FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

AGLC Project Final Report

Period: October 1, 2015 to July 19, 2018

Feed the Future Africa Great Lakes Region Coffee Support Program

Associate Award under the Feed the Future Innovation Lab for Food Security Policy

Award Number: AID-OAA-LA-15-00006

Submitted August 10, 2018

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1. Executive Summary

The long-term viability of the coffee sector in the Africa Great Lakes region, the main source of cash income for millions of smallholder farmers and families in the region, is threatened first by the prevalence of antestia bug (and associated potato taste defect—PTD), and second by coffee yields that are among the world's very lowest. AGLC was a three-year, USAID-funded collaborative initiative led by Michigan State University designed to meet these combined challenges through an integrated program of applied research, farmer capacity building and policy engagement. The solution to these challenges requires a public-private sector coordinated response across the entire value chain, including producers, washing stations, dry mills, exporters and the government agencies that support the sector's growth.

The applied policy, household, and agronomic (field-level) research of AGLC drew upon a broad mix of quantitative and qualitative data collection methodologies, including a series of coffee farmer/household survey, experimental field/plot level data collection, and a broad set of targeted key informant interviews (KIIs) and focus group discussions (FGDs). The baseline survey of coffee growers was conducted on a sample of 1,024 households randomly selected from listings of 16 coffee washing stations (CWS) geographically dispersed across four districts/communes in each country (Rwanda and Burundi) ensuring that the four CWSs in each district/commune would include an even distribution of privately/cooperatively operated CWSs. The subsequent midline and endline surveys were conducted using a random 50 percent sample of the baseline households and included data on AGLC's core indicators in addition to new programmatic areas identified during the earlier stages of the stakeholder engagement activities.

The combined research and policy engagement activities targeted a set of eight problem areas identified by coffee value chain stakeholders. They include: farmer investments, pricing & quality, zoning, coffee cooperatives, gender, inputs access, PTD/antestia control, and coffee sector sustainability. Important findings and policy debates emerged from each of these program areas.

Farmer investments. AGLC research on farmer investments has provided data and analysis on how chronically low cherry prices have contributed to a decline and stagnation in coffee production over the past two decades. Detailed estimates of farmer cost of production and analysis of farmer incentives have provided the empirical basis for a new cherry price policy that has begun to incentivize farmers to invest in their coffee plantations, a change that has led to higher productivity and over time is expected to result in improved coffee quality, higher volumes and more attractive prices from international buyers.

Pricing and quality. All levels of the value chain have demonstrated opportunities to increase value addition through greater emphasis on differentiation of quality segments, including multi-tier pricing by coffee washing stations. These opportunities are maximized by NAEB policies that emphasize the cherry floor price as a price paid for high quality cherry, and by innovative coffee washing stations that are implementing multi-tier pricing as one component of an integrated farmer education and quality control strategy.

Zoning policy. Rwanda's 2016 "zoning" policy requires that farmers within a geographic zone must sell to specific CWSs within that zone and CWSs must only buy from designated farmers. Designed to improve relationships between CWSs and farmers, improve traceability, and reduce activities of middlemen, evidence presents a mixed picture of the policy's success. After its first year (2016), many farmers did not know about zoning, and those that did thought it harmed them. After its second year (2017), more farmers knew about zoning, and were more positive about the policy. Other stakeholders suggest that the policy has created challenges for some cooperatives and CWSs, but also that the policy has reduced the activities of middlemen, while in practice allowing farmers to sell across adjacent zones.

Coffee cooperatives. Coffee producer cooperatives emerged in AGLC studies as a critical institution for building farmer capacity, promoting adoption of improved technologies and inputs, and increasing productivity. Cooperative membership also serves as a catalyst to the payment of premiums (second payments) to coffee farmers.

Gender in coffee. Female-headed households are disadvantaged in their access to inputs. They are also challenged in that they often have to pay wage labor for many production tasks such as stumping, pruning and inputs application.

Inputs access. An important influence on coffee productivity and quality is use of inorganic fertilizer and pesticide. Rwanda's coffee input distribution system is organized such that a private sector organization takes a fee from exported coffee and uses it to purchase and distribute bulk fertilizer and pesticide. Over the course of the project, AGLC studied changes in inputs distribution and use. Distribution has improved since 2015, with more farmers accessing inputs. However, many farmers still do not receive inputs, and the volume of inputs farmers receive per tree remains low. In addition, vulnerable farmers such as women who are heads of households and older farmers either fail to receive inputs or receive smaller volumes than other farmers.

PTD findings. AGLC research findings show that potato taste defect (PTD) is highly correlated with antestia bug density and damage but not with coffee berry borer infestations. Controlling antestia bug is found to be most effective using a combination of pruning coffee tree branches and the application of insecticide. Of the insecticides tested, Fastac is found to be the most

effective, dramatically reducing the incidence of PTD. Based on these results leaders in Rwanda's coffee industry now purchase and distribute Fastac to coffee farmers throughout the country.

Coffee sustainability. Long-term sustainability of the coffee sector depends on two important changes. The first is to go beyond the current focus simply on building farmer capacity, giving equal attention to the importance of farmer incentives through improved compensation aligned with the real cost of production. The second is a fundamental policy change aimed at restoring coffee production as a pillar of growth to Rwanda's rural economy. This strategic change must recognize coffee's comparative economic and agronomic advantages as well as its potential for addressing soil erosion on steep slopes as an alternative to expensive bench terrace construction.

2. Introduction and Program Description

The long-term viability of the coffee sector in the Africa Great Lakes region, the main source of cash income for millions of smallholder farmers and families in the region, is threatened first by the prevalence of antestia bug infestation (and associated potato taste defect—PTD), and second, by coffee yields that are among the world's very lowest. AGLC was a three-year, USAID Feed the Future initiative led by Michigan State University designed to meet these combined challenges through an integrated program of applied research, farmer capacity building and policy engagement. The solution requires a public-private sector coordinated response across the entire value chain, including producers, washing stations, dry mills, exporters and the government agencies that support the sector's growth. The goals of the program were to significantly reduce the effects of antestia/PTD and to raise farm-level productivity, two changes that will in turn improve smallholder farmer incomes and help to sustain the Africa Great Lakes region's reputation for producing among the highest quality coffees in the world.

AGLC addressed these challenges through a set of three core program components, identified as the following:

- *Applied policy, household, and agronomic (field-level) research* to serve as the basis for smallholder capacity building and policy engagement aimed at reducing antestia/PTD and low coffee productivity and profitability in the Africa Great Lakes Region.
- *Capacity building/farmer training & outreach* with project partners in the Africa Great Lakes Region taking the lead in training coffee producers and processors on antestia/potato taste control and other practices needed to improve productivity and farmer incomes.

- *Policy engagement* to help create an enabling institutional environment to debate, formulate and adopt policies that will motivate producers and other actors in the coffee value chain to invest their labor, land and capital in ways that will increase smallholder farmer incomes from coffee and improve control of antestia/PTD.

The AGLC initiative fills important gaps in our knowledge base on controlling PTD, improving coffee farm management practices and creating a policy environment that is fully supportive of farmer and other stakeholder investment in the sector.

While survey data collection activities were conducted in both Rwanda and Burundi, policy engagement activities were restricted to Rwanda only. As a result, AGLC policy analysis, roundtable discussions, key informant interviews, conferences, and other activities focused uniquely on the policy issues in the Rwanda context. In like manner, the present report focuses almost exclusively on the Rwanda experience, challenges and impacts.

3. Summary of Program Activities in Each of the AGLC Component Areas

This section describes the major activities undertaken in each of AGLC's three major components: applied research, capacity building and policy engagement. Results and implications of the research and policy engagement are reported in Section 4 thematically as they pertain to AGLC's eight targeted policy issues.

3.1. Applied Policy, Household, and Agronomic (Field-Level) Research

The applied policy, household, and agronomic (field-level) research of AGLC drew upon a broad mix of quantitative and qualitative data collection methodologies, notably: 1) coffee farmer/household surveys, 2) experimental field/plot level data collection, 3) a broad set of targeted key informant interviews (KIIs), and 4) a program of focus group discussions (FGDs) with coffee sector stakeholder groups. Each of these four methodologies is summarized below.

Coffee farmer/household surveys. AGLC conducted a series of three annual surveys of coffee producing households over the course of the three-year project. The first was the *baseline survey* fielded in December of 2015. The baseline survey was implemented in both Rwanda and Burundi. In Rwanda the survey was conducted in four major coffee-growing districts representing Rwanda's four agricultural provinces. The selected districts were Rutsiro (Western Province), Huye (Southern Province), Kirehe (Eastern Province), and Gakanke (Northern Province). From each District, and with the assistance of NAEB staff, the team purposively selected four high volume coffee-producing Sectors and one coffee washing station from each. 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 in all (Figure 1).

In Burundi the baseline design mirrored the approach in Rwanda, with four provinces being selected (Kayanza and Ngozi in in the northern coffee-growing region and Karusi and Gitega in the central region, with a total of 1,024 producer households randomly selected from 16 CWS listings in those communes).

The second was the *midline survey*, fielded on a 50 percent subsample in both Rwanda and Burundi a year later, in 2016. The midline survey included the AGLC core indicators plus a set of additional research areas including food security, climate change factors and, in Rwanda, farmer perceptions of the new zoning policy.

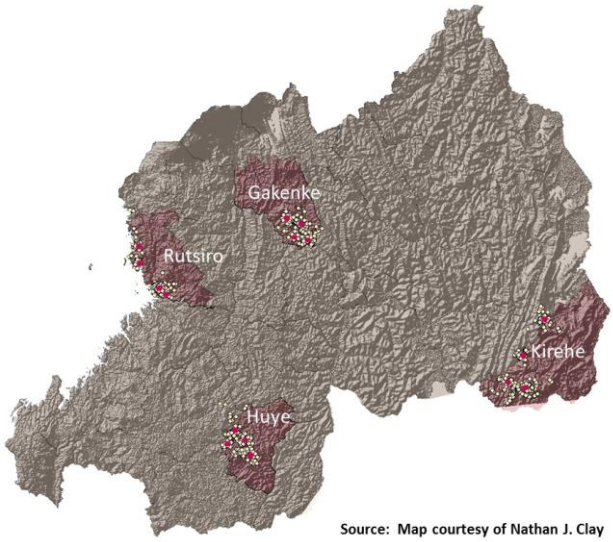

Figure 1. Map of Sampled Districts, Washing Stations and Households

The third survey round was the *endline survey* and it was conducted in November-December of 2017 on the same 50 percent panel of households surveyed in the midline. Due to funding constraints the endline survey was not fielded in Burundi. In addition to the measurement of core indicators the endline survey included a follow up on the zoning policy as well as a focused set of questions on youth and gender in coffee.

