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Feed the Future Innovation Lab for Food Security Policy

Research Paper 100 June 2018

Africa Great Lakes Region Coffee Support Program (AGLC)

THE CHALLENGE TO SUSTAINABLE GROWTH IN RWANDA'S COFFEE SECTOR

By

Daniel C. Clay
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1. Introduction & Summary

Recent in-depth analysis of current trends in Rwanda's coffee sector, together with research findings from the Africa Great Lakes Coffee Support Program (AGLC) have revealed that low and stagnating production has placed Rwanda's coffee sector in a vulnerable state (AGLC, 2016). Perennially low coffee prices (24 percent below others in the region) have resulted in low, often negative profits to farmers, discouraging them from investing in their plantations. Simply put, farmers have been left out of Rwanda's "coffee renaissance" over the past 15 years and the consequences are now more apparent than ever.

Many farmers report that losses in coffee have driven them to abandon their coffee trees and increasingly to uproot them in favor of other, more profitable crops. AGLC research shows that these trends are particularly acute among largeholder coffee farmers (those with 1000+ trees). These are farmers who are more highly commercialized, are highly responsive to cherry prices, and have other farming and off-farm options. They also own the majority (57 percent) of coffee trees in Rwanda (AGLC, 2016). Equally disconcerting is the finding that young farmers are choosing not to enter into coffee at all, often for the same reasons. They see clearly how their parents struggle to make a living in coffee and opt to produce other crops instead.

The main position of this research paper is that to restore sustainable growth to Rwanda's coffee sector, two closely connected changes will be required:

- First, there must be a commitment from all stakeholders in the value chain to ensure that producers are compensated fairly, with cherry prices commensurate with those paid for similar quality coffees elsewhere in East Africa. Producer prices in Rwanda lag behind others in the region by an average of 24 percent (ICO and NAEB figures). Due to the perishability of coffee cherry which requires farmers to deliver their coffee to the washing station the same day as harvest, as well as the exigencies of the newly implemented zoning policy (requiring sales to a designated CWS, usually the closest), competition for coffee cherry is very limited. With a few regionally localized exceptions, producers have only one designated buyer. For these reasons setting cherry prices must be executed in a fair and balanced way so that farmers, too, can make a reasonable profit from their cultivation of coffee and be incentivized to invest further in their coffee plantations.
- Second, the coffee sector must once again become a high priority for strategic thinking and support in Rwanda. Full consideration should be given to restoring coffee as a pillar of rural economic growth. Why? Because global specialty coffee markets continue to grow; Rwanda has remarkable comparative advantage in high quality specialty coffee, an advantage not shared by any other high priority crops such as maize, bean, rice, wheat, and cassava; and because coffee grows well on steep hillsides, protecting them against devastating soil erosion and eliminating the need for high-cost terrace construction and maintenance otherwise required to make those fragile slopes stable and productive.

Until these two changes are successfully addressed, the ever-ambitious national targets for coffee sector performance in production, productivity, percentage of coffee in the fully-washed channel, and total coffee sales and revenues, are likely to remain well out of reach.

The analyses summarized below provide further empirical support to these recommendations. Additional data analysis and support can be found in a recent AGLC research report entitled, *Determinants of Farmer Investment in Coffee Production: Finding a Path to Sustainable Growth in Rwanda's Coffee Sector.*[1]

2. Methodology

This research draws upon a broad mix of quantitative and qualitative data collection methodologies. The AGLC household surveys of coffee growers is the primary source of quantitative information reported; it is supplemented by a program of focused key informant interviews (KIIs) with public and private sector industry leaders, as well as focus group discussions (FGDs) with the major coffee stakeholder groups including farmers, cooperatives and coffee washing station managers.

The AGLC surveys were conducted in two stages. In 2016 (the baseline) data were collected on a sample of 1,024 coffee producer households. In 2017 a follow up survey was conducted on a 50 percent subsample (512 households). Both samples were randomly selected from listings of 16 coffee washing stations (CWS) geographically dispersed across four major coffee-growing districts representing Rwanda's four agricultural provinces (Figure 1). The selected districts are Rutsiro, Huye, Kirehe, and Gakenke. 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.

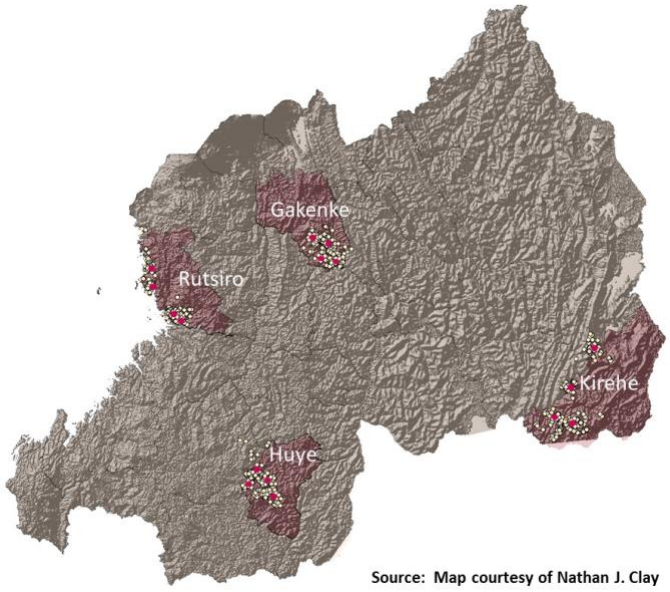


Figure 1. Map of Sampled Districts, Washing Stations and Households

[1] Full report reference: Clay, Daniel C., A.S. Bro, R. A. Church, A. Bizoza, D.L Ortega. (2016*). Determinants of Farmer Investment in Coffee Production: Finding a Path to Sustainable Growth in Rwanda's Coffee Sector*. Feed the Future Innovation Lab for Food Security. Research Paper #32. http://fsg.afre.msu.edu/fsp/glc/FSP_RP_32_rev.pdf

3. Research Findings

Farmer investments in labor, inputs & equipment. There is wide variation in how farmers invest in their coffee plantations, both in terms of the types of investments they make and the amounts they invest. The major types of investments farmers make in the production of coffee include household labor, hired labor, purchased inputs, and purchased equipment. Overall, they total 231 RWF per tree in 2015. Breaking out this figure proportionally we find that by far the largest investment made by farmers comes in the form of labor at 78.2 percent of all investments (42.0 percent as household labor and 36.2 percent as hired labor). This is followed by purchased inputs (fertilizer and pesticides) at 14.8 percent, and equipment/tools (pruning shears, sacks, etc.) at 8.1 percent of total farmer investments per coffee tree. Freely distributed inputs are not included in this computation as they are not a direct investment from the farmer.

