations and Households

Survey instruments and enumerator training. The survey instruments were implemented at the farm household and field levels. Sections of the questionnaire covered a diversity of topics including: coffee growing practices, cost of production, area under coffee production, number of trees, slope of coffee field, location (GPS), cherry production and sales, landholding, equipment & assets, household income, perceptions of barriers to investment in coffee, cooperative membership information and basic household demographics. The questionnaires were then translated to Kinyarwanda, programmed for Samsung 7" tablets using *CSPro Mobile*, and pretested in the field. Experienced enumerators were hired and trained just prior to the pretest. Immediately following the pretest, a series of debriefing sessions were organized and the survey instruments were revised based on the pretest results and the debriefing sessions.

Data collection and processing. Fielding of the survey took a team of 10 enumerators approximately 50 working days in Rwanda. The survey instrument was comprehensive and included over 400 questions. The coffee fields section of the instrument required interviewers and farmers to walk to the coffee fields to collect data on their physical characteristics. The average interview took close to three hours to administer, so in most areas each interviewer was able to complete only two interviews per day. After the field implementation, the data were uploaded from the tablets to a designated Dropbox folder for access by the project's IT staff. Data were uploaded and backed up regularly through the data collection phase, usually once or twice a week. Next, the data were aggregated into a unified Statistical Package for the Social Sciences (SPSS) file for cleaning, coding and transformation. During this process, errors were corrected, open-ended questions were coded, and many variables were aggregated and otherwise transformed to put the data in useable form for analysis and reporting.

3.2 Key Informant Interviews (KIIs).

AGLC project staff conducted an extensive series of personal interviews with key coffee sector leaders including public sector representatives (NAEB, Ministry of Agriculture, RAB, etc.), a farmer organization (RWASHOSCCO), and numerous private sector stakeholders (Starbucks, CEPAR, KZ Noir, and others). These interviews focused on challenges identified during a meeting held in Kigali with different representatives of the coffee sector in Rwanda in October 2015. The interviews provide insights into critical areas of convergence and disagreement among the various specialty coffee sector stakeholder groups on issues such as coffee prices, quality, pre-financing, and farmer incentives among others. These data were compiled, organized and analyzed to allow their integration with data from the surveys and other applied research activities.

3.3 Focus Group Discussions (FGDs).

A series of focus group discussions were held with major coffee stakeholder groups in Rwanda in Fall 2015/Spring 2016. These include, coffee farmers (several separately with only women), washing station managers, coffee exporters, and others. The advantage of FGDs is that they are held with groups of 5-7 members of each stakeholder group which leads to a different dynamic in the conversations, enabling the participants to internally debate, discuss and come to a degree

of consensus in their views on the critical issues put before them. Like the KII data, information from the focus groups has been integrated into the larger analyses by the research teams.

3. Hypothesis

The objective of this study is twofold: (1) to determine what are the key factors, including cooperative membership, influencing the adoption of coffee best management practice and (2) to assess the effects of cooperative membership on coffee productivity. To guide our analysis, we have developed the following null hypotheses:

H1: Cooperative members have lower costs of production

One common barrier that smallholder producers face is access to inputs at low cost and in smaller quantities, cooperatives are able to access inputs for their members through subsidies and enable their members to lower their production costs.

H2: Cooperative membership increases adoption of best management practices.

We hypothesize that even when controlling for personal and household characteristics, producers who belong to cooperatives will be more likely to adopt sustainable practices that increase productivity and coffee quality, because they have more exposure to these practices through the extension services and other information provided by the cooperatives.

H3: Cooperative members have higher levels of productivity and receive higher cherry prices

Given that cooperatives can enter profitable specialty markets, in particular through direct trade or by receiving a specialty certification, farmers who belong to cooperatives are more likely to receive training to improve productivity and quality, therefore receiving higher prices or a second payment (premium) for their cherry.

H4: Cooperatives play an important role in increasing social capital.

In addition to all the financial benefits that cooperatives provide to their members, cooperatives play an important role in increasing social capital, through the provision of training and the empowerment of their members in taking collective action and a role in the decision making process, we hypothesize that this capital results in members who are more actively working towards reaching their goals.

4. Methods

The focus of this study is on cooperative members and the effects of membership on adoption of best coffee farming management practices and coffee productivity. We start our analysis by comparing basic household, socio-demographic and coffee production characteristics between cooperative members and their non-member counter parts. We explore how adoption of management practices, barriers to investment, cost of production, productivity, and motives differ between these two groups of farmers. To determine the effects of cooperative membership on adoption of management practices and productivity, we use a regression

framework. In total we evaluate adoption of six management practices and one measure of productivity which become our dependent variables. The six management practices we evaluate include: fertilizer application, pesticide application, mulching, pruning, weeding, and manure application. Productivity is measured as kilograms of cherry per productive tree. We analyze the effects of cooperative membership and other covariates on the individual practices. The econometric specification of our models follows

$$y = X\beta + \mu$$

where y represents our dependent variables (adoption of management practices, productivity), X is a vector of explanatory variables or covariates, including cooperative membership and relevant socio-economic variables, and μ is the error term.