Survey instruments and enumerator training. The survey instruments were developed at the farm household and field levels. Sections of the questionnaire covered a diversity of topics including: coffee growing practices, antestia control practices, cost of production, coffee field size, number of trees, slope, location (GPS), cherry production, cherry sales, landholding, equipment & assets, household income, perceptions of barriers to investment in coffee, coffee zoning policy, food security, climate change impacts and basic household demographics. The questionnaires for all three surveys were translated to Kinyarwanda/Kirundi, programmed for Samsung 7" tablets using *CSPro*, and pretested in the field. Experienced enumerators were hired and were 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.

Data collection. Fielding of the baseline survey took a team of 10 enumerators approximately 50 working days in Rwanda, and a similar team and timeframe in Burundi. 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 the physical characteristics of each field. The average interview took approximately 2.5 hours to administer, so in most areas each interviewer was able to complete only two interviews per day. The midline and endline surveys were considerably smaller in scope and only surveyed a 50 percent subsample so data collection was completed in just a 3-4 week period each.

Data processing. After the field implementation, the data were uploaded from the tablets to a designated Dropbox folder for access by the project's IT staff. In both Rwanda and Burundi data were uploaded and backed up regularly through the data collection phase, usually once or twice a week. The data were then aggregated into a unified (one for each country) file for cleaning, coding, transformation and analysis.

Experimental field/plot level data collection. The applied research on experimental fields was designed to empirically inform coffee sector stakeholders in Rwanda and Burundi concerning the most effective practices for controlling antestia/PTD and for reducing low and fluctuating coffee production.

Design. The agronomic team, led by the University of Rwanda and the Rwanda Agricultural Board (RAB), developed the experimental design employed by the project. It included the designation of treatment types, frequency of data collection, categories of farmers and the number to select from each of the sampled CWSs. This activity was conducted jointly with the Burundi team and RAB to make sure that the applied research methodologies would be comparable across the two countries and consistent with RAB protocols and ongoing research efforts.

Farm/field/plot selection. The next step was to implement the field selection and plot set up for the 64 fields across the four study districts in each country. The on-farm field-based research was established, as planned, in existing coffee fields. Four fields were drawn from among the sampled farmers at each coffee washing station using a participatory process. The process included a presentation of the research objectives and a request for farmers to volunteer their fields for experimental purposes for a two and a half year period. Thus, from each country, a total of 64 fields and their 256 test plots were selected for experimental treatments.

Soil sampling. In each selected field, the teams collected composite soil samples for analysis of major nutrients and soil acidity. The samples have been analyzed by technicians in the UR and PUG laboratories and results have been incorporated into the experimental fields data base.

Data collection. After training the research assistants, the Rwanda and Burundi teams began the weekly/monthly data collection process using the research instruments designed for that purpose. Data were collected on coffee physical parameters, antestia knockdown, living antestia counts, and coffee productivity.

Key Informant Interviews (KIIs). AGLC project staff conducted an extensive series of 35 personal interviews with key coffee sector leaders including public sector representatives, farmer organizations, washing station managers and numerous private sector stakeholders. These interviews focused on challenges identified during the October AGLC 2015 kick off meeting in Kigali, and they 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, farmer incentives, among others. These data were compiled, organized and analyzed in a way that they can be integrated with data from the surveys and other applied research activities.

Focus Group Discussions (FGDs). Focus group discussions were held with over 100 coffee farmers grouped principally by gender and region. The advantages of the FGDs is that they are held with groups of 5-7 members of each stakeholder group and that led to a different dynamic in the conversations, enabling the participants to internally debate/discuss the critical issues put before them. The discussions helped to identify some of the inconsistencies in the issues and in some instances to achieve a degree of consensus in otherwise divergent views. FGDs also have the advantage of adding a depth of understanding to quantitative results that, on their own, often lack the nuanced interpretation required. Like the KII data, information from the focus groups was integrated into the analyses of the eight AGLC thematic research areas.

3.2. Capacity Building

The AGLC capacity building component focused on increasing farmer awareness and reducing the effects of antestia/PTD and low productivity at the farm level. Demonstration plots, farmer training, and media messages served as the primary vehicles for building capacity at the producer level. In Rwanda and Burundi, capacity building included farmer training and outreach and informational radio messages for farmers. In Rwanda, capacity building also included an SMS program to share information with and gather information from farmers. Unfortunately, due to administrative and technological challenges, this platform was not ready for use until the very end of the project.

Of the three components of AGLC, farmer capacity building was the most challenging to execute, particularly in Rwanda. While the SMS program did not get off the ground until near the project close, administrative hold-ups also delayed the dissemination of radio messages. However, over the course of the program over 1,350 farmers received training, and many more heard informational messages to improve their farming capacities via radio broadcast.

3.2.1. Farmer Training & Outreach

Formal farmer training activities were based on investments in experimental fields that were implemented near all sampled CWSs in Rwanda and Burundi. In Rwanda, over 775 farmers received formal training, as did over 575 in Burundi. In addition, the AGLC project funded University of Rwanda students to focus their theses on problems related to antestia and PTD.

Farmer training in Rwanda. In Rwanda, farmer training and outreach included formal trainings and informal outreach to farmers who were connected to demonstration plots in the selected experimental fields. Informal outreach often included activities such as working with research assistants to scout for and count antestia bugs. The more formal trainings involved the development of specialized training materials by UR staff, and the delivery of interactive trainings to farmers connected with CWSs in the AGLC sample. UR faculty developed training materials and delivered presentations focused on:

- Coffee tree and structure
- Tree canopy management and the importance of pruning
- Coffee varieties in Rwanda
- Erosion control
- Basic coffee pest management, with a focus on antestia bug control
- Soil and fertility management, with a focus on mulching and fertilizer use
- The role of intercropping coffee with trees that provide shade and organic matter
- Coffee quality standards, harvesting, processing, drying, sampling, storage, and cupping
- Farm record keeping

Training in Burundi. Farmer training in Burundi was largely executed via farmer field schools on good agricultural practices. The Burundi AGLC partners worked with technical partner AgriBusiness Services (ABS) to implement trainings for over 575 farmers. They focused trainings especially on 64 “leader farmers,” who would train numerous other farmers connected to sampled CWSs. Trainings involved the explanation of farming and harvesting techniques, followed by demonstrations in coffee plantations. The Burundi team developed novel case studies on successful coffee farming to help motivate farmers to implement best practices.

3.2.2. Radio Messages

Radio messages were designed to provide information to coffee farmers on good agricultural practices, specifically with a focus on improving productivity and reducing the effects of antestia and PTD.

Rwanda messages. Five radio messages were developed and disseminated over the course of the project in Rwanda. Radio Salus disseminated these messages. These messages focused on topics such as:

- Objectives of the AGLC project and field activities
- The connection between coffee cherry quality and price
- Antestia bug control
- Proper harvesting techniques to improve coffee quality
- The connection between the antestia bug and PTD

Burundi messages. In Burundi, two radio broadcast messages were written and disseminated early in the project. Messages focused on topics related to productivity and antestia and PTD. Radio stations FM HUMURIZA and STAR FM disseminated these messages to a broad listening audience.

Beyond scripted radio messages, the Burundi team members went on local radio shows and discussed best practices. They shared information from research, took questions from moderators, and then took questions over the phone from farmers. In addition, students from the Polytechnic University of Gitega developed and disseminated radio sketches portraying best practices in coffee production.

3.2.3. SMS Messaging Platform

MSU and UR jointly developed an SMS messaging system in Rwanda that enables out-going and in-coming messages. This tool was developed in collaboration with telecommunications company MTN and partners at Carnegie Melon University in Rwanda. It is designed to promote the adoption of available technologies and techniques for antestia control and productivity improvements through informational messages. This technology can also be used to gather information from farmers for research and extension purposes.

Due to administrative and technological challenges at UR, this platform was not functional during the life of the project. However, at the project's close it is functional and can be used by UR, government entities, and/or others for farmer capacity development, extension, and research.

3.3. Policy Engagement

The AGLC program used a focused set of policy engagement activities to bring together a diverse group of stakeholders in the coffee sector to discuss the current state of challenges in the sector and to debate potential opportunities. Ultimately, the goal of the policy engagement and dialogue component was to develop policies that will motivate producers and other actors in the coffee value chain to invest their labor, land, and capital in ways that will increase smallholder farmer incomes and improve control of antestia/PTD.

3.3.1. Sector-wide Workshops

In October 2015 the AGLC project was launched through a Kick-off Workshop in Kigali, Rwanda hosted by the Institute of Policy Analysis and Research (IPAR) Rwanda and co-hosted by the Global Knowledge Initiative (GKI), Michigan State University (MSU), and the University of Rwanda (UR). The goal of this workshop was to set a vision for impact that could be accomplished through the program's implementation. During this workshop, participants developed a shared understanding of the project's goals, activities, and desired outcomes. With that shared understanding, sector leaders discussed the most pressing challenges, opportunities, and priorities as they related to coffee productivity and potato taste defect (PTD). Those key challenges identified in the workshop were grouped into three thematic areas:

- Theme 1: Inputs & Potato Taste Defect
- Theme 2: Improving Knowledge Dissemination to Farmers
- Theme 3: Market Factors

Over the first year of applied research, capacity building, and policy engagement, AGLC team members worked to address these challenges by conducting a baseline survey with over 2,000 farmers in Rwanda and Burundi. The team also collected data on experimental plots, engaged over 80 high-level stakeholders in Rwanda on key policy issues, and conducted outreach to farmers for capacity development, among other activities. At the End-of-Year 1 Workshop held in August 2016 in Kigali, AGLC team members presented findings from the project's first year. Participants from the private sector, government, cooperatives, and academia provided thoughtful comments and questions based on these presentations. The dialogue revolved around farmer incentives to invest in their coffee plantations; challenges faced by cooperatives; exporter image; balancing quality and volume; cherry prices; timely application of inputs; input distribution; and farmer knowledge of PTD. Toward the end of the workshop, participants broke into two groups to engage in deeper discussions around input availability and zoning.

Finally, in June 2018 in Kigali, the AGLC End-of-Project Workshop—which focused mainly on AGLC's Rwanda components—provided an opportunity for the AGLC team to present findings, receive feedback from over 60 key stakeholders, and identify opportunities for growth and sustainability in Rwanda's coffee sector. Rather than focusing in detail on the project's methodology and the details of analysis conducted, the bulk of the workshop centered on discussions of the implications of research findings and forward-looking opportunities. These opportunities included a focus on developing a multi-tiered pricing system; involving the private sector in input distribution; capitalizing on the environmental benefits of coffee; gender equality and youth involvement in the sector; and more.