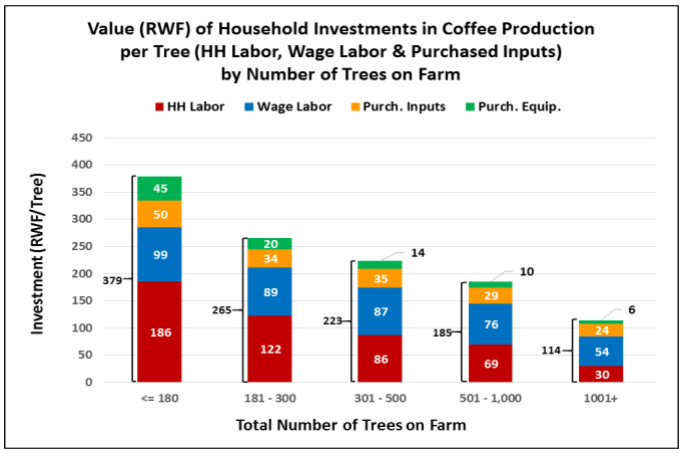


Figure 2

The number of trees in the coffee plantation makes a substantial difference in the total amounts that farmers invest per tree. As shown in Figure 2, farmers with large scale plantations invest markedly less per tree (114 RWF/tree) than those with small plantations (379 RWF/tree), more than a three-fold difference.

Productivity by plantation size. Breaking out productivity levels by plantation size (number of productive trees grouped in rounded quintiles) one finds that farmers with smaller plantations are more productive per tree than are those with larger plantations. This pattern holds true even after controlling for many of the factors/covariates known to affect productivity including: total household non-coffee income, land owned, age of head, education of head, active adults in household and farm elevation (m). The analysis of variance (ANOVA) model results reported in Figure 3 show that the highest level of productivity, estimated at 2.17 KG cherry/tree, is found among farms with fewer than 180 trees; productivity declines markedly as the size of the plantation grows and registers its lowest point, estimated at 1.08 KG/tree, among those with more than 1,000 trees.

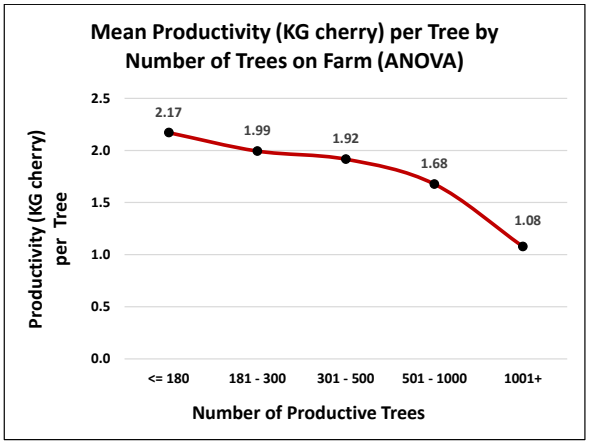


Figure 3

Do these investments and productivity rates translate into higher returns? While there is a clear drop in productivity associated with lower investments and more trees on the farm, it is equally important to examine how returns to farmers (gross margins) vary across these groups. Gross margins, or profits, are measured at the farm level as total revenues from coffee sales, less the cost of production.

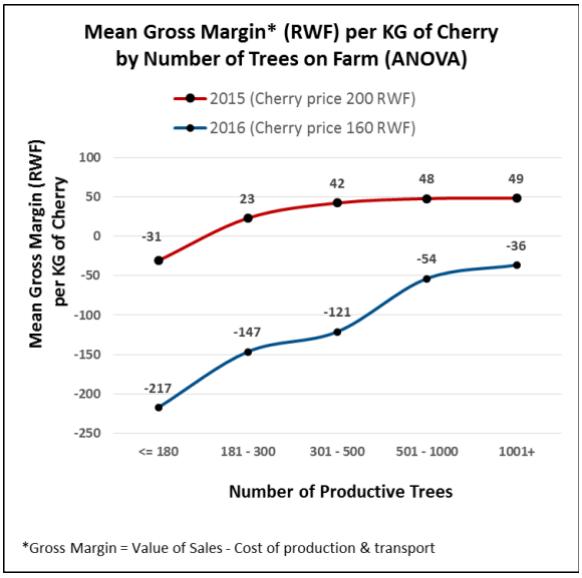


Figure 4

Figure 4 compares the average gross margins of producers (grouped by plantation size) in 2015 and 2016. The major difference in these two years was that in 2015 the mean cherry price received by farmers was 198 RWF/Kg (median 200); the next year, 2016, the price dropped radically to an average of 172 RWF/Kg (median 160). The lowered prices resulted in a significant drop in gross margins to farmers. In 2016, all five groups showed losses for the year.

Incentives vary by plantation size. What accounts for the ostensibly contradictory patterns of productivity and investment? What causes smallholders to be the most highly invested and productive farms yet the least profitable of all? At the other end of the scale, why are the largest coffee farms so poorly invested and unproductive compared to others?

The answers to these questions lie in the differences in the capacities and incentives to invest held by farmers at opposite ends of the farm size spectrum. High performance in agriculture requires that producers have *both* the capacity and the incentive to invest. Farmers must hold the resources and abilities to invest in their coffee trees and they must also be motivated to do so. One without the other will not have a positive result. How do farms differ in their capacities and incentives to invest in coffee?

Smallholder coffee producers (mean trees among smallest quintle = 106) are more productive (per tree) than largeholder farmers. They lack capacity but are highly motivated to extract as much value as they can from their small holdings simply out of *necessity*. Their main investment is their own household labor. Despite higher productivity, their high labor investment makes coffee unprofitable for most.

Largeholder coffee producers, by contrast, have much larger plantations (mean trees among largest quintile = 2,200), and 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, as they have been in recent years, they prefer to temporarily abandon their coffee plantations or even to uproot trees in favor of other crops (e.g., bananas) or livestock production. This causes their productivity to be the lowest of all groups.

While the contributions and performance of all of Rwanda's coffee farmers are vital, and all must be recognized as full partners in the transformation of Rwanda's coffee value chain, the largeholder

group is where the long-term future of coffee in Rwanda lies. They are commercially oriented, have a larger scale and more capacity. They keep a close watch on profit margins and when prices are low they do not invest. Incentivizing this largest quintile alone to invest and produce coffee at a rate even up to the modest productivity level of the lowest capacity group (2.17 KG/tree) will increase production in Rwanda by 46.2 percent. Bringing the three mid-range producer quintiles up to the same yield level would add another 10.3 percent to the overall volume of coffee processed and exported from Rwanda. A change of that magnitude would place Rwanda on a path toward sustainable growth.