A weakness associated with estimating our models using the ordinary least-squares method is the presence of endogenous regressors leading to biased and inconsistent parameter estimates. The problem of endogeneity arises when explanatory variables are correlated with the error terms. This correlation occurs when the dependent variable causes at least one of the covariates (an issue known as reverse causation), or when there are relevant explanatory variables omitted from the model. To circumvent this problem, we employ an instrumental variable (IV) approach. Instrumental variables are used to estimate causal relationships in the absence of controlled experiments and obtain consistent estimates. For example, in the present context, we wish to estimate the causal effect of cooperative membership on productivity. Correlation between membership and productivity does not imply that membership causes increases in productivity because other factors may affect both membership and productivity. An instrument is a separate variable, *Z*, which affects productivity only through its effect on cooperative membership. Therefore, requirements for using an IV include that the instrument be correlated with the endogenous explanatory variable (cooperative membership), and that the instrument not be correlated with the error term in the explanatory equation. Therefore, if a correlation between *Z* and cooperative membership exists, this can provide evidence that membership causes increases in productivity, as *Z*'s effect on productivity would be through a causal relationship of membership on productivity.

Regression analyses show relationships between variables, and not necessarily demonstrate causality. With regards to whether increased adoption of management practices or productivity are caused by cooperative membership, or vice versa, we follow the logic in Kolade and Harpham (2014): cooperative membership can strengthen the factors involved in the stages that come before production or adoption of innovation, including information and awareness of practices. In other words, whereas cooperation can affect productivity and influence adoption of practices, productivity or adoption does not logically lead to awareness of the practices. We identify two IVs to capture the effects of cooperative membership on adoption of management practices and productivity: whether farmers sold cherry to a cooperative, and whether farmers identified cooperative support as an advantage to growing coffee, respectively. Both of these variables were vetted and found to not influence the dependent variable, but had a correlation with membership. For our model on productivity, we utilize a 2SLS estimator which is defined

as follows:

$$\beta_{2SLS} = (X'PzX)^{-1}X'PZy \text{ where } P = Z(Z'Z)^{-1}Z'$$

Since, unlike productivity, adoption of best management practices is a binary outcome, use of 2SLS is not appropriate. Therefore, we follow Woolridge's (2015) use of a two stage control function approach designed for discrete models. With this method, the first stage involves regressing the instrumental variable on the suspected endogenous variable using a logit model. In the second stage, the generalized residuals from the model in the first stage are introduced as an explanatory variable into the structural model (Woolridge, 2015).

5. Results

5.1 Cooperative membership and services

Our sample of farmers is comprised of 55% (567) cooperative members and 45% (457) non-members. The main reasons cited by non-members for not belonging to a cooperative include the initial fee being too high, not being invited to participate in one and the absence of cooperatives in the area (Figure 2). The main services provided by cooperatives, as self reported by farmers in our sample, include paying a premium, providing inputs, delivering extension services, processing cherry, access to markets, and social benefits (Figure 3). A side by side comparison of services provided and perceived advantages, reveals that cooperatives are falling short with regard to providing financial services and paying more to farmers for their coffee cherry.

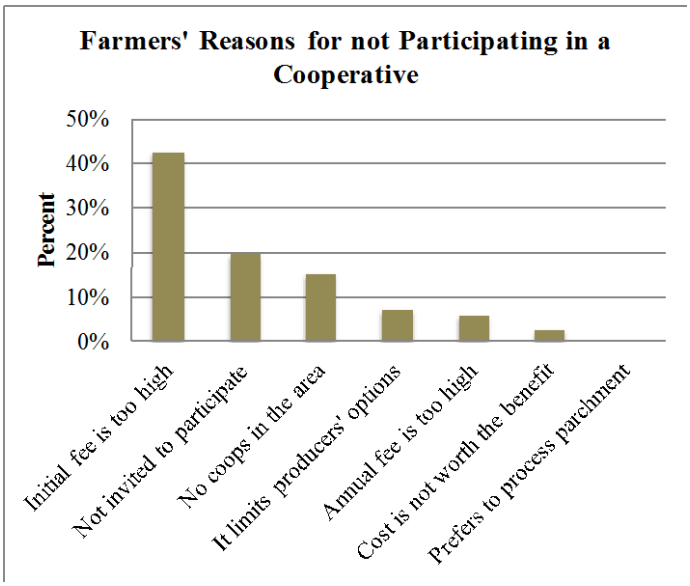

Figure 2. Barriers to Cooperative Participation

Results from our focus group discussions reveal that cooperatives often fall short in providing benefits to their members because they are unable to obtain pre-financing from banks; a