3.3.2. Policy Roundtables

In May 2016, the AGLC team held a series of five roundtable discussions in Kigali. These discussions were designed to build off of quantitative and qualitative research conducted by the AGLC team, and to bring together stakeholders from across the Rwandan coffee sector (including policymakers, regulators, private sector representatives, academics, etc.) to debate five critical topics in Rwandan specialty coffee. The discussions revolved around policy issues observed through collected baseline data and key informant interviews. The topics discussed in these roundtables were: (1) ensuring that producers are rewarded for high quality coffee; (2) motivating farmers to invest more in their plantations; (3) improving access to financing for cooperatives; (4) increasing the proportion of "fully washed" coffee; and (5) ensuring that farmers have access to needed inputs. These roundtables provided a space for smaller groups of key stakeholders to react to the findings within specific topical areas and debate how best to take action on those findings through public or private policies, stakeholder collaboration, and/or farmer engagement.

In March and June 2017, the team hosted a second intensive series of five roundtable discussions in Kigali. These roundtables served as an opportunity for coffee stakeholders to discuss challenges in the sector and explore possible policy solutions, using research conducted by the AGLC team as a basis for discussion. Bringing together representatives of the major coffee stakeholder groups from the previous year, as well as participants new to the discussion, these roundtables covered policy issues related to the following topics in Rwanda's coffee sector: (1) pathways to sustainable growth; (2) geographic zoning; (3) access to improved inputs; (4) challenges and opportunities for women; and (5) mechanisms to link coffee price and quality. The insights and proposed solutions taken from the roundtables were integrated into a set of focused AGLC policy briefs which were submitted to the Rwandan National Agricultural Export Development Board (NAEB) to inform their policy decisions. All

presentations, background documents, policy briefs, and research papers developed either for or as a result of the policy advocacy roundtables can be found here.

3.3.3. Targeted Stakeholder Meetings

Beyond hosting official events such as the workshops and policy advocacy roundtables discussed above, the AGLC engaged in more targeted outreach as well. Members of the AGLC team held dozens of individual and small group meetings over the course of this three-year project to discuss research findings and how to interpret them, listen to feedback / concerns, and discuss potential policy options aimed at improving coffee quality and productivity. These meetings, held with coffee sector leaders at NAEB, CEPAR, MINAGRI and private sector companies, helped to develop vision alignment that supported public and private decision-making for the benefit not just of stakeholders with decision-making power, but for the benefit of smallholder coffee farmers as well.

Links to Related Documents. Policy briefs, research reports, roundtable backgrounders and other documents supporting AGLC policy engagement activities can be found at: http://foodsecuritypolicy.msu.edu/news/policy_roundtables_in_rwanda_foster_dialogue_among_coffee_sector_stakeholde

4. Thematic Program Issues: Summary of Problems, Findings and Implications

AGLC research and policy engagement activities addressed a set of problem areas identified by coffee value chain stakeholders during the inception conference in 2015 and later as a part of the many interviews and roundtable discussions held with key actors in the sector. These problem areas are grouped into eight thematic program issues as presented in the subsections below. They include: farmer investments, pricing & quality, zoning, coffee cooperatives, gender, inputs access, PTD/antestia control, and coffee sector sustainability. Each AGLC program theme is summarized along with selected findings and policy implications that emerged from the research and policy engagement activities of the project. Although data were collected in Burundi, because policy activities only took place in Rwanda, the following problem areas focus solely on Rwanda.

4.1. Farmer Investments

Background. Since 2001, the coffee value chain has seen a transformation in quality (fully-washed coffee) and is now well-established in specialty coffee markets around the globe. With

the construction of over 250 washing stations, the processing segments of the sector have prospered. Dry mills and export companies, both domestic and international, have similarly emerged during this period. While the value-added from this transformation has benefited Rwanda, those at the base, the coffee producers, have shared the least in the new prosperity. AGLC research shows that failing to include the producers as full partners is the main reason that coffee production in Rwanda has declined and stagnated in recent decades. Sub-par compensation for their cherry, an average of 24 percent below the revenues of their counterparts elsewhere in the region, has resulted in the neglect and disinvestment in coffee by many producers, particularly largeholder producers.

Findings & Conclusions. Findings presented in this report show that the cost of production in Rwanda, including household and wage labor, inputs and equipment, totals 177 RWF/Kg of cherry, a figure well above that currently used as a reference for establishing cherry floor prices in Rwanda (Figure 2). As a result, a large proportion of growers suffer unsustainably low margins or even net losses in coffee (over one-third in 2015).

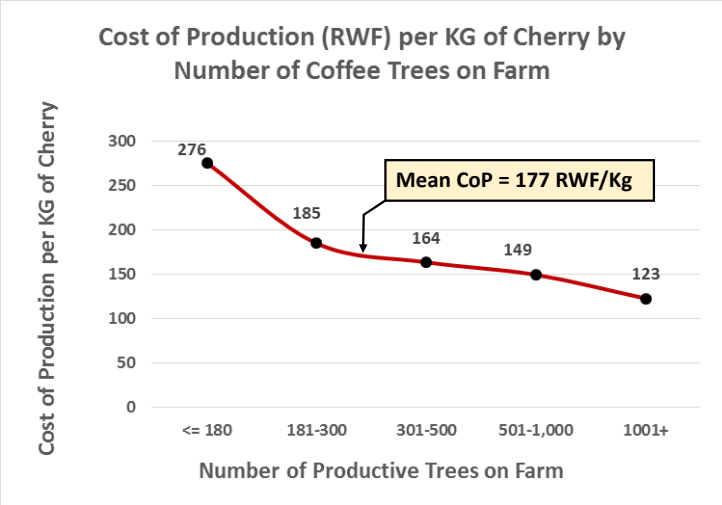

Figure 2

Another noteworthy contribution of this research lies in its analysis of how different farm household capacities and incentive structures influence farmer investment strategies. Data presented in this analysis provide a unique perspective on how smaller, low resource producers differ from their higher capacity largeholder counterparts in their incentives to invest in their coffee plantations (see Figure 3). We find that smallholders lack capacity but are highly motivated to extract as much value as they can from their small plantations simply out of economic necessity. They live on the edge and the prospects of going hungry and sliding into poverty are very real. Their core investment is their own household labor. Despite higher productivity, diminishing returns to their high labor investment makes coffee unprofitable for many in this group. Largeholder coffee producers, by contrast, have the lowest productivity of all farmer groups. They have high capacity but do not use that capacity for coffee production. They are responsive mainly to coffee cherry prices and when prices are low, they have been found to effectively abandon their coffee plantations or even uproot trees in favor of other crops and activities. As the majority of coffee trees (57%) are located on

largeholder farms, a continuing regime of chronically suppressed cherry prices in Rwanda has led to an overall decline and stagnation of coffee production over the past two decades.

Findings also show that end-of-year premium payments provide an additional incentive for farmers to improve productivity. Farms that receive premiums (8.3 percent, on average) have an estimated productivity that is 29.4 percent higher than those that do not receive premiums, all else equal. These findings are especially germane to our understanding of farmer incentives. It demonstrates how sensitive farmers are to even small changes in remuneration.

Rwanda Coffee Farmer Typology: Capacity to Invest versus Incentive to Invest (*in Low Cherry Price Scenario*) by Size of Plantation

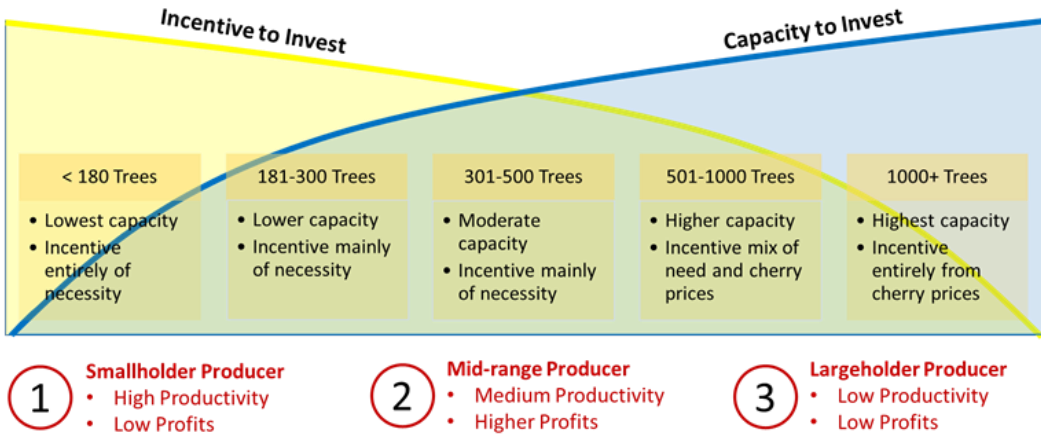

Figure 3

Policy Implications. This research has been vital to Rwanda's National Agricultural Export Development Board (NAEB) in that it has enabled NAEB, starting in 2017, to set coffee cherry prices based on more accurate estimates of farmer cost of production. In the longer term this development is expected to catalyze a virtuous circle in the coffee sector of higher farmer investments in their plantations => improved productivity and quality => higher coffee volumes => lower processing costs => higher export prices and margins. AGLC research findings have also helped private sector actors to appreciate more fully the importance of extending their efforts beyond farmer capacity building programs to consider incentivizing coffee producers through more attractive farm gate prices and premium/second payments.

Links to Related Documents. "Determinants of Farmer Investment in Coffee Production: Finding a Path to Sustainable Growth." Research Paper #32.
http://foodsecuritypolicy.msu.edu/uploads/resources/FSP_Research_Paper_32.pdf

"Incentivizing Farmer Investments for Sustainable Growth in Rwanda's Coffee Sector." Policy Brief #23. http://foodsecuritypolicy.msu.edu/uploads/resources/Policy_Brief_23.pdf

"Estimating Cost of Production." Research paper #33. http://foodsecuritypolicy.msu.edu/uploads/resources/FSP_Research_Paper_33.pdf

4.2. Pricing and Quality

Background. The Government of Rwanda (GOR) is implementing a strategy of shifting away from the commodity trade with its associated low-prices and towards higher levels of quality and specialty coffee markets. The national goal is to reach 80% fully-washed coffee. The AGLC program documented that farmers invest more in their coffee when cherry prices make coffee production profitable, and that increased investment leads to higher volumes and more high quality cherry, two trends that benefit all levels of the coffee value chain. Unfortunately, some structures and policies are still ill-fitted to maximize Rwanda's potential for high quality coffee.

AGLC has recommended a cohesive policy framework to more effectively allow and promote differentiated prices for low- and high-grade cherry. The policy recommendations are rooted in the fact that coffee has various quality levels. Appropriate metrics and incentives at each level of the industry, (farm-level, processing and government) are needed to continuously sort low grades from high grades, facilitating more levels of quality segmentation than exist today. With better sorting, definition of grades, and multi-tier pricing, government and private sector actors, beginning with farmers, will have increased opportunities to capture higher levels of value.