How do premiums affect productivity? AGLC research shows that in addition to cherry prices the payment of premiums (sometimes called "second payments"), an additional amount that often comes at the end of the season after coffee is cupped and sold, also has an important effect on farmer productivity (AGLC, 2016). The premiums are paid mainly by the coffee buyers, sometimes as a reward for higher quality in coffee produced. In 2015 only 26.8 percent of sampled coffee farmers received premiums for their coffee, and in 2016 the proportion increased to 35.4 percent. More than two-thirds of farmers receiving premiums are those who belong to coffee cooperatives. Private CWSs make such second payments much less frequently than do the cooperatively owned CWSs. While premiums emerge as incentive for farmers to improve productivity in both 2015 and 2016, the premium effect on productivity was found to be smaller and not significant in 2016 when coffee prices were notably lower and productivity over all was low.

Future depends on how to attract a new generation of farmers to coffee. While incentivizing largeholder producers with higher returns to coffee, a second critical factor lies in the effects of low coffee profitability and other factors on attracting farmers to the coffee sector in the first place. The problem signaled by stakeholders across the value chain is the aging of the population of coffee growers due to the inability of the sector to attract a younger generation of coffee farmers. This is referred to by one major coffee processor and exporter as the "youth in coffee" problem. Moreover, inheritance of coffee trees is often delayed as parents tend to hold on to them until very late in life. Figure 5 reveals that the age distribution of coffee farmers from the AGLC survey (red) is highly skewed to the older ages compared to Rwanda's rural heads of household overall. For example, only 5.8 percent of coffee growers are aged 30 years or less, while the overall proportion of rural household heads in this age group is 24.6 percent—four times as high. At the other end of the scale, in the two oldest age groups, coffee producers are vastly over-represented. Unless a new generation of coffee farmers can be attracted to coffee through higher returns and the potential for growth, these younger farmers will continue to turn to other more profitable crops, particularly those that receive subsidies and

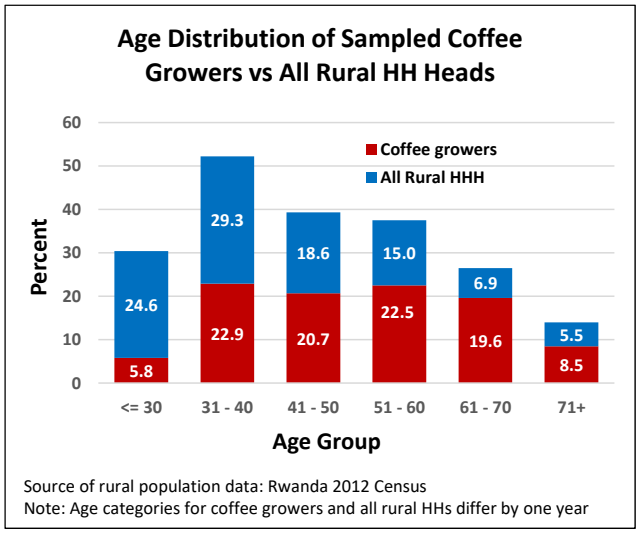


Figure 5

other public incentives; these include maize, beans, potatoes and other priority crops in Rwanda's Crop Intensification Program (CIP) (Kathiresan, 2011).

This point on how government priorities can affect the growth prospects of particular subsectors of the agricultural economy provides a fitting segue into the next section of this report, one that focuses on the need for an "all hands on deck" strategic investment approach to achieving long-term sustainability in Rwanda's coffee sector.

4. Restoring Coffee as a National Priority and Pillar of the Rural Economy

Addressing the farmer incentives problem by reworking the process of setting cherry floor prices will be a first and necessary step to putting Rwanda's coffee sector back on track, but it will not be a sufficient step. A second critical piece will involve all stakeholders recognizing the high potential of specialty coffee and getting behind the sector in broadly strategic ways. This section walks us through a set of concepts and supporting data that will help us to rethink the role of coffee in Rwanda's pursuit of a sustainable agricultural future.

4.1 The state of strategic thinking in coffee

It would be a mistake to assume just because of Rwanda's prominence in coffee and global celebration of the country's transition into specialty coffee production (its coffee renaissance), that the sector must be at the core of its economic growth strategy. It is not.

A review of key strategy documents and programs in agriculture reveals that coffee is largely a secondary concern, and almost never are coffee producer incentives identified as a challenge. For example, the coffee sector is scarcely mentioned in the forward-looking policy strategy report, *Rwanda National Agriculture Policy: A productive, green and market-led agriculture sector towards 2030*. Similarly, the *NAEB Medium Term Strategic Plan (2013-2018)* for coffee and other export commodities follows a very similar pattern that concentrates on building farmer, washing station and institutional capacity, but does not address producer incentives, the most critical factor of all. And in studying a major MINAGRI development effort, the Project for Rural Income through Exports (PRICE), one must conclude that even though the program is designed to promote "sustainable increased returns to farmers from key export-driven agricultural value chains," it is focused mainly on production and marketing through farmer cooperatives; there is little consideration for basic farmer incentives (IFAD/Rwanda, 2017).

Finally, we find that the current MINAGRI Strategic Plan (PSTA III) does reference the importance of putting markets and value chains first (coffee, dairy, horticulture, cereals, others). Yet, the proposed solution is again highly production-oriented, proposing to "increase efforts to improve productivity through improved access to inputs including better planting material, control of pests and diseases and improvement in technical skills through capacity development." In other words, the PSTA III is all about building farmer capacity, but is unmistakably quiet on the real problem—farmer incentives. In order to motivate farmers to invest in coffee, compensation for cherry needs to be adjusted to reflect their true cost of production and provide margins for profitability and growth. Such questions are not yet formally addressed as a barrier to the sector's sustainability.

However in fairness, it is important to note that among all of these strategic initiatives it is the PSTA III that explicitly acknowledges the importance of *policy* in setting fair cherry prices, stating that, "the policy environment should also be reviewed to ensure it is supportive to value chain development, including export taxes and fees, selling requirements and price setting for cherries." This acknowledgement is a very important step forward and helps to set the stage for concrete, evidence-based action as Rwanda prepares for the upcoming PSTA IV, currently in its inception phase.