situation often tied to management of the organization. One key informant stated "Cooperative CWS often cannot obtain pre-financing because banks believe cooperatives are mismanaged, and that cooperatives will default on their loans. Bank loan cycles [also] often do not match up with the coffee season. As a result, even when CWS do receive financing, it may not be at the right time. Since cooperative CWS often cannot receive the pre-financing necessary to pay farmers upfront, many farmers sell to private CWS, which do not advocate for farmers' needs, elicit trust from farmers, incentivize farmers to produce high quality coffee, or increase traceability in the sector."

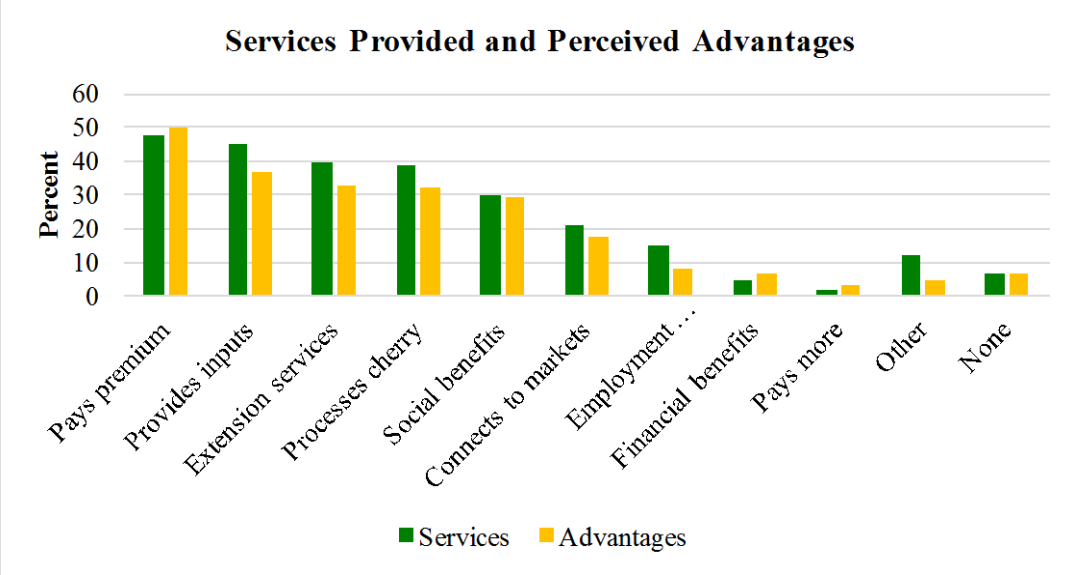

Figure 3. Benefits of Cooperative Membership

5.2 Socio-demographic Characteristics

Statistical tests on socio-demographic characteristic of our samples reveal that a higher proportion of cooperative members are female (21%), more educated (41% have at least primary education), have more active adults in their household (3.2 on average) and have more experience growing coffee (25 years) than non-members (20 years) (Table 1). Total household income is not significantly different between the two groups, however, cooperative members receive a higher proportion of their household income (49%) from coffee than non-members (36%).

Table 1. Socio Demographic Statistics

Variable	Non Members			Members			
	Median	Mean	St Dev	Median	Mean	St Dev	*p*-value
Female (%)	.16			.21			.03
Age of HHH (yrs)	50.00	50.77	14.92	52.00	51.25	13.54	.52
HHH Primary Educ (%)	.35			.41			.06
Nbr Adults in HH	2.00	2.71	1.50	3.00	3.21	1.66	<0.01
Elevation (m)	1715.00	1706.53	182.00	1722.00	1715.69	149.00	.38
Experience (yrs)	20.00	22.78	15.18	25.00	25.44	15.19	.01
Total HH Income (RWF)	257055.00	498968.00	2015497.00	430250.00	623484.00	646263.00	.17
Coffe Income (RWF)	79200.00	157921.00	431683.00	170000.00	259739.00	301402.00	<0.01
Coffe Income (%)	.36	.39	.28	.46	.49	.27	<0.01
Non Coffee Income (RWF)	150000.00	34774.00	1709647.00	210000.00	363744.00	501577.00	.76

Note: p-value denotes significance of statsitical test for differences in distributions across membership

5.3 Coffee Production

On average cooperative members have approximately 50 percent more land in coffee production than non-members, with nearly 300 more productive trees (Table 2). Coffee productivity is significantly higher for members than non-members at 1.96 and 1.48 kilograms per tree, respectively. On average, both groups received similar prices for cherry and parchment, averaging 198 RWF/kg and 720 RWG/kg in 2015. However, a significantly higher portion of cooperative members received a premium (38% vs 13%). Our results are reflective of the practice that cooperatives often share their profits through end-of-year bonus payments to farmers. Whether the bonuses farmers receive are enough to incentivizes them to improve the quality of their coffee is a questions that remains unanswered. As one key informant stated, "the culture of bonuses needs to be integrated into all levels [of the value chain]. Farmers need to know precisely when they're getting bonuses and under what condition."