Findings: Coffee washing stations play a critical role in maximizing quality increases through their interventions, including training and initial cherry assessment (quality control). These facts and the new higher floor price policy implemented by the GOR in 2017, led to increased pressure in the cherry market for differentiated pricing in the following two seasons (2017 and 2018).[1] The AGLC project, through roundtables and workshops, has created a dialogue with the National Agricultural Export Development Board (NAEB) on the benefits of policy that supports this direction of multi-tier pricing for cherry at the washing stations.

[1] As was described by panelists at the End-of-Project Workshop, June 26, 2018, in Kigali, some of Rwanda's leading coffee processing organizations have already tested and used systems that pay two prices, one for high grade and one for low grade cherry.

Through research, the project estimated the costs of the status quo. The missed opportunity in not maximizing quality appears to be 125 RWF/KG cherry sold for producers in the time period considered, and exporters had 43 percent *lower* profits than might have been possible. At the national level, the country missed an estimated $2.6 million in foreign exchange, just in 2016. The damage (or discount based on perceived risk) from potato taste defect is estimated at $.30 - $2.00 per pound FOB for exported green coffee, depending on the quality level. These estimated, unrealized gains, combined with general recognition that insufficient supply of cherry is one of the greatest challenges to profitable operations of CWSs, provide the impetus to examine the problem of mixing (not differentiating) low and high quality coffee in the value chain.

Case studies of four organizations demonstrated some of the behavioral, pricing and technological methods being tested by the industry's "early adopters" to improve graded sorting of cherry. These case studies show how through an ideal mix of pricing, technology, and human resources support, CWSs can perform a crucial step in farmer education, in addition to implementing a quality control function that objectively separates grades, leading to higher margin opportunities.

A final, critical finding of the AGLC program is the positive impact of second-payments on productivity. An estimated 26 percent improvement in productivity, (2.07 Kg/tree compared to 1.64 Kg/tree), resulted from an average 8.3 percent bonus payment in 2016. The study also emphasizes that when premiums recur regularly (annually), their impact increases.

Policy Implications. All levels of the value chain have opportunities to increase value addition through greater emphasis on differentiation of quality segments, including multi-tier pricing by CWSs. These opportunities can be maximized if NAEB utilizes formulas that emphasize the cherry floor price as a price paid for high quality cherry, and, at the same time, directs CWSs to implement multi-tier pricing as one component of an integrated farmer education and quality control approach.

Recommended best practices for coffee washing stations include requiring farmers to sort and float cherry before weighing and paying for the cherry. The farmers who have invested the time and energy it takes to delivery only high quality cherry will then have the opportunity to earn a higher price for their effort. CWSs should be formally allowed by NAEB to either pay a low price (e.g., 150 RWF/KG cherry) for the low grades, or to reject the low grades entirely. Ideally, the agronomists employed by the washing station can be made available as the sorting/floatation and payment transaction takes place, enabling coaching and positive reinforcement of lessons taught during farmer field schools.

Links to Related Documents. "Determinants of Farmer Investment in Coffee Production: Finding a Path to Sustainable Growth." Research Paper #32. http://foodsecuritypolicy.msu.edu/uploads/resources/FSP_Research_Paper_32.pdf

"Understanding and Improving the Price-Quality Relationship in Rwanda's Coffee Sector." Research Paper **(**forthcoming**)**.

"Pricing Coffee Cherry to Incentivize Farmers and Improve Quality." Policy Research Brief #43. http://foodsecuritypolicy.msu.edu/uploads/resources/Policy_Brief_43.pdf

4.3. Zoning Policy

Background. In 2016, the National Agricultural Export Development Board (NAEB) implemented a zoning policy, which entails the development of geographic "zones" around coffee washing stations. Coffee farmers within a geographic zone must sell to specific CWSs within that zone and CWSs must only buy from farmers in their designated zones. The purpose of zoning is to better organize the industry, improve relationships between CWSs and farmers, improve traceability of coffee, and reduce the role of middlemen (traders who previously purchased coffee from farmers and then re-sold it to CWSs).

Zoning responds to several challenges. In the past decade, competition has increased between CWSs purchasing coffee from farmers. Historically, CWSs have often provided farmers with inputs and training based on an implicit agreement that farmers would sell coffee cherry to the CWS that provided inputs. Middlemen, however, purchased coffee from across Rwanda —— including coffee from farmers who had agreements with CWSs —— damaging relationships between CWSs and farmers.[2] Through zoning, NAEB hopes to encourage CWSs to work productively with farmers, to improve traceability, and to increase the sector's stability.

Findings and conclusions. Research conducted on zoning includes analysis of data from the AGLC Midline and Endline surveys, and analysis of key informant interviews and focus groups. Findings can be split between those from after the first year of zoning (2016) and after the second year of zoning (2017).

Findings from 2016. After the first year of zoning implementation, nearly half of farmers (46.7%) still did not know what zoning was, which complicates the evaluation of zoning's impact

[2] Macchiavello, R. & A. Morjaria. (2015). Competition and Relational Contracts: Evidence from Rwanda's Coffee Mills. Working Paper. Warwick: University of Warwick.

on farmers. Farmers who did not know about zoning were concentrated in Kirehe district, where 92.2% of respondents were unaware of the policy. This may be because of Kirehe's low CWS density, which results in a lower likelihood of farmers being affected by zoning. For farmers who did know what zoning was, views were largely negative. Farmers reported that it did not help them and also lowered cherry prices. Importantly, 2016 was a year with low cherry prices, so farmers may have been reacting to an unfavorable economic environment and attributing causation to zoning.

Qualitative findings were more mixed. In workshops and interviews, stakeholders expressed concern about zoning's effect on farmers, cooperatives, and on CWSs that had invested in certification for farmers and who had been moved to other zones. However, other stakeholders believed that zoning was necessary because of the negative effects of competition between CWSs, and that the policy would pay dividends once fully implemented.

Findings from 2017. After zoning's second year, farmers were more likely to know about it, and felt more positively toward it. In 2017, 67.2% of farmers knew what zoning was, a 13.9 percentage point increase. This still means that 32.8% of farmers did not know about zoning two years into its existence. Those who knew about zoning had more positive perceptions than in 2016. As Figure 4 shows, the percentage of respondents who thought zoning benefited farmers massively increased between 2016 and 2017. In 2016, 64.5% of farmers disagreed or strongly disagreed that zoning benefited farmers like them. In 2017, 60.8% of farmers agreed or strongly agreed that it benefited farmers like them.

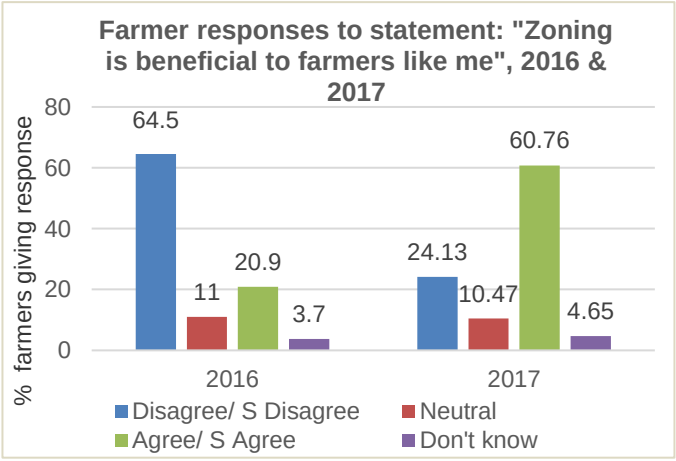

Figure 4

Potential reasons for this change include higher cherry prices paid in 2017, improvements in services provided by CWSs, and limited enforcement of zones. In 2017, NAEB set a cherry floor price that was substantially higher than in 2016. This is a reasonable possible government response to zoning, which reduces the chance for higher cherry prices driven by competition. However, it may have influenced farmer views. In terms of service provision, although limited data is available, it may be the case that CWSs have hired agronomists or otherwise provide services to farmers under zoning. It is also possible that enforcement has not been as intensive as expected. Interviewed exporters note that some individual farmers can violate zones without being punished. However, zoning has effectively kept middlemen from crossing zones.

Policy implications. The following policy options aim to improve the effects of zoning on farmers and other stakeholders, while maintaining the goals of improved relationships between farmers and CWSs, traceability, and a reduction in the activities of middlemen. Some are mutually exclusive, or would not work well together, so these should be considered as fodder for additional analysis and policy development.

1. *Conduct impact analysis.* Conduct a thorough study of zoning's impacts on farmers and others. NAEB can use gathered data to design longer-term adjustments to zoning.
2. *Share information about zoning.* Given limited knowledge about zoning, it is critical that coffee sector stakeholders receive more information. This includes information about the purpose of zoning, how zones are drawn, and what stakeholders can do if they have concerns. A written policy will help ensure that stakeholders receive accurate information.
3. *Increase sale options for farmers.* Formally allow individual farmers to deliver cherry outside their zones on foot or allow CWSs to compete within districts (as is done in Huye). Either of these options would allow for farmers to receive better prices through local competition, while still allowing for traceability and reducing the role of middlemen.
4. *Maintain fair floor price.* If zoning is effective, it will reduce CWS competition, thus weakening incentives for CWSs to increase prices. This means that the price floor will be a major driver of price. Thus, it is vital for NAEB to continue supporting attractive farmer prices.
5. *Ensure CWSs support farmers.* Analyze whether CWSs provide farmers extension services and sufficient inputs. NAEB can reward CWSs that support farmers and/or penalize CWSs that do not.

Links to related documents. "Stakeholder Perceptions on Geographic Zoning in Rwanda's Coffee Sector and Opportunities for Policy Adjustment." Policy Brief 42. http://foodsecuritypolicy.msu.edu/resources/stakeholder_perceptions_on_geographic_zoning_in_rwandas_coffee_sector_and_o

4.4. Cooperatives in Coffee

Background. Rwandan 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. Many of these cooperatives have emerged as a result of government and NGO support aiming to improve farmers' incomes by providing services and inputs for

production, to process high quality products and increase farmers' bargaining power. 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. Additionally, NGOs and development programs have helped farmers to establish cooperatives and have trained members in various aspects of coffee production, processing and marketing. Currently, 14 percent of coffee farmers are members of a cooperative or smallholder association.

Findings & Conclusions. Our sample of farmers in the AGLC baseline survey (2015) is comprised of 55 percent (567) cooperative members and 45 percent (457) non-members. These survey data and information gathered through focus groups finds that the main benefits and services provided by cooperatives, as self-reported by farmers, include premiums, input provision, delivery of extension services, and market access. Barriers to cooperative participation include high membership fees, and the absences of cooperatives in specific areas. Additionally, some member farmers reported complaints regarding cooperative governance and management.