4.2 What makes coffee so uniquely important for Rwanda's agricultural growth?

Bringing coffee back as a national priority has to begin with a clear and compelling understanding of its market potential, agro-ecological attributes, and contributions to food security among its producers. In this section we consider eight fundamental arguments in support of why stakeholders in the coffee sector, both public and private, must organize and take necessary collective action to restore coffee as a pillar of Rwanda's rural economy.

Reason #1. Coffee is a longstanding source of export earnings and economic growth

Coffee has been grown in Rwanda since the 1930's and has been the backbone of the country's agricultural foreign exchange earnings. As depicted in Figure 6, coffee has historically seen production volumes in the range of 30,000-40,000 MT, far above the annual production of tea, the next closest competitor as an export crop. However in recent decades coffee has declined and stagnated, and now lags behind tea, a sector that has seen steady growth over the past 40 years. Despite coffee's recent struggles, the important point to be made is that coffee has a long tradition in Rwanda and benefits from an established institutional structure that has the capacity to rapidly reverse the downward trend under the right policy framework and needed programmatic support from a growing public and private stakeholder group.

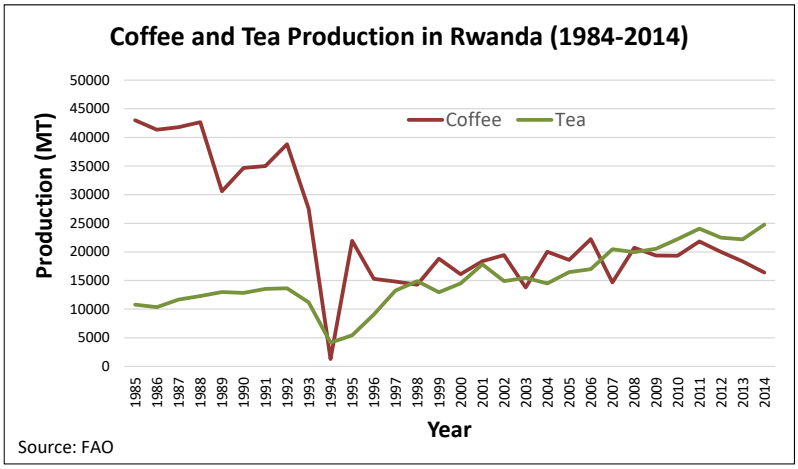


Figure 6

Reason #2. Coffee directly affects the lives of over 350,000 farmers and their families

Not only is coffee a crop with a long production history in Rwanda, but it is a pervasive crop that is grown by over 350,000 households in every province of the country, thereby directly contributing to the livelihoods of 1.5 million Rwandan residents.[2] For many of these households, coffee is their

[2] Based on an average rural household size of 4.3 members (NISR, 2012).

main source of cash income, making it vital to their health, nutrition, education and overall wellbeing. Data from the AGLC baseline survey help us to better understand just how important coffee revenues are to rural households. Figure 7 reports on how coffee producers spend cash received from coffee sales. Meeting overall household expenses, procuring health services, food, clothing and paying for school fees and related expenses are at the top of this list. Also important are expenditures on livestock and other assets that help to build longer term household resilience in the face of adversity. These statistics highlight the coffee sector's importance in promoting food security and economic development.

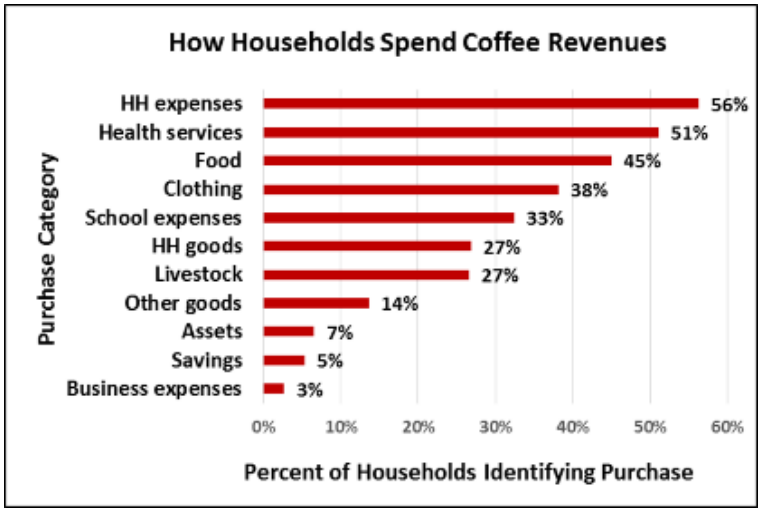


Figure 7

Reason #3. Specialty coffee is in high and growing demand worldwide

Unlike lower quality, "ordinary coffee," specialty coffee consumption globally has seen tremendous growth in recent decades and shows no sign of tapering off anytime soon. This growth has occurred in spite of relatively flat coffee consumption overall. In short, the demand for specialty coffee has been a bright spot for the coffee industry and has compensated for global declines in "ordinary" coffee. Figure 8 documents this trend and projects continued growth in specialty coffee demand into the future.

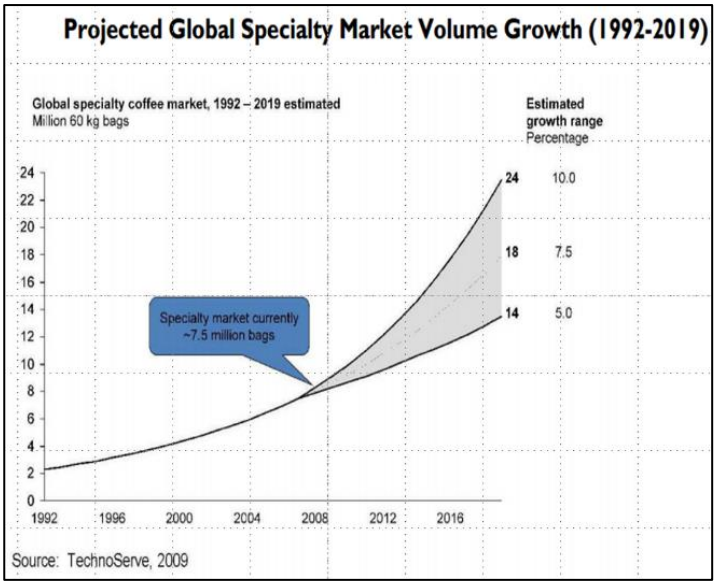


Figure 8

This is exciting news for Rwanda, a country whose reputation has become synonymous with high quality specialty coffee. It has been a hard-earned reputation and has resulted in a stream of high-end coffee buyers coming to Rwanda and establishing direct-buy relationships with many of the country's 250+ washing stations. It has also incentivized major companies such as Starbucks, San Francisco Bay Coffee, Sustainable Harvest, Sucafina, Westrock and others to place a local footprint with their own wet mills, dry mills, offices and even retail roasters and cafes. These important

investments and developments bode well for the future, but only if Rwanda can take steps to reinforce the foundation by ensuring that producers can share in the potential prosperity. Government policy and programs will also need to make increased coffee production and productivity a strategic priority.