Table 2. Coffee Production Statistics

Variable	Non Members			Members			
	Median	Mean	St Dev	Median	Mean	St Dev	*p-value*
Coffee Area (sqm)	1460.00	2547.07	5198.48	2140.00	3828.84	4545.18	<0.01
Nbr of Fields	2.00	2.28	1.43	3.00	3.07	1.79	<0.01
Nbr of Productive Trees	315.00	566.43	1289.95	500.00	872.69	1027.93	<0.01
Prod (kg/tree)	1.25	1.48	1.08	1.59	1.96	1.45	<0.01
Prod (kg/daylabor (hh&wage)	6.55	9.48	14.69	8.16	12.58	16.32	.01
Total Harvest (kg)	400.00	777.26	2126.47	850.00	1318.87	1582.57	<0.01
Parchment Sale (kg)	.00	7.79	41.38	.00	13.01	50.95	.08
Cherry Sale (kg)	382.00	765.69	2123.87	820.00	1299.00	1571.98	<0.01
Parchment Price 2014 (RWF/kg)	700.00	770.00	242.90	800.00	801.11	240.17	.43
Parchment Price 2015 (RWF/kg)	750.00	727.01	209.34	750.00	730.24	167.67	.90
Cherry Price 2014 (RWF/kg)	200.00	206.88	41.94	200.00	207.76	35.53	.72
Cherry Price 2015 (RWF/kg)	200.00	198.86	34.59	200.00	197.66	30.74	.56
Recived Premium (%)	.00	.13	.33	.00	.38	.49	<0.01
Premium (RWF/kg)	20.00	17.72	5.35	15.00	16.02	5.13	.03

Note: p-value denotes significance of statsitical test for differences in distributions across membership

Cooperative members sold the majority of their cherry to their cooperatives (76%), while a significant percentage supplied coffee to private CWSs and traders (24%) (Figure 4). This issue of side selling has been documented in the literature (Mujawamariya et al., 2013) and poses a challenge to cooperatives. Indeed, reducing side selling is one of the primary rationales for the recently implemented coffee zoning policy in Rwanda. At the same time, 36% of non-members sold their coffee to cooperatives, often receiving the same price as members. Our statistical analysis shows that cooperative members often travel farther to sell their cherry than non-members. They travel an average of 0.17 kilometers (or 2.5 minutes) farther, often bypassing another CWS before reaching their cooperative (Table 3).

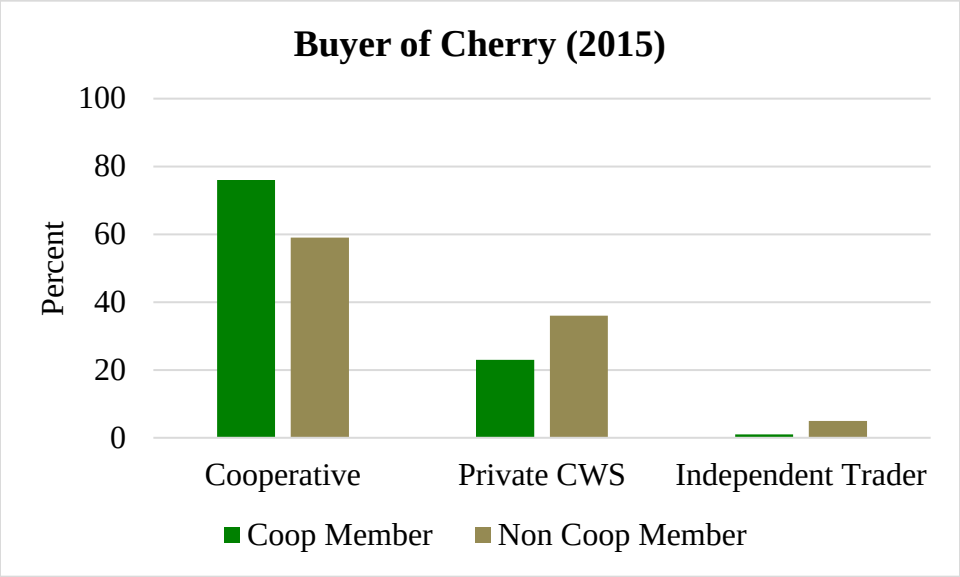

Figure 4. Buyer of Cherry, Cooperative and non-Cooperative

Table 3. Distance and time to seller

Variable	Non Members			Members			
	Median	Mean	St Dev	Median	Mean	St Dev	*p-value*
Parchment Distance (km)	0.00	0.67	2.03	0.00	0.74	2.11	0.59
Parchment Time (min)	0.00	8.84	25.52	0.00	10.29	27.05	0.38
Cherry Distance (km)	1.00	1.57	1.40	1.00	1.74	1.65	0.08
Cherry Time (min)	20.00	20.65	16.13	20.00	23.14	17.83	0.02

