Designing for Transparency of Coffee Production Costs

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Abstract
Smallholder coffee farmers in Latin America depend on global supply chains for their livelihood, and many join certified cooperatives to increase access to fair prices. In order to find out what a fair price is, we designed CalcuCafé, a tool for coffee farmers to calculate their cost of production. An evaluation in Peru uncovered tensions between coffee farmers and cooperative technicians, highlighting barriers to information transparency at the production level. Our ongoing work to address these barriers strives to support the long-term viability of smallholder coffee producers, a sizable yet marginalized group at the intersection of HCI for sustainable agriculture and HCI for development.

Author Keywords
Coffee; farming; Latin America; agriculture; sustainability; HCID.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction and Background
The livelihood of a large number of smallholder coffee farmers in Latin America depends on global coffee value chains. Certification initiatives such as Fair Trade USA (FTUSA) aim to profitably integrate coffee growers into

Cost Model Inputs

1. Number of hectares per young, mature, and old coffee plants; since productivity depends on plants' growth level.

2. Farming method: organic, chemical, or in-transition; each imposing cost structures and productivity levels.

3. Daily wage paid to laborers.

4. Average productivity in kilograms per hectare.

Cost Model Outputs

1. Variable costs, related to the operations of coffee production, e.g., hired labor, transportation, and production inputs such as fertilizers and pesticides

2. Fixed costs, paid whether or not coffee is produced, e.g., cooperative membership fees, property taxes, and machinery.

3. Additional costs, e.g., tool depreciation and land and labor opportunity costs.

global specialty coffee chains by helping to establish direct, long-term trading partnerships between coffee roasters and smallholder farmers toward improving social and environmental outcomes [1]. Coffee cooperatives, owned and managed by producers, support individual farmers toward the benefits of such certifications by providing farmers with a collective market power to bargain directly with international buyers [8].

Consumers are willing to pay higher prices for certified specialty coffee, but smallholder farmers also need to be paid fair prices to cover costlier sustainable production practices. For example, high quality shade-grown coffee involves slower ripening cycles, smaller quantities, and higher prevalence of fungal diseases [5].

Initial efforts toward understanding the costs of sustainable coffee production include developing cost models based on comprehensive farm-level data collected from hundreds of