Reason #4. Specialty coffee has price stability in global markets (compared to ordinary)

One of the traditional challenges to all stakeholders in the coffee industry is market price instability. Coffee is grown in many tropical countries around the globe and swings in coffee supply, most often caused by climate events in one or more large coffee producing country such as Brazil, can have dramatic effects on coffee prices everywhere. Year to year price fluctuations are especially hard on producers as many of them are highly vulnerable, with low incomes and few livelihood options available, especially in a bad production year.

The good news, however, is that specialty coffee prices are considerably higher than prices for ordinary coffee (i.e., the New York "C" auction price). Figure 9 shows the average price of African specialty coffee to be approximately double that of the NY C. Equally important, specialty coffee prices have become increasingly stable and "decoupled" from the more volatile NY C price. This is because specialty coffee has a much higher and more stable upside retail price, often $15/lb or more, and because it is often sold through direct and longer-term contracts established between producer groups and buyers. Ordinary coffee sold on the C market, by contrast, is typically sold at auction which is known to vary daily, as are most commodity auctions. The relative stability of the specialty coffee price compared to the NY C is also clearly observable in Figure 9. The growing stability of specialty coffee prices benefit Rwanda and other countries in the region because farmers and other stakeholders can more confidently plan and invest in coffee with relatively lower risk of a rapid price drop than do those supplying ordinary coffee.

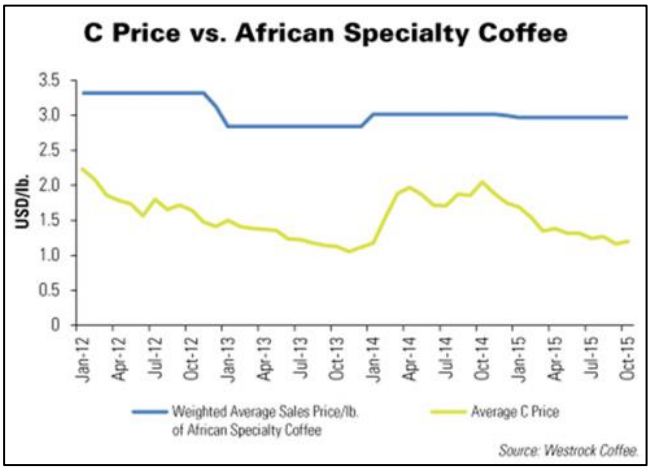


Figure 9

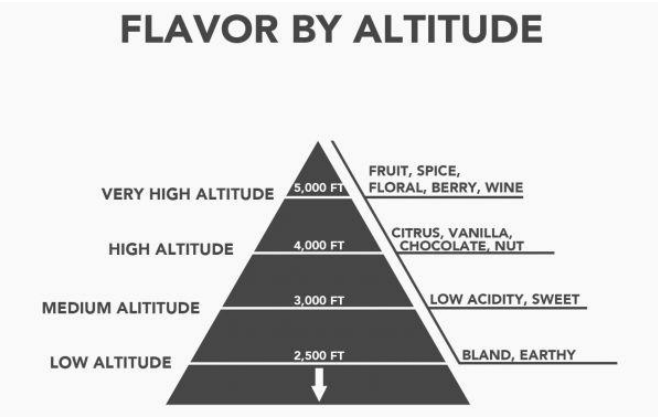
While the NY C price still figures into the formula for setting coffee cherry floor prices in Rwanda, this research recommends, due to the growing insulation of African specialty coffee prices from the C auction price, that the importance of the NY C price be minimized in the formula and the process by which floor prices are established each year.

Reason #5. Comparative advantage: Rwanda stands out in specialty coffee

Rwanda has exceptional comparative advantage in coffee production and sales based on its agroecology, labor availability and strong market appeal. The alignment of these three factors places

Rwanda coffee in an exceptionally advantageous position relative to other countries and other potential agricultural exports in Rwanda.

Looking first at Rwanda's agroecology, it is well established that high quality Arabicas grow best in high elevation tropical environments with well-defined dry and rainy seasons. While Arabicas grow at elevations as low as 2500 ft (800 m), coffee quality steadily improves in elevations up to the 6,500 ft (2,000 m) range where some of the world's rarest and most sensational coffees are grown (Figure 10). Lower oxygen and cooler temperatures at higher elevations causes coffee trees to grow more slowly, resulting in a denser bean with a rich and concentrated flavor (Scott, 2015). Rwanda's ample rainfall and steep slopes ensure the ideal moist but well drained soils required for high quality coffees (Smriti, 2016). These conditions are especially well-suited for production of the highly prized Bourbon variety coffees that predominate in Rwanda.



Source: DT Coffee Club

Figure 10

The highest quality coffees also require ample labor inputs, another factor in Rwanda's comparative advantage. Rwanda's predominantly rural and agrarian population provides an important source of low cost manual labor required for careful planting, pruning, mulching and harvesting coffee trees. Unlike many other crops, high quality specialty coffee utilizes relatively little mechanized, labor-saving equipment. Harvesting coffee cherry, in particular, requires a concentration of manual labor to ensure that cherries are carefully picked only when perfectly red and ripe.

As a final factor contributing to Rwanda's strong comparative advantage in coffee, is the country's exceptional "market appeal." Specialty coffee consumers are known for their concern for the welfare of coffee growers and for environmental stewardship (Samper and Quiñones-Ruiz, 2017); it is no surprise that coffee serves as the backbone of the entire Fair Trade movement (Linton, et al., 2005). Rwanda's coffee story sets it apart, encompassing its struggle with persistent poverty, healing from a tragic history of conflict, and the uplifting resurgence of smallholder cooperatives. Few products or places capture the imagination of consumers the way Rwanda coffee can.

Reason #6. Coffee is environmentally superior to most other crops grown in Rwanda

Rwanda is a country of steep slopes and abundant rainfall. As such, soil erosion has long been one of the country's most formidable agricultural challenges, resulting in declining crop production and productivity (Clay et al., 1998), mud slides, slumps and silting of water systems (Lewis & Nyamulinda, 1996). As much as 77 percent of the country's farmland suffers from moderate to severe erosion (Bizoza & de Graaff, 2012; RADA, 2005). Controlling soil loss on Rwanda's farmland is largely a function of the conservation investments that farmers make (terraces, hedgerows, agroforestry, tree plantation, etc.) and how they use their land—most notably the crops they grow (Lewis et al., 1998).