Note: p-value denotes significance of statsitical test for differences in distributions across membership

Cost of production (CoP) was calculated based on four component parts: household labor (by task), wage labor (by task), equipment (e.g., pruning shears, sprayers, masks) and purchased inputs (fertilizer, pesticide, mulch, etc.). The four components were valuated and the costs were summed and divided by the number of Kgs of coffee cherry produced for a total CoP per Kg of cherry.

Our analysis finds that cooperative members have on average a significantly lower cost production at 163 RWF/kg of cherry than non-members (202 RWF/kg) (Table 4). As expected cost of production decreases as the number of trees increases and this is true regardless of plantation size. For farms with less than 500 trees, on average cooperative members have a lower cost of production. Cost of production decreases from 271 RWF/kg for members with less than 180 trees to 120 RWF/kg for farmers with over 1,000 trees (Figure 5). On a per tree basis, we find that gross margins are statistically significantly higher for members (142 RWF/tree) relative to non-members (56 RWF/tree).

Table 4. Cost of Production

Variable	Non Members			Members			
	Median	Mean	St Dev	Median	Mean	St Dev	*p-value*
Cost of Production (RWF/kg)	137	202	193	113	163	176	0.00
Cost of Production (RWF/tree)	174	230	230	188	244	250	0.36
Gross Margin (RWF/kg)	58	-7	205	80	31	184	0.00
Gross Margin (RWF/tree)	56	64	295	107	142	329	<0.01
Gross Margin (RWF/labor day)	343	842	2368	657	1362	2791	0.00

Note: p-value denotes significance of statsitical test for differences in distributions across membership

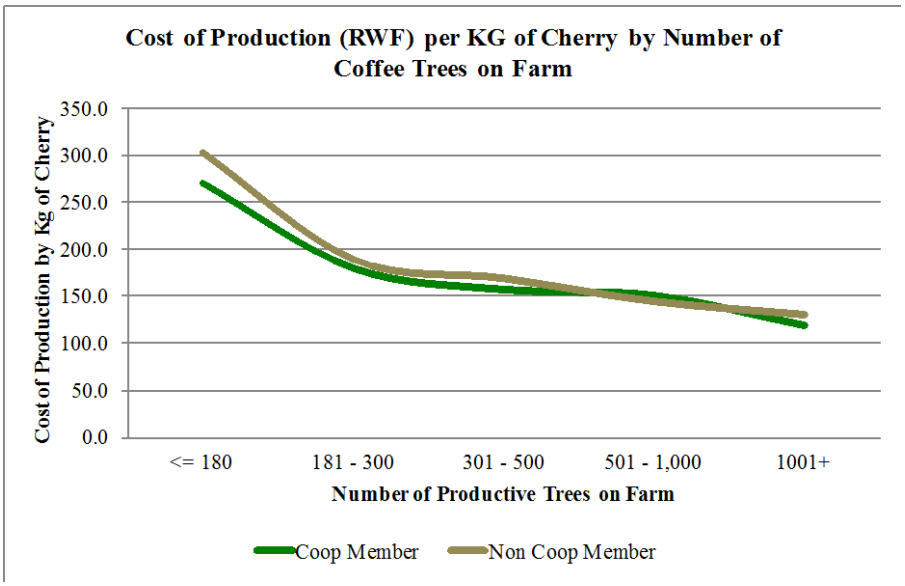

Figure 5. Cost of Production, by Number of Trees

5.4 Effects of coop membership on adoption of practices

We evaluate the effects of cooperative membership on adoption of six practices: fertilizer application, pesticide use, weeding, mulching, pruning and manure use. Our data suggests that fertilizer application by month between members and non-member households does not differ significantly. With regard to pesticide application, we find that more member households apply pesticides earlier in the coffee season relative to non-members (Figures 6, 7), likely the result of the cooperative-based networks used to distribute pesticides.