Average coffee productivity in 2015 was reported at 1.75 kg of cherry per tree, with cooperative members having 0.48 kg/tree more than non-members. Coffee income per tree was significantly different between members and non-members at 347 and 268 Rwandan Francs (RWF), respectively. The average share of income from coffee was 45 percent across the entire AGLC sample. Coffee household's cost of production was calculated by summing all household and wage labor invested in coffee, as well as inputs and equipment costs. Our data show that cooperative members have a significantly lower cost of production at 163 RWF/kg compared to non-members at 202 RWF/kg. On average, cooperative members reported a higher level of adoption of best practices relative to their non-member counterparts; index of scores of 4.97 and 4.71 (out of 6), respectively. These trends between members and non-members continue in our midline (2016) and endline (2017) survey data. In 2016 average productivity in our sample was 1.48kg per tree for members and 1.17kg for non-members; in 2017 productivity was 2.12 kg per tree and 1.47 kg, respectively. Similarly, the index of best practices finds that adoption was higher for members than for non-members in 2016 (3.96 vs. 3.82), with the gap narrowing in 2017 (3.99 vs. 3.94).

To estimate the effect of cooperative membership, treatment (member) and control (non-member) households from our baseline sample (2015) were matched on observable characteristics from an estimated propensity score. Our results generally suggest that cooperative membership significantly affects adoption of best practices, tree productivity, coffee income, and reduces farmers' cost of production. The effect of cooperative membership on adoption of best practices is an increase of 0.46 index points. Coffee cooperatives are known

to train farmers on the benefits of adopting best practices and to promote their use among members.

In addition to training, cooperatives distribute inputs such as fertilizer and pesticides, which helps to facilitate adoption of best practices. Adoption of best practices is linked to increases in tree productivity. As such, our analysis finds that cooperative members are 14 percent more productive (per tree) than non-members. Our results indicate that cooperative members receive 16 percent more income from coffee per tree than non-members. This increase is likely a result of both increased productivity as well as better cherry quality due to adoption of best practices. Coupled with a 22 percent reduction in the cost of production, we find that membership has a significant effect on net coffee income, or profits. Members' cost of production is significantly lower as some cooperatives provide inputs such as fertilizer and pesticides at lower costs and often assist farmers in their application, reducing labor costs. As a percentage of total income, our analysis finds that cooperative members obtain 9 percent more income from coffee than do non-members. This finding speaks to the cooperative's role in increasing household incomes and promoting food security.

Policy Implications. AGLC findings show that cooperatives are a critical institution for building farmer capacity, adoption of improved technologies and inputs, as well as increasing coffee productivity and farmer welfare. These results also inform the role that collective action can play in coffee sector policies in Rwanda. While governance and management issues have been known to affect some cooperatives, our results show that these organizations can help incorporate the 'voice' of the farmer into sector policy discussions. This highlights the importance of equal voice and accountability as crucial aspects of good governance which are linked to economic growth and cautions that lack of farmer and stakeholder participation can lead to demonstrably poor outcomes for farmers. While coffee's market potential, agro-ecological attributes and contributions to food security make a persuasive case for bringing coffee back as a national priority in Rwanda, the results from our project make a compelling argument regarding the role that cooperatives can play in helping to establish the sector as a pillar of growth in the country.

Links to Related Documents. "Role of Cooperatives on Adoption of Best Management Practices & Productivity in Rwanda's Coffee Sector." Research Paper #27. http://foodsecuritypolicy.msu.edu/uploads/resources/FSP_Research_Paper_27.pdf

4.5. Gender

Background. The Rwandan government has implemented different policies in recent years to promote gender equality and empower women. This has included land tenure reforms that

guarantee women the right to own and inherit land. This development is particularly important in light of the finding that 96.1 percent of economically active Rwandan women are engaged in agriculture,[3] and that 28 percent of rural households are headed by women.[4] Understanding how women contribute to agriculture, particularly to coffee production, and the challenges they face has been a priority for the AGLC project. Two aspects that captured much of the project's attention were the contributions women make to the Rwandan coffee sector in general and the importance of women's labor to coffee production in households headed by males.

Findings & Conclusions. Our baseline survey included households of three types: 4 percent male-headed with no female spouse present; 18.5 percent female-headed households with no male spouse present; and 77. 5 percent male-headed with female spouse present. Study results show that female-headed households differ from male-headed households in several ways. For example, the majority of the female heads of households are widows (78%) and are on average nine years older than male heads of households. In 2015, 92 percent of the female headed households faced food shortages, compared to 78 percent of the male headed households. Female heads of household own less land than their male counterparts (on average 10,243 m^2 compared to 12,380 m^2). In terms of coffee production, female heads of household have on average 596 productive trees, and the trees have on average age of 27 years. By contrast, male-headed households own and average of 767 productive trees, aged 20 years on average. Women headed households derived 49 percent of their income from coffee, while male heads of households derived 43 percent of their income from coffee. Female-headed households are more likely to be members of coffee cooperatives than are male-headed HHs.

Figure 5 presents the different activities related to coffee production compared across male and female headed households. In male headed households, there are some activities like stumping, pruning, planting seedlings, and applying pesticides that are conducted largely by

[3] FAO (2011). The State of Food and Agriculture 2010–2011. Women in Agriculture: Closing the gender gap for development. Rome: UN Food and Agriculture Organization. ISSN 0081-4539

[4] Abbott, Pamela and Malunda, Dixon. 2013. "Analysis of Three Rwanda Strategic Agricultural Policies and Programmes (Vision 2020, EDPRS, PSTA) with a Critical Gender-Informed Review of their Implementation and Financing".

men; whereas sorting and mulching and weeding are done by both. In female headed households, hired labor is often used for pruning, stumping and fertilizer applications.

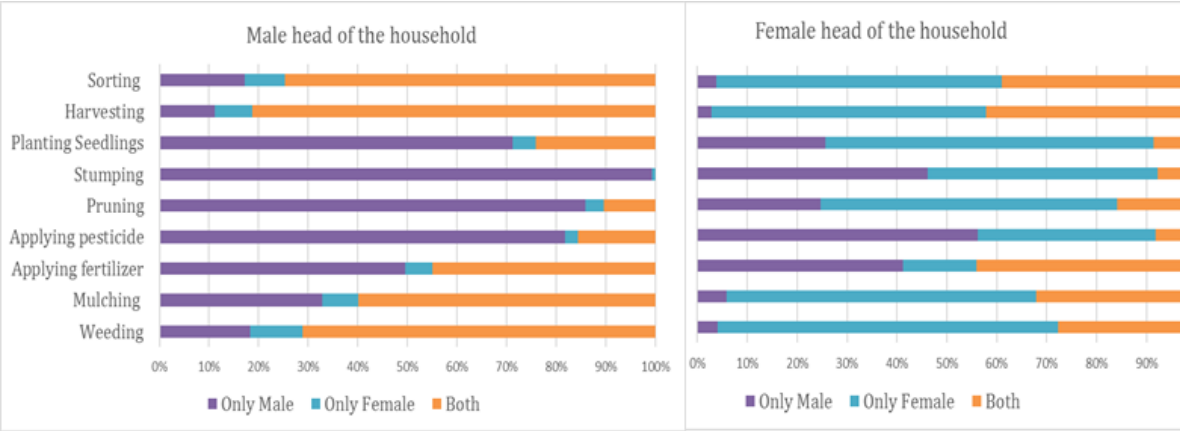

Figure 5. Coffee prodution activities disaggregated by gende of household head

As discussed with stakeholders in the AGLC policy roundtable on gender in coffee, in female headed households, women also have household responsibilities such as childcare, cooking, cleaning, and fetching water—all of which prevent them from dedicating more time to coffee. Thus it is not surprising to find that coffee productivity is lower in female-headed households. In addition, we have found that women headed households in 2015 and 2016 applied less pesticides and less fertilizers than did their male counterparts.

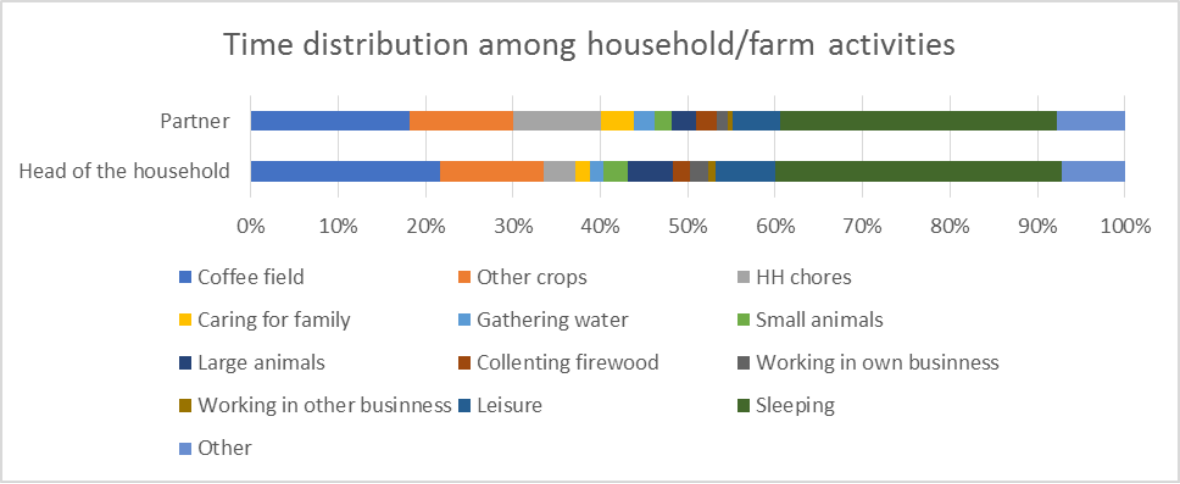

Figure 6

In the 2017 endline survey we asked a series of questions on the daily time allocation among different activities of the heads of the households and their partners. The results of that

question set are found in Figure 6. Results showed that in male-headed household with a spouse present, males spend 21.5% of the day working in the coffee fields, whereas their spouses spend 18% of the day working in coffee. Both spend the same amount of time on other crops (11.8% of the day). Females spend more time doing household chores, caring for family members, collecting wood and hauling water, whereas men spend more time taking care of small and large animals. A conclusion reached in the gender roundtable is that men control the revenues from coffee, and this reduces women's motivation to invest in coffee and limits their ability to purchase equipment.

Policy Implications. Even though in Rwanda coffee is considered to be a men's crop, our results show that females play an important role in the coffee sector. Coffee is grown both by males and females and that needs to be recognized by the coffee sector (i.e., government, coffee washing stations, coffee companies). Female-headed households still struggle to match male farmers' productivity and in their access to inputs. The right policies could help to address this gap. Since women are more likely than men to belong to cooperatives, these organizations can play a greater role in guaranteeing gender empowerment and equality in the sector. Training should be targeted to both females and males, because when it is only targeted to females, they have a hard time transferring that knowledge to males (either partners or hired labor), and it may create problems at home. Training both males and females will help to ensure the implementation of best practices, though training must also accommodate women's responsibilities at home.