Perhaps the most compelling argument of all in favor of supporting greater coffee production and productivity is the established fact that coffee is one of Rwanda's most successful crops at combating soil loss (Lewis et al, 1988; Clay & Lewis, 1990). It is a perennial crop that does not

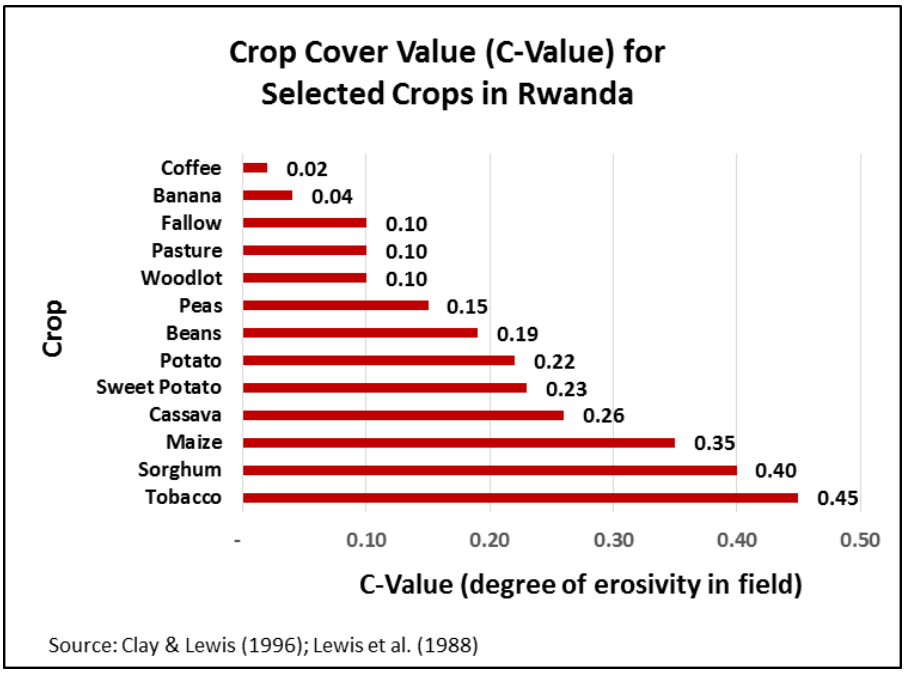


Figure 11

require tilling/exposing the soil (as annual crops do several times a year), and it has good leaf canopy and root structure, both effective attributes in controlling erosion. Equally important, coffee is a crop that is nearly universally mulched in Rwanda. Mulch protects the soil from erosion, helps to retain water, and in the long term contributes needed organic matter to the soil.

Moreover, unlike many other crops, coffee grows especially well on hillsides where soils tend to drain well, an agronomic requirement for coffee. This means that coffee does not compete for valuable valley lands which are more suitable for field crops such as maize, sorghum, vegetables and other annual crops. Further enhancing coffee's suitability for hillside production is that coffee quality is heightened when interspersed with shade trees. And along with higher quality, shade trees are an added measure in controlling soil loss as well as enhancing biodiversity (Bro, 2016).

Quantifying coffee's extraordinary ability to combat soil loss, research in Rwanda has compared actual soil loss on fields planted in the country's primary crops. Figure 11 shows that coffee has the lowest C-value (erosivity index) of any crop/land use evaluated in the study, including fallow, pasture and woodlot (Lewis, et al., 1988).

In short, thanks to these protective agronomic characteristics, there is generally little need for the costly construction and maintenance of bench terraces or other engineering approaches to erosion control on slopes where coffee is grown.

Since 1970s Rwanda has embarked on soil erosion control measures using heavy and high cost measures such as bench terraces (Figure 12), trenches coupled with hedgerows, tree plantation, and now irrigation. Past interventions using these measures are highly dependent on government subsidies because of their elevated costs, well beyond the capacity of ordinary farmers. The estimated per hectare cost of bench terrace construction is in the range of US$ 2500-3000, with annual maintenance costs conservatively estimated at 5% our about US$ 125-150 per hectare. And from 2012 to 2016 Rwanda has constructed 91,000 hectares of bench terraces, covering 37.5 percent of the land deemed suitable for such terraces (Bizoza et al., 2016). The remaining 62.5 percent of such hillsides are scheduled for terrace construction in the future.

Figure 12

Bench terrace construction in Rwanda is a high cost, engineering approach to land conservation

A conclusion from the present research is that 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. Figure 13 provides an example of this low-cost, land use approach to soil conservation in Brazil. 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. The current land use accounting program undertaken by the Ministry of Natural Resources will shed light on lands that will be most suitable for such intervention. Moreover, the conservation plantation approach could be used to attract young farmers to coffee on available public lands suitable for coffee production. To be sure, it will take a concerted effort by all stakeholders in the coffee value chain to realize such a vision. It will also require motivated farmers and our research shows that farmers are ready to take action, as soon as cherry prices, second payments and other incentives once again make coffee profitable for them.

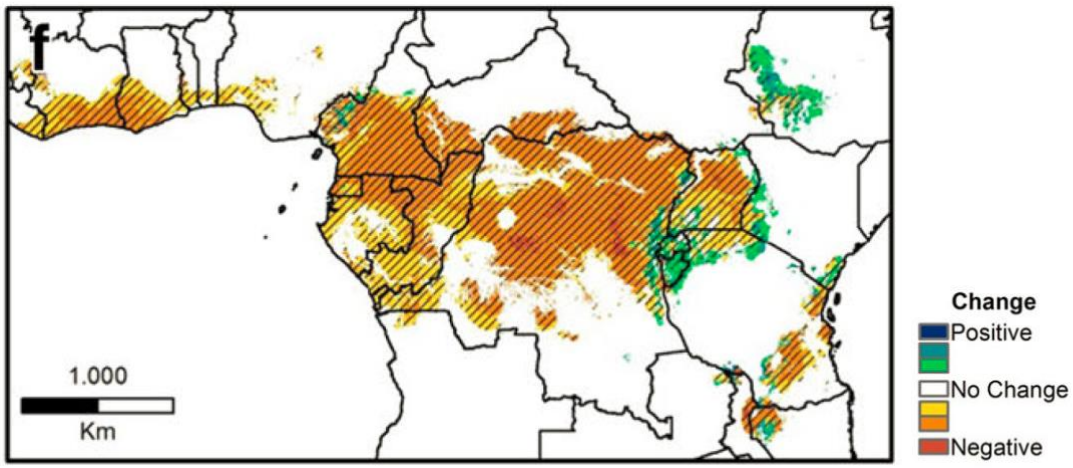
Figure 13

Coffee plantations in Brazil are a low-cost, land use approach to land conservation