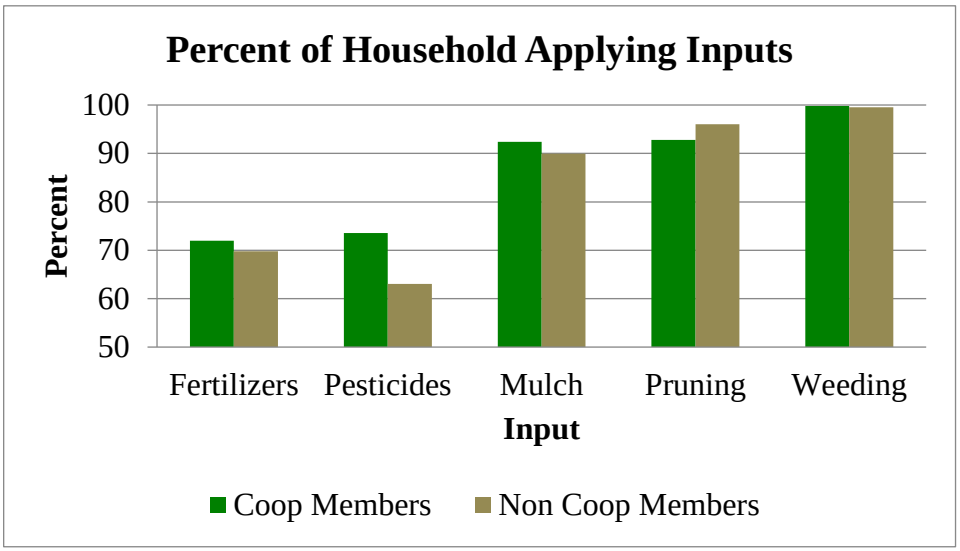

Figure 6. Input Application

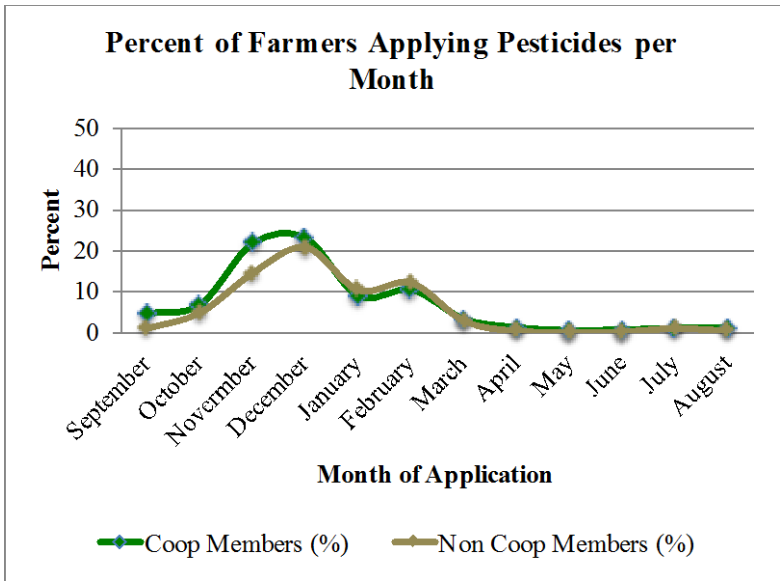

Figure 7. Monthly Pesticide Application

We estimate an econometric model controlling for socio economic factors and potential endogeneity using a control function approach (Table 5). Our statistical findings are corroborated by our econometric model. We find that cooperative membership does not significantly influence fertilizer use, weeding or mulching. It has a positive and significant effect on pesticide application, and manure application. We also find a negative relationship between membership and pruning. This is likely the result of a lack of farmer knowledge and training on the practice.

Table 5. Adoption Regressions

Variable	*Fertilizer Use*		*Pesticide Use*		*Weeding*	*Mulching*		*Prunning*		*Manure Use*	
COOP	0.154		0.650	***	0.234	0.125		-1.321	**	0.518	**
Female	-0.326	*	-0.486	***	0.262	-0.257		-0.576	*	-0.341	**
Cherry Price 2015	0.002		0.003		-0.037	-0.008	**	0.002		0.003	
Received Oremium	0.276		0.032		-1.005	0.449		-0.358		0.046	
Coffee Inc (%)	0.467		0.085		2.660	2.643	***	1.588	**	-0.359	
Nbr of Productive Trees	3.65E-04	***	3.35E-04	***	3.93E-03	1.89E-04		-1.32E-04		9.70E-05	
Non Coffee Inc	3.03E-07		3.03E-07		4.29E-05	1.11E-06	**	6.41E-07		-1.03E-07	
Total Land	1.35E-05		-3.10E-06		-1.57E-04	-1.75E-05		1.23E-05		-2.05E-06	
Age of HHH	0.004		-0.005		-0.015	0.003		-0.028	**	-0.010	**
Educ of HHH	0.109		-0.093		0.705	0.112		-0.256	**	0.037	
Nbr Adults in HH	-0.121	***	-0.072		0.495	-0.036		-0.116		0.044	
Elevation	0.003	***	0.002	***	0.007	0.003	***	0.001		0.001	**
Gen_residual	-0.268	**	-0.181		-0.456	-0.301		0.340		0.060	
Constant	-4.744	***	-3.171	***	-3.281	-2.709		2.714		-1.385	
Log-likelihood	-557.690		-586.230		-11.230	-245.640		-189.210		-653.260	
Psedudo R2	0.066		0.053		0.450	0.096		0.075		0.033	

Note: ***,**,* represent significance at the 0.01, 0.05 and 0.10 levels.