4.6. Inputs Access

Background. A key factor influencing coffee productivity and quality is the use of commercial fertilizer and pesticide. As a part of studying coffee productivity, AGLC analyzed fertilizer and pesticide distribution to coffee producers. Rwanda's coffee input distribution system is organized such that a private sector organization—Coffee Exporters and Processors Association of Rwanda (CEPAR)—takes a fee from exported coffee and uses it to purchase bulk fertilizer and pesticide. CEPAR then works with government and local representatives to distribute inputs to farmers based on the number of trees they have. When AGLC started in 2015, CEPAR had just taken over distribution responsibilities from Rwanda National Export Development Board, a change intended to improve input distribution efficacy.

Over the course of the project, AGLC studied changes in distribution and use, and proposed approaches for relevant stakeholders to take forward. To allow farmers to know the volume of inputs they should expect to receive, NAEB sends SMS messages to individual coffee farmers. However, farmers still may receive different amounts of inputs per tree, and some do not receive distributed inputs at all. Because all farmers pay into the input distribution system

indirectly through an export fee, AGLC analysis focused on gaps in distribution and volumes received.

Findings & Conclusions. In considering the effectiveness of the input distribution system, we considered three questions: (1) Are inputs distributed to everyone? (2) What volumes do farmers receive? and (3) Are there patterns in who receives inputs and at what volumes?

Are inputs distributed to everyone? Inputs are not distributed to every coffee farmer, however the percentage receiving inputs has increased. In 2015, 69.4 percent of farmers received distributed fertilizer, and 68.1 percent received pesticide. By 2017, those numbers had increased to 79.3 percent of farmers using distributed fertilizer and 74.0 percent using pesticide. This constitutes an improvement, but it means that many farmers still do not receive distributed inputs. In terms of pesticides, one potential challenge may be farmers who have pesticide available, but do not have the means to spray their coffee trees with it. There are shortages of sprayers, and many farmers cannot afford to hire technicians to spray their trees.

What volumes do farmers receive? While the percentage of farmers receiving inputs has increased, the volume per coffee tree remains low. Of farmers receiving distributed fertilizer, the median farmer receives 54.4 grams per tree. This amounts to around a quarter of the recommended 200 g per tree.[5] For farmers who receive pesticide, the median farmer receives 0.111 ml per tree. This is just under the 0.113 ml recommendation for a *single* dose.[6] However, it is also recommended that farmers spray multiple times per year (*ibid*.). Two sprayings per year would require and average of approximately 0.225 ml per tree, or double the amount actually distributed to farmers.

Are there patterns in who receives inputs and in what volumes? Though distribution gaps have shrunk, gaps remain in distribution of pesticide and volume of fertilizer distributed. All results reported here should be interpreted as "all else equal," because they are estimated using a regression model that holds constant the effects of other variables.

The most important gap in receiving pesticide is gender. Men are more likely than women to use distributed pesticide. Women avoid applying pesticides because of cultural and health

5 TechnoServe (n.d.) Soil Survey of Rwandan Coffee Sector for Developing Area Specific Lime and Fertilizer Programs.

[6] Rukazambuga, D. (2018). Personal correspondence. Email exchange July 2018.

concerns, instead hiring laborers to spray. Many female household heads are widows, and face labor and cash shortages, which may keep them from hiring labor.

The most salient influences on distributed fertilizer volume include age, cooperative membership, and number of coffee trees. Older farmers receive less fertilizer per tree. They may face difficulties in transporting and physically applying inputs and may not be able to afford hiring laborers to transport or apply inputs. Cooperative members receive more fertilizer per tree than non-members. AGLC publications show that Rwandan cooperatives are effective at ensuring members can access inputs.[7] Finally, the more trees farmers have, the *less* fertilizer they receive per tree. This shows that fertilizer distribution is not strictly based on number of trees, but instead is "lumpy," with some farmers receiving similar fertilizer volumes despite having different sized farms.

Policy Implications. Rwanda's input distribution system is improving, with more farmers receiving inputs, and improvements to the type (effectiveness) of inputs used. However, gaps remain. How can Rwanda continue improving distributions and reach farmers who face challenges in accessing inputs or sufficient volumes of inputs? These policy alternatives aim toward meeting three goals: (1) ensure all eligible coffee farmers receive inputs, (2) increase the volume of inputs available, and (3) cost-effectively boost productivity through input use. These alternatives require additional analysis and are presented as fodder for in-depth analysis and policy formulation.

1. *Ensure that woman headed households and older farmers receive inputs.* Work with coffee washing stations (CWS) to develop mechanisms to ensure that vulnerable groups access inputs. For example, CWSs could be required to ask farmers within their zones if they need inputs delivered to farms. Given gender norms and the physical difficulty of spraying pesticides, it is worth considering having CWSs hire sprayers to visit woman-headed households in their zones, or spray all coffee farmers during the same period.
2. *Increase export fee or subsidize CEPAR to purchase more inputs.* Increasing the export fee would avail more inputs, but would need to be carefully implemented because of the potential to harm farmers and other value chain actors. However, if designed well, increased productivity and quality could make coffee profitable for more value chain

[7] Ortega, D., Bro, A., Clay, D., Lopez, M., Church, R., & A. Bizoza. (2016). The Role of Cooperative on Adoption of Best Management Practices and Productivity in Rwanda's Coffee Sector. Feed the Future Innovation Lab for Food Security Policy Research Paper 27. Michigan State University, East Lansing, Michigan.

actors despite the higher costs. An alternative to (or step in conjunction with) increasing the export fee would be for government to subsidize inputs so that purchase is not solely based on export fees, which are a form of tax on farmers.

3. *Conduct cost/benefit analysis of bulk purchase and distribution.* It may be worth analyzing the current system itself in comparison to other structures (e.g., individual farmers buy inputs; cooperatives buy inputs; government subsidizes input purchase, etc.). Is it worth transaction and transport costs to deliver small volumes of inputs to farmers? At what volumes is it wise to bulk purchase and distribute? Finally, might the current system crowd out a private sector input market? Further analysis could answer these questions.
4. *Facilitate farmer investment in inputs.* If, rather than expanding distributed inputs, the government decided to support expanded private sector involvement in inputs, they might focus on facilitating farmer input purchases. For example, subsidizing farmers to purchase from agro-dealers through a voucher system might promote the growth of agro-dealer networks.

Links to related documents. Gerard, A., Clay, D., Lopez, M., & K. Bowman. (2018). Policy Brief: Analysis of distributed coffee inputs in Rwanda; pesticide access and fertilizer volume. Forthcoming.

4.7. PTD/Antestia Control

Background. Potato taste defect (PTD) is a potato-like taste and smell found in green and roasted coffee beans and in brewed coffee. This defect reduces the flavor experience of roasted coffee, diminishes its value, and can cause affected coffees to be rejected by roaster/buyers. In turn, potato taste defect has an economic effect on producers, because PTD can reduce the value of coffee paid to farmers and cooperatives. Additionally, international buyers may more generally reduce prices they are willing to pay for coffee coming from the areas suspected to have PTD, whether or not there is specific evidence of the defect in a given lot of coffee. Potato taste defect occurs mainly in coffees from the Great Lakes Region of Africa, most notably in Burundi, Rwanda, and Democratic Republic of Congo.

PTD has been closely associated with the presence of antestia bug, *Antestiopsis thunbergii* (Hemiptera, Pentatomidae). Antestia bug is a major pest of coffee in the African Great Lakes Region where it occurs in coffee farms at all elevations. Both the nymphal and adult stages feed on the vegetative (flower buds, green shoots and leaves) and fruiting parts (berries at different stages of development and maturation) of the coffee tree, in turn leading to poor yields and low quality. The antestia bug is known to cause yield losses of up to 40%.

Findings & Conclusions. AGLC research findings show that different insecticides have varying degrees of effectiveness in controlling antestia bug. The most effective from our trials are pyrethroids (Fastac, Pyrethrum 5EW and Pyrethrum EWC). We also find that the efficacy of Imidacloprid (neonicotinoid) increases over time, but does not reach the levels of success achieved with pyrethroids. More specifically, in laboratory conditions, Fastac achieves 100% mortality of antestia bug compared to Imidacloprid, which only kills 71%.

A second important finding is that the field efficacy of these insecticides improves when they are combined with pruning of coffee tree branches as part of an integrated pest management (IPM) approach. Pruning opens up the coffee canopy and thus creates unfavorable conditions for antestia bug, and also improves pesticides penetration and efficacy. Our findings show that pruning plus pyrethroids, such as Fastac achieves the highest mortality of antestia bug, with a mean of 15.0 ± 1.2 bugs compared to plots sprayed with Imidacloprid which show a mean of 6.9 ± 1.6 bugs, 12 hours post-treatment.

Another noteworthy finding is that pruning alone provides better control of antestia bug compared to plots not pruned and not sprayed with insecticides possibly because the bugs do not like the habitat of exposed coffee trees.

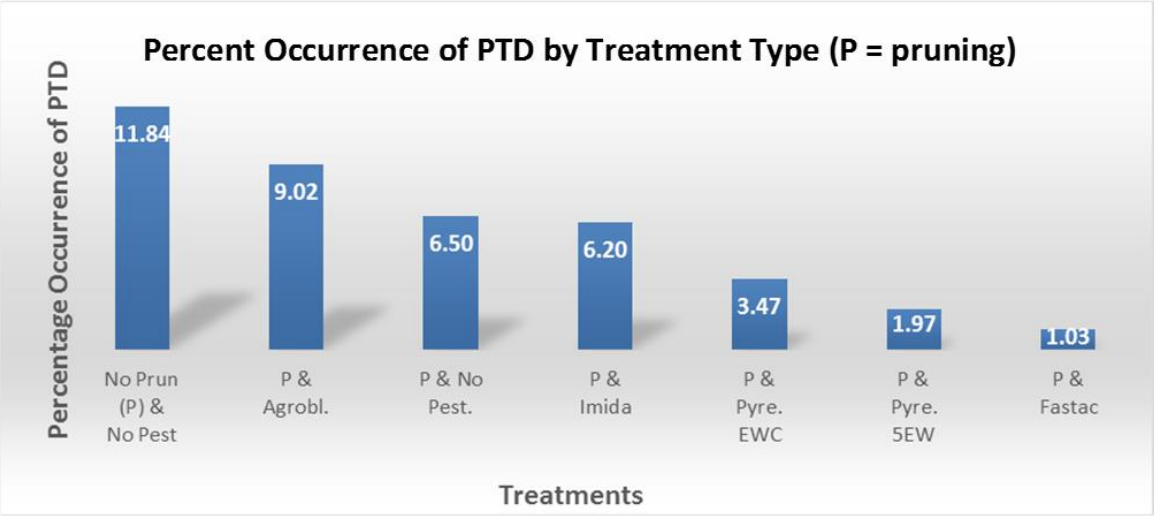

Figure 7

Field treatments against antestia bug influence the level of cherry damage by the pest. Our data show that pruned plots sprayed with Pyrethrum 5EW are the least damaged with a mean of 13.1 percent infested berries. Plots not pruned and without insecticide application show more than three times the level of damage compared to treated plots (with a mean infestation rate of 47.2 percent).