Reason #7. Positive climate change effects for Rwanda coffee

Rwanda is expected to remain highly suitable for Arabica coffee production under predicted climate change scenarios. Coffee in many countries is known to be vulnerable to the impacts of climate change. Due to increased worldwide temperatures and changes in precipitation patterns, climate scientists predict a significant loss of coffee productivity, a reduction in coffee quality and greater pest infestation on coffee farms in the future (Ovalle-Rivera, 2015). Coffee growing regions in the world, especially in Latin America and many of the African countries (such as Tanzania and Uganda), will see a sharp decline in their suitability for coffee production.

In Rwanda, however, climate scientists expect to see a generally *positive* shift (Figure 14) in agro-ecological conditions for coffee production (Bunn et al., 2015). With the expected overall decline in the worldwide supply of Arabica coffees due to the negative impacts of climate change in major coffee growing regions, Rwanda finds itself in a unique and desirable position of potentially increasing coffee production as higher elevation slopes along the Congo-Nile divide become increasingly suitable for coffee production. This advantage, taken together with coffee's high potential for climate change mitigation (Bro, 2016) and its positive carbon accounting (Rahn et al., 2013), further supports the environmental case for increased investment in coffee.



Source: Bunn et al. 2015

Figure 14

Suitability changes by the 2050s in the RCP 6.0 scenario; A-D: Arabica, E-G: Robusta. Hatching indicates the current suitability distribution.

Researchers in Ethiopia have similarly concluded that shifting coffee plantations to that country's deforested highlands will be advantageous in that such high elevation areas are expected to become increasingly suitable for coffee as climate change progresses. They also maintain that coffee, particularly shade grown coffee, will provide sorely needed forest cover to these erosion-prone slopes and a viable source of livelihood to local farmers (Columbus, 2017).

The AGLC coffee producer midline survey lends further strength to the argument that Rwanda coffee will show resilience to climate change. Results suggest that events associated with climate change, such as droughts, floods and plant pests and diseases, are less of a risk for coffee than for several other top priority CIP crops, notably bean and maize (Figure 15). When asked about the

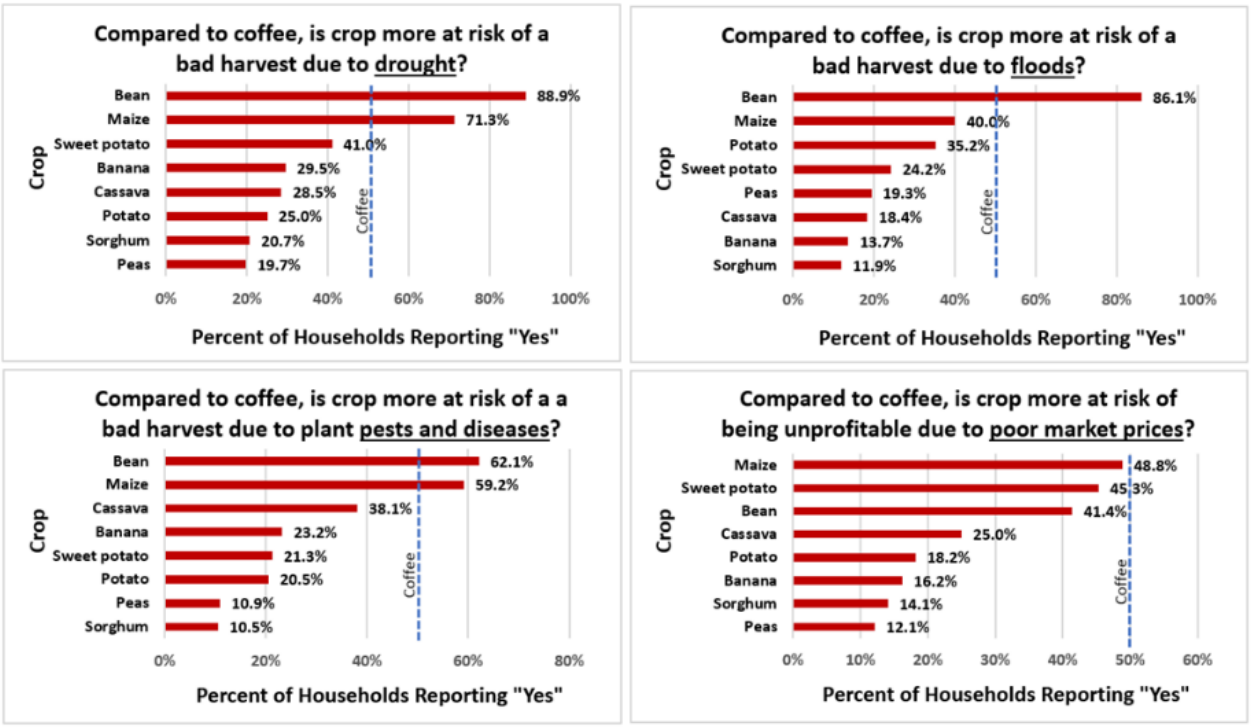


Figure 15

relative risk of a bad harvest due to drought, 88.9 percent of farmers report that bean is more risky to grow than coffee. Similarly, 59.2 percent report that maize is more risky than coffee. The same pattern holds for the relative threat of plant pests and diseases where bean and maize are a greater concern to farmers than is coffee. Risk of a bad harvest due to floods is especially acute for bean production, but less so for maize. Finally, Figure 15 also includes data (lower right quadrant) on the relative risk of crops being unprofitable due to poor market prices. On that score, coffee exceeds all other major crops. Highly variable coffee cherry prices in Rwanda are seen by farmers as a significant risk (hence disincentive) to producers. The good news for Rwanda's coffee growers is that, unlike the climate-induced risks of droughts, floods and pests, cherry floor prices can easily be regulated/stabilized through changes in government policy.

Reason #8. Dedicated coffee producing households have better food security

Decades of research has shown that cash crops have a highly positive effect on food security (Achterbosch et al., 2014) by providing households with higher incomes which are used to purchase food and to invest in improved farm management, agricultural intensification and higher food crop yields. More to this point, the 2008 World Development Report (World Bank, 2008) writes that "more than half of poor rural households are… net food buyers" as opposed to being net food sellers or being self-sufficient.