5.5 Effects of coop membership on coffee productivity

To explore whether increases in coffee productivity between members and non-members are driven by cooperative membership we estimate a 2SLS regression instrumenting cooperative membership with a variable indicating whether farmers identified cooperative support as an advantage to growing coffee. We utilize kilograms of cherry per tree as our measure of productivity (dependent variable). Results of our model specification are presented in contrast to an OLS regression (Table 6).

Table 6. Productivity Regression

Variables	OLS			2SLS		
	Coef.	Std. Err.		Coef.	Std. Err.	
COOP	0.306	0.080	***	-0.072	0.440	
Number of Fields	0.146	0.024	***	0.156	0.033	***
Cultivated Land	1.14E-05	5.07E-06	**	1.34E-05	5.59E-06	**
Nbr of Productive Trees	-4.52E-04	4.48E-05	***	-4.46E-04	4.51E-05	***
Female	-0.242	0.102	**	-0.185	0.120	
Age of HHH	-0.007	0.004		-0.007	0.004	*
Educ of HH	0.122	0.037	**	0.138	0.042	***
Nbr Adults in HH	0.014	0.025		0.030	0.030	
Yrs Experience	0.008	0.004	**	0.009	0.004	**
Non Coffee Income	2.50E-07	3.78E-08	***	2.43E-07	3.84E-08	***
Coffee Inc (%)	1.337	0.153	***	1.416	0.183	***
Elevation	0.000	0.000		0.000	0.000	
Const	1.058	0.454	**	1.140	0.461	**
R2	0.211			0.188		
Wu-Hausman				*p*- value: 0.378		

Note: ***,**,* represent significance at the 0.01, 0.05 and 0.10 levels.

Upon controlling for endogeneity, we find that cooperative membership does not have statistically significant causal effect on productivity as measured by our dependent variable. We find that the number of coffee fields has a positive effect on productivity while the number of trees a farmer has reduces productivity per tree. The former effect can be partially attributed to a recently talked about phenomenon known as the edge effect, where productivity is typically higher in the exterior areas or edges of a plot rather than the plot interior (Bevis and Barrett, 2016). Farmers with multiple coffee fields would then have more edge space leading to increase productivity. Number of trees, as expected, leads to lower per tree productivity as smallholder farmers invest far more in their trees, particularly labor for maintenance but also inputs, than do large holder producers (AGLC, 2016). We do not find gender of the household head to be a significant factor affecting productivity. Age of the household head has a negative effect on productivity, while the level of education has a positive effect. These results suggest that increases in productivity are associated with younger, more educated farmers. We find evidence that experience as measure by the number of years a household has been growing coffee significantly increases productivity. This provides evidence that farmer experience and knowledge improve productivity. We also find that non-coffee income has a significant, positive effect on productivity. Farmers with additional income may be better positioned to hire labor and invest in tools and other productivity improving inputs. Moreover, we note that households that invest significantly in coffee (those deriving more of their income from coffee) tend to be more productive, suggesting that these households are more devoted to improving productivity.

5.6 Social capital: hopes and aspirations of coffee producers

While success of the coffee sector depends on adoption of best management practices and increases in productivity, farmers' level of social capital and internal motivation are also key factors. The "economics of hope" is a topic which has recently garnered the attention of economists and development researchers as a conceptual tool for improving our understanding of human behavior and decision making. Hope as conceptualized by Snyder (1994) consists of three elements: aspirations, agency and pathways. Lybbert and Wydick (2016) incorporate these elements into a theoretical economic framework. Aspirations are context specific and can take on multiple dimensions. This abstract concept is often measured by the "aspirations gap" which is the difference between a state which an individual aspires to achieve and their current state (Ray, 2006). Agency represents an individual's motivation to achieve a desire outcome, and pathways are the mediums which individuals employ to achieve their goals. We measure the aspirations gap as the difference between farmers' desired number of coffee trees in 10 years relative to their current number of trees. We use farmers' responses to a series of 5 point Likert-type scale questions to assess their level of agency and pathways. Table 7 presents the results of an analysis of variance model that assesses the impact of cooperative membership on the aspirations gap, controlling for gender and a set of covariates thought to influence aspirations, as noted. We find the aspirations gap to be smaller (as a percentage of current trees owned) for cooperative members: members aspire to have 121% more trees in 10 years compared to non-members at 140%. This implies that upon controlling for relevant factors and covariates, members report being closer to realizing their goals; this is encouraging for cooperative members as a large gap is often associated with unattainable goals and can lead to aspirations frustration (Lybbert and Wydick, 2016). Our analysis also finds that while the level of pathways does not differ between the two groups, cooperative members report a higher degree of agency or motivation.