Findings also show significant differences in PTD incidence among different antestia treatments. Treatment with Fastac in pruned coffee trees results in the lowest incidence of PTD while the control group has the highest incidence (about 12 times that of Fastac spraying in pruned plots). Pruned plots treated with Fastac or Pyrethrum 5EW have the lowest PTD incidence on average. Additionally, coffee from the control plots have twice the PTD incidence of those with pruning alone, which have the same PTD incidence as pruned plots treated with Imidacloprid (Figure7).

Moreover, we find that pruned plots are almost 67% (inverse odd ratio of 1.48) less likely to develop PTD compared to unpruned plots, controlling for other covariates. Finally, our data show that the occurrence of PTD is significantly correlated with Antestia bug density and damage but not with coffee berry borer infestations.

Policy Implications. Prior to conducting this research, export fees deducted from coffee sales were used to buy Imidacloprid, which was distributed to farmers for antestia bug control for almost 4 years. When the AGLC data were shared with NAEB and CEPAR, the policy quickly changed to purchase and distribute Fastac based on its greater effectiveness in controlling antestia bug and because it is more cost effective than Pyrethrum 5EW under use in organic coffee production. Pruning campaigns are now implemented in Rwanda soon after the coffee harvest season to make sure that pruning will be completed in time for the next season's spraying. In short, findings from this research have been instrumental in guiding coffee sector leaders to adopt policies to disseminate the most effective treatments and practices for reducing antestia and PTD.

More research is needed to effectively control antestia bug and to eliminate PTD in coffee. Because insecticides are expensive and sometimes have negative effects on human health and the environment, there is need to explore other options for antestia bug control, such as biological control, mating disruptions, attract and kills, etc. We also need to understand all the factors responsible for the occurrence of PTD in order to fully eliminate this defect in coffee.

Links to Related Documents. "Mitigating Antestia Bug Damage and the Potato Taste Defect in Rwandan Coffee." Research Paper 63.
http://foodsecuritypolicy.msu.edu/resources/mitigating_antestia_bug_damage_and_the_potato_taste_defect_in_rwandan_coffe

Bigirimana, J., Gerard, A., Mota-Sanchez, D., & L. Gut. (2018, forthcoming). "Options for Managing Antestiopsis thunbergii (Hemiptera: Pentatomidae) and the Relationship of Bug Density to the Occurrence of Potato Taste Defect in Coffee". Florida Entomologist.

4.8. Coffee Sector Sustainability

Background. Findings from the AGLC surveys of coffee producing households and interviews with stakeholders and focus groups confirm that the long-term success of the coffee sector (all stakeholders) depends on growth in production and productivity on the farm. Efforts to address these needs has to date focused almost exclusively on helping to build farmer capacity through training in best practices and the use of inputs. While strengthening farmer capacity is a necessary condition, it is not a sufficient condition to increasing farmer investment in coffee. The other side of this equation requires that farmers be equally *incentivized* to invest, and this comes primarily by compensating them fairly through cherry prices and premium/second payments that enable hard-working farmers to make a sufficient return to the land, labor and cash resources they put into their coffee plantations.

Equally important to long term sustainability of the sector is the need to restore coffee as a pillar of economic growth. Strategically, coffee has slipped to secondary status relative to other crops that are now seen as a higher priority (e.g., those in the Crop Intensification Program—CIP).

Findings & Conclusions. Recent adjustments made by NAEB to the cherry price setting formula and process, notably more accurate farmer cost of production figures, constitute a critically important step to rebuilding a farmer-oriented incentive structure. AGLC research shows that sustaining prices for high quality cherry in the range of 300 RWF will provide farmers with a fair return to their investment and will result in a sustained increase in coffee volumes and quality, developments that will benefit the entire sector.

This research also shows that Rwanda's coffee sector has great potential for long-term growth, but fulfilling that potential requires that the government of Rwanda along with all stakeholders in the coffee sector come together and restore coffee as a pillar of growth for the rural economy. Strategic planning and policy must once again take action with pragmatic investments that will elevate coffee production and enable production and productivity to live up to the enviable reputation that Rwanda coffee has achieved in global markets over the past two decades. We highlight eight interrelated trends and defining characteristics that will help to ensure the long-term sustainability of Rwanda coffee if the right policy steps are taken. They are summarized as follows:

1. Coffee is a longstanding source of export earnings and economic growth in Rwanda and as a result, farmer know-how and strong coffee sector institutions provide a viable platform for growth.

2. Coffee directly affects the lives of over 350,000 farmers and their families, making it one of the country's most important crops as an income generator.
3. Specialty coffee is in high and growing demand worldwide, making it an important target of opportunity for economic growth in Rwanda.
4. Specialty coffee has price stability in global markets (compared to ordinary coffee); stable prices are a precondition for producers and processors to make long-term investments in the sector.
5. Rwanda has strong comparative advantage in specialty coffee, an advantage not shared by any of the country's highest priority CIP crops such as maize, bean, rice, wheat, and cassava.
6. Coffee is environmentally superior to most other crops grown in Rwanda and because coffee grows well on steep hillsides it can help to protect them against devastating soil erosion and reduce the need for high-cost terrace construction and maintenance otherwise required to make those fragile slopes stable and productive.
7. Positive climate change effects for Rwanda coffee compared to coffee growing countries in Africa.
8. Dedicated coffee producing households have better food security than those with a smaller share of income from coffee.

Policy Implications. NAEB has begun to make policy changes in farmer compensation, changes that are vital and are expected to boost farmer investments in their coffee plantations. But more work needs to be done to put Rwanda on a path to sustainable coffee production and productivity from the broader strategic policy perspective. Coffee needs to be placed front and center in Rwanda's strategic planning. The government should consider directly or indirectly improving farmer access to inputs. Fertilizer and pesticide use in Rwanda is especially low and there are many programmatic options that governments have for addressing low inputs use. Placing coffee on par with other favored (CIP) crops would be a good start.

Consideration should also be given to integrating coffee into the current program for addressing soil erosion. Coffee is a potential low cost alternative to the costly construction of bench terraces, and with the right programmatic support farmers will likely embrace the plantation of coffee trees on many of these steep and otherwise unproductive slopes. Planting coffee trees on steep slopes may be a more viable and much less costly alternative approach to land conservation in areas not yet protected by terraces, particularly on slopes in the range of 25-55 percent. Together with development partners the government of Rwanda can simultaneously solve the soil loss problem and improve the livelihoods of tens of thousands of

rural families willing to invest in establishing such "conservation plantations." Instead of subsidizing terrace construction, a program can be initiated at a small fraction of the cost to provide coffee production incentives that would motivate farmers to partner in this win-win endeavor.

MINAGRI is currently embarking on its new five year strategic plan for the transformation of agriculture (PSTA IV), so now is the time for stakeholders in the coffee sector to fully engage in that process and put forward concrete goals and actions for coffee expansion and intensification that will help to ensure its sustainable future and once again become a contributor to the growth of Rwanda's rural economy.

Links to Related Documents. "The Challenge to Sustainable Growth in Rwanda's Coffee Sector." http://foodsecuritypolicy.msu.edu/uploads/resources/FSP_Research_Paper_100.pdf

5. Monitoring & Evaluation Program Summary Results

This section summarizes the results of the AGLC project as reported in the M&E indicator table shown in Annex 1 and discusses how the core project indicators stack up against the targets set at the outset of the project. Overall, the indicators show a very positive result, amply exceeding targets.

Two of the indicators are policy-related and are also related to the Food Security Policy Innovation Lab (FSP-IL) leader award strategic results. They are "number of policy instruments (briefs, presentations, reports) on target issues," and "number of new data sets informing food security policies available for public use." For these indicators, (#5 and #6 in Annex 1) the project has met or exceeded targets in every semi-annual period. For #5, the project generated eight instead of only four reports in both years 1 & 2. For indicator #6, number of new data sets, the project also met or exceeded targets in each semester.

Two key goals of the AGLC program are captured by custom indicators, "incidence of PTD/antestia in fields" and "percent of total kg producer cherry processed through fully-washed channels," which are #1 and #7 in Annex 1. The incidence of antestia bugs per tree was down more than expected in this period. For this indicator lower is better, so it is encouraging that the incidence was .52 instead of the anticipated .73. The reason for the better than expected performance is, we believe, the impact of the higher price policy implemented in 2017. Farmers were more motivated to implement best practices, including those that reduce the incidence of antestia. This result is a welcomed reversal from year 1 when the indicator increased (i.e., poorer performance) from the baseline value of .76 to .85, missing the target of .73.

The "percent fully-washed" indicator, #7 in Annex 1, was slightly higher than its target at 99.8% instead of 98.0%, which is not representative of the national situation in Rwanda. The 1,024 farms comprising the sample for the AGLC project were intentionally all supposed to be supplying coffee to a washing station and were randomly selected from lists provided by the 16 selected washing stations in the project. Thus, it is not surprising that this indicator was already 95% at the start of the project.

The remaining three project indicators are from the Feed the Future handbook and, like those described above, they assess critical outcomes of the AGLC project. They are: "hectares under improved technologies," "number of farmers who have applied improved productivity and/or PTD mitigation technologies," and "gross margin per hectare." These are indicators #2, #3 and #4 in Annex 1. One notes in year 2 that all three have exceeded their target levels by significant amounts; in fact, the year 2 actuals for these indicators are higher than the targets set for year 3. For example, gross margin per hectare was at $756 in year 2, much higher than both the $550 and $556 targeted for years 2 and 3 respectively. This should not be assumed to mean that year 3 of the project was not needed, instead it should confirm that these types of indicators are difficult to forecast. However, the improvement in year 2 compared to year 1 is dramatic, since in year 1 each of these indicators was below or only slightly above the targets.

6. Conclusions: Themes and Knowledge Gaps

Communication with and action by stakeholders from government, private sector, and cooperatives confirms that the AGLC project was instrumental in Rwanda in providing an empirical basis for decision making on issues related to farmer productivity and control of antestia and PTD. In Burundi, it is more difficult to analyze the success of the project because of restricted engagement with in-country stakeholders. Additional research and policy outreach will be needed to ensure that the project is effective in improving productivity and reducing PTD in Burundi.

One of the elements of the AGLC project that led to its success in Rwanda was the focus on policy communication. It was helpful to bring stakeholders together around key issues facing the coffee sector and to help work through and debate options for improvement. This led to better research reports and policy briefs, but also ensured that the research conducted did not languish in papers, but was directly fed back and intensively discussed with the actors in the value chain who can most effectively use it.

AGLC research demonstrates the importance of investment in Rwanda's coffee sector. The sector requires investment and prioritization on a policy level. Rwanda's government and other

stakeholders should focus on improving cherry prices, incentivizing quality, providing support structures for small-scale and vulnerable farmers, and improving access to inputs. Beyond these practical investments, there is a need for continuing applied research on the various challenges uncovered through the course of the AGLC project.

Our hope is that coffee leaders will appreciate these findings, and will work to build more permanent structures that will inform and guide the sector in the future. In the concluding subsections we summarize priority themes identified by the project, and directions to take forward, followed by gaps in our knowledge base that we believe will require additional research.

6.1. Themes from Project

Farmers often lose money on coffee, but they will invest when prices are fair. AGLC analysis of farmer cost of production shows that many farmers lose money on coffee, or barely break even, when cherry prices are low. This disincentivizes investment in coffee, and in the long run has been shown to result in lower and stagnant coffee production. It also means that thousands of farming families who have come to rely on coffee for cash income are faced with shortages in cash for food, school expenses, and other important expenses.

There is also a mismatch between farmer capacity and incentives; those farmers who are most incentivized to invest (small-scale, low income farmers) have the least capacity to invest. By comparison, larger scale farmers have a greater capacity to invest. However, when prices are low, larger scale farmers—who make up the bulk of coffee production in Rwanda—can more easily move away from investment in coffee in favor of other crops and even non-farm activities. This transition can have dire effects on the sector generally.

Data show that farmers invest in coffee when prices are high and when they receive second payments. This investment of labor, cash and land improves both volume and quality, which in turn allows coffee to fetch better prices on international markets. Because of this and because of farmers' difficulties in profiting from coffee, it is important to support prices that make coffee an attractive farming enterprise.

In light of these conclusions, we recommend that NAEB support an attractive and fair floor price for high, "A" quality cherry, with a second price or channel for lower quality cherry. NAEB has several options for managing low quality and mixed "B" cherry: 1) set a lower price (as has been done in Burundi) for low quality and mixed cherry; 2) Choose not to set a "B" price, but formally allow CWSs to pay a lower price (than the floor price) for low quality cherry; and 3) allow CWSs to completely reject low quality cherry. In all three cases, NAEB is supporting a high floor price for quality, and actively regulating pricing for low quality as well.

Input access and antestia control has improved, but gaps remain. Access to fertilizer and pesticide improved between 2015 and 2017, but volumes distributed remain low and some farmers miss out entirely. Greater volumes of fertilizer and pesticide are needed, and gaps in distribution should be filled. Increasing volumes of inputs purchased may require an increase in the input export fee, direct subsidy, or the facilitation of farmer input purchases from local suppliers. Filling gaps in distribution, as described below, should focus on those vulnerable producers currently missing out.

CEPAR's movement to distributing Fastac pesticide from Confidor is positive for control of the antestia bug. This is particularly important because the data show a strong connection between antestia and potato taste defect. Additional research is needed on antestia control mechanisms, specifically those that do not involve synthetic pesticides.

Farmers thrive when given support, but some farmers are missing out. Smallholder coffee farmers require support to be successful. When they receive support from cooperatives, NAEB, CEPAR, and local government, they do well. Cooperatives specifically are found to have a positive impact on farmers. Cooperatives provide more attractive prices to farmers for their cherry, they distribute inputs effectively, and they deliver trainings on best practices. Because of the support they receive, cooperative members have lower costs of production than other farmers. Additional support to coops is needed, with the goal of expanding access to membership. Experts suggest that capacity building for cooperative management can be helpful, as could assistance in receiving appropriately structured loans from banks.

NAEB and CEPAR are working to improve how they support farmers with inputs. However, some farmers are falling through the cracks. Specifically, women headed households are less likely to receive distributed pesticide than male headed households, and older farmers receive smaller volumes of distributed fertilizer per coffee tree than do younger farmers. Government and/or CWSs should provide targeted support for these disadvantaged farmer groups in accessing inputs or sufficient volumes of inputs, and possibly in hiring laborers to conduct difficult tasks such as pesticide application.

Female headed households specifically have lower productivity than male headed households. This may be related to labor and input costs, however additional research is needed on why their productivity is lower. Female headed households may require support from NAEB or the CWSs associated with their zones in accessing labor for stumping, pruning, and pesticide application, as well as other tasks traditionally performed by men.

Rwanda's zoning policy aims to strengthen support provided to farmers by their CWSs, and if managed well could potentially serve as a mechanism for building farmer capacity in general. However, it is unclear the extent to which this is currently happening. Zoning limits farmers in

whom they can sell to, though local enforcement of the policy is far from uniform or ensured. Unless they receive needed services from CWSs, and sustainable coffee prices, farmers may not benefit from zoning. NAEB should closely monitor whether CWSs provide services, and should consider allowing farmers greater sale options (e.g., allowing farmers to sell to multiple CWSs within the same district, allowing individual farmers—but not vehicles—to transport cherries across zone lines, etc.).

All of the above should be part of a comprehensive coffee investment strategy. Coffee is key to Rwanda's economy and environment, and should be invested in as such. Coffee should feature prominently in agricultural policies and strategies. Given the positive externalities provided by coffee—environmentally and in terms of poverty reduction—it is worth considering government subsidies for coffee.

6.2. Knowledge Gaps

1. *Cost of production across coffee value chain.* Rwanda needs a full coffee value chain analysis. Because of challenges with farm level productivity and antestia/PTD, AGLC primarily focused on the farm level. However, stakeholders note the need for analysis of the costs of production at higher levels of the value chain (e.g., CWS, dry mills and exporters).
2. *Best way to implement price tiers for quality.* To determine the best way to connect cherry price to quality, Rwanda should implement larger-scale pilot projects on multiple price tiers. Different prices for "A" and "B" cherry have been implemented by specific companies/CWSs, with mixed records of success. A larger pilot (e.g., at district level) will allow for greater information on the best way to implement such a policy approach.
3. *Causal mechanism for PTD and additional control approaches.* The Africa Great Lakes region requires additional research on PTD's causal mechanism. While researchers preceding AGLC, and those on the AGLC team (specifically Joseph Bigirimana and his partners at Rwanda Agriculture Board), have shown a connection between controlling antestia and reducing PTD, the specific causal mechanism for PTD has not been identified. We also need additional research on non-pesticide antestia control approaches, both because of the negative environmental effects of synthetic pesticide and because insects can become tolerant to pesticides over time. Finally, because this project largely focused on PTD control at the farm level, research is needed on methods to identify coffee beans with PTD at processing (CWS, dry mill, etc.) stages.
4. *Effects of zoning on farmer well-being and effectiveness of policy.* Our initial analysis of zoning presents a mixed picture of the effects of zoning on farmers. There are potential

benefits of zoning, but there are also real risks in terms of the stability of the sector, cherry price competition, and ultimately farmer well-being. Rwanda needs more farm and CWSs level quantitative and qualitative data to judge the effects and effectiveness of zoning.

5. *How best to avail fertilizer and pesticide to farmers.* Although Rwanda has seen success in expanding access to inputs, it is difficult to deliver more inputs without raising the export fee or subsidizing inputs. However, farmers are not used to paying for inputs and CEPAR provision of inputs may disincentivize private agro-dealers from marketing inputs to farmers. What is best way to deliver inputs to farmers? Is the current system optimal? How can CWSs/zones be used to help farmers? These are questions that future research should tackle.
6. *Intra-household relationships and coffee production.* In Rwanda, additional research is needed on intra-household relationships (between men and women), especially in joint headed households. Specifically, research should focus on the roles the women have in coffee production and sales, and how these relate to men's roles. Without further research, it is difficult to understand the leverage points that will empower women and lead to stronger, more resilient households overall.
7. *Best policy steps to take based on analysis of AGLC Burundi data.* Because of appropriate constraints on engagement with the government of Burundi and coffee stakeholders in Burundi, AGLC analysis of data and policy outreach focused largely on Rwanda. However, for the data gathered to have an impact on decision-making, it is important that AGLC team members and others analyze data from Burundi and identify mechanisms to feed findings back to coffee sector stakeholders.

Annex 1: AGLC - Performance Indicators with Targets

AGLC Core Indicator	Indicator definition	Unit of Measure (gender disaggregated when possible)	Method of Data Collection	Reporting Frequency	Baseline (reported Mar 2016)	Target Year 1	Actual Year 1 (reported Apr. 2017)	Target Year 2	Actual Year 2 (reported Jan. 2018)	N.A. Targets Year 3 (Oct. 2018 – n.a.)	Variable(s)
#1	Incidence of PTD/Antestia in fields	Avg. # of bugs/tree	Farmer surveys (N=2,048) & Field observ on exper. plots (N=128)	Annually	0.76	0.73	0.84	0.70	.52	.65	Farmers: ANTPERTREE
					n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Avg. # bugs/tree in *treated* study fields.
#2**	Hectares under improved technologies	# of hectares under improved practices	Farmer surveys (N=2,048)	Annually	132 ha	135 ha	127 ha	139 ha	149 ha	145 ha	Productivity: COFFEESQM2_sum BestProdPract
#3**	Number of farmers who have applied improved productivity and/or PTD mitigation technologies. *USAID wording: improved technologies or management practices.*	# of farmers in treatment areas exhibiting changed behavior	Farmer surveys (N=2,048)	Annually	530	557	574	583	666	610	Productivity: BestProdPract
#4***	Gross margin per hectare	Value in US$	Farmer surveys (N=2,048)	Annually	$530	$543	$261	$550	$756	$556	USAID: CofGrossMargNOLAB
					$374	$376	$61	$383	$571	$392	AGLC: CofGrossMarg
#5****	Number of policy instruments (briefs, presentations, reports) on target issues	Number	Research results	Semi-annually	0	0 4	0 8	2 2	3 5	2 2	
#6****	Number of new data sets informing food security policies available for public use	Number	Research results	Semi-annually	0	2 2	6 0	2 2	2 3	2 2	
#7	Percent of total kg producer cherry processed through fully-washed channels.	Kg cherry processed as FW/total kg cherry processed	-Farmer surveys	Annually	95%	97%	96%	98.0%	99.8%	99.0%	Farmers: SALE15CHERKG CherToParchKG

**Indicators to be submitted to the FTFMS system.

***AGLC will calculate this indicator two ways. The indicator reported in FtFMS will be calculated as described in the FtF Handbook. The second version will be used by the project for monitoring, which will include a value for unpaid HH labor in the input costs. The FTF gross margin (which values unpaid household labor at 0) is not being used by the project but we expect it will increase as indicated.

****Indicators related to the FSP-IL leader award strategic results.