It was shown earlier (reason #2) that coffee provides producer households in Rwanda with an important source of cash income and that food purchases are among the top priority expenditures

made with coffee revenues. But does this food purchasing power also translate into improved household food security?

To explore this question, sampled farmers were asked to report whether their housholds experienced long-term food shortfall (i.e., > 1 month without enough food to eat) at any time during the previous year. A total of 24.4 percent of households in the study reported that they had, indeed, experienced the hardships of extended food shortage. Many reported taking mitigating actions such as borrowing from friends or finding additional work off farm. To further examine whether coffee income helped households to avoid food shortages an indicator of share of total income coming from coffee was constructed. This indicator varied from 0 to 100 percent with a mean of 44.5.

Figure 16 models food shortage in a logistic regression against households" share of income from coffee, controlling for a set of covariates known to affect household food security. The results are consistent with the research cited above. They show that households with a larger share of income from coffee are almost three times *less* likely to have experienced extended food shortfall (inverse odds ratio of 2.93) compared to those with a lower share of income from coffee. Covariate effects controlled in the model include total land owned, non-coffee income, various household demographics, years growing coffee, cooperative membership and elevation of the farm.

Logistic Regression Model: Household Experienced Long-term Food Shortfall (> 1 month) by Coffee Income Share and Selected Covariates

Regressors	B	S.E.	Wald	df	Sig.	Exp(B)	Inverse Odds Ratio‡
Coffee share (%) of total HH Income	-1.077	0.421	6.524	1	0.011**	0.341	2.93
Member of coop	-0.289	0.200	2.085	1	0.149	0.749	1.34
Total land owned (Ha)	-0.297	0.110	7.325	1	0.007***	0.743	1.35
Income 2015 (not including coffee)	0.000	0.000	3.884	1	0.049**	1.000	1.00
Gender of HH head	0.866	0.265	10.680	1	0.001***	2.377	-
Age of HH head	0.000	0.010	0.000	1	0.994	1.000	-
Active adults in HH	0.081	0.066	1.511	1	0.219	1.084	-
Education of HH head	-0.209	0.096	4.776	1	0.029**	0.811	1.23
Years growing coffee	0.011	0.009	1.477	1	0.224	1.012	-
Elevation of HH (m)	0.000	0.001	0.268	1	0.605	1.000	1.00
Constant	0.608	1.182	0.265	1	0.607	1.837	-

*, **, *** indicates significance at the 10%, 5% and 1% levels, respectively.
‡ For ease of interpretation inverse odds ratio computed for covariates with negative log odds (B).
N=508 housholds

Figure 16

5. Conclusions and Recommendations

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 provision 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 *motivated* 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.

Without sufficient compensation, capacity building efforts will have limited impact. The persistently low cherry paid to Rwanda's coffee farmers, which are 25-30 percent lower than what their counterparts are paid in neighboring countries, have led to decline and stagnation, with total production volumes less than half of what they were 25 years ago. Recent adjustments made by NAEB to the cherry price formula and process, notably more accurate farmer cost of production

figures, constitute a critically important step to rebuilding a farmer-oriented incentive structure. This 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. In this research report we have highlighted 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
2. Coffee directly affects the lives of over 350,000 farmers and their families
3. Specialty coffee is in high and growing demand worldwide
4. Specialty coffee has price stability in global markets (compared to ordinary)
5. Rwanda has strong comparative advantage in specialty coffee
6. Coffee is environmentally superior to most other crops grown in Rwanda
7. Positive climate change effects for Rwanda coffee
8. Dedicated coffee producing households have better food security

More work needs to be done to put Rwanda on a path to sustainable coffee production and productivity. However, based on AGLC's intensive program of household and experimental research, coupled with dozens of personal interviews with leaders of all stakeholder groups and focus group discussions with producers and processors across the country, we recommend that several initial steps be taken without delay.

First, we urge NAEB and all stakeholder groups to continue to revise the formula and process used to establish annual cherry floor prices. The recent inclusion of more current farmer cost of production figures (mean of 177 RWF/Kg) is an important step in the right direction. Easing the floor price up to 300 RWF and stabilizing it at that level will send a clear message to farmers that they can confidently return to coffee and will receive a reasonable return to their investments. Processors and exporters will benefit greatly from the higher volumes of coffee that will become available. Higher volumes will reduce per unit costs for washing, dry milling and exporting coffee. Experiences reported by companies already adopting this recommendation and paying prices in the 300 RWF/Kg range are all positive. Their producers have been highly incentivized and are now producing larger volumes and high quality coffee. These experiences can be achieved across the board with the right investments.

Second, there is a complicating issue in how to handle the lower quality cherry that is sorted out from quality cherry by flotation or by hand sorting. There is no clear policy on what to do with lower quality coffee and this is a problem that urgently needs to be addressed. Of course it is not reasonable to simply lower cherry floor prices to a corresponding level (lowest common

denominator). This effectively became the default policy in recent years and has resulted in a disincentive for all producers, leading to stagnant production, low productivity, an exodus of younger farmers, and little incentive to produce higher quality cherry.

It is time for Rwanda to consider a formal policy on how to handle poor quality cherry. One option is to simply turn it away at the washing station, sending it back with the farmer to process through the semi-washed channels and "ordinary coffee" market. This approach has been recommended by the 2016 study on washing station best practices in East Africa (published by TWIN via a Trademark East Africa grant)[3] and it has been implemented by several CWSs with considerable success. Another option is two-tiered pricing based on quality, where high quality cherry receives one price and the "floaters" and other lower quality coffee receives a discounted price (e.g., 40% discount off the floor price). Some washing stations take that approach, but one has to ask whether processing would be more beneficial to farmers if it is semi-washed on farm and sold to those who trade in the semi-washed market. Also, one has to ask, what is the rationale for farmers to *stop* bringing defective and under-ripe cherry to the washing station if they know they will be paid for it? From the washing station's perspective, wouldn't the resources spent on buying bad cherry, however small, be better spent on systems and efforts to improve quality, such as a higher price for good cherry? These are questions for further debate.

Third, coffee needs to be placed front and center in Rwanda's strategic planning. The government should consider directly or indirectly increasing compensation for farmers and improving access to inputs. Fertilizer and pesticide use in Rwanda is dismally 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 would likely embrace the plantation of coffee trees on many of these steep and otherwise unproductive slopes. MINAGRI is currently developing 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.

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