Table 7. Hope and aspirations

Measure	Coop Membership	N	Predicted Means			*p-value*
			Unadjusted	Adjusted for Factors (Gender of HHH)	Adjusted for Factors and Covariates	
Aspirations Gap	No	455	149.84	147.83	140.33	0.01
(Pct)	Yes	567	113.23	114.84	120.86	
Agency	No	455	3.62	3.61	3.62	0.01
	Yes	567	3.80	3.81	3.80	
Pathways	No	455	3.68	3.67	3.68	0.11
	Yes	567	3.78	3.79	3.78	

Note: Covariates include Nbr of trees on farm, Total HH Income, Total land owned, Age of HHH, Educ. of HHH, Active Adults in HH, Elevation

6. Policy and Research Implications

One of the main challenges facing the sector is recognizing that providing premiums to farmers may increase incentives for increasing coffee quality and quantity. Given the relationship that farmers develop with their cooperatives, this link is often found within cooperative CWSs. Cooperative CWSs tend to have stronger relationships with producers, though many private CWS have succeeded in developing enduring allegiances with producers in their areas. Our data and observations show a (weak) positive relationship between productivity and farmers who received a premium. Being a member of a cooperative gives farmers access to a follow up, thus developing a relationship with the buyer. As a result, cooperatives often have more bonuses to pay at the end of the year. Cooperatives often provide technical assistance and training for farmers that allows the relationship between farmer and buyer to cement. Ensuring that premiums directly relate to quality rather than other factors, however, is an issue that deserves more attention. Sometimes premiums aren't clearly defined by quality. Farmers from a given CWS receive the same price and the same premium at the end of the year, despite differences in cherry quality. More transparency in the system is needed so that farmers know when they will receive bonuses and under which conditions.

The newly implemented zoning policy will likely impact the operation and membership structure of cooperative CWSs. While the effects of this policy won't be fully realized for some time, our results can inform some of its anticipated consequences. Given the longer distances that cooperative members travel to sell cherry to their CWSs (Table 3), we anticipate that the zoning policy will affect cooperative members disproportionately more than non-members. Our focus group discussions reveal that it is not uncommon for a farmer to travel past several CWSs before arriving at their cooperative. This indicates that the marginal benefit of patronizing the cooperative CWS is greater than the (opportunity) costs associated with selling to another more proximate CWS. By limiting the geographic area where farmers can sell their coffee, many cooperative members may not be able to sell their coffee to their current CWS. By restricting cooperative membership, this policy distorts competition in the cherry (or specialty coffee) market. Since private CWSs under this policy are now 'guaranteed' a supply of cherry, they have less of an incentive to increase prices, thus reducing the prices which farmers receive.

Results from our focus group discussions also reveal that farmers often belong to multiple cooperatives, paying fees and at times investing significantly to become members. By banning farmers from selling to their preferred CWS, this policy risks severing the social and technical assistance structures that many farmers receive and benefit from by being cooperative members.

This report has contributed to a better understanding of the role of cooperatives in adoption of management practices and effects on productivity in Rwanda's coffee sector. In carrying out this analysis, we have encountered areas that need further investigation. The impacts of the new zoning policy, particularly, needs to be carefully considered and analyzed. In what remains, we layout a series of research questions that should be prioritized in order to inform the current policy debate.

- Collective action in Rwanda's coffee sector needs additional research attention, because cooperative associations don't always thrive or provide the same level of services that

their members expect. With this in mind, additional research should separately examine and compare the level of social capital present among farmers that belong to a cooperative CWSs. This line of research should draw upon the social capital and relational contracting literature and assess the various dimensions of social capital (e.g. structural, relational and/or cognitive). Our finding that cooperative membership raises the future coffee production aspirations of producers is a clear indication that such effects are important to farmers and can contribute to a more sustainable future for the coffee sector.

- Informal farmer organizations (*amatsinda*) are known to play a role in technical assistance and social capital formation, yet their effectiveness in the coffee sector has seldom been the subject of policy research (Bizoza, 2011). How do governance and benefits from these organizations differ from those of cooperatives?
- We have shown that cooperative membership affects adoption of specific practices and has no causal effect on coffee productivity. However, it is unclear whether cooperatives affect other aspects of household welfare. What other benefits are farmers receiving from cooperatives and can a causal relationship be established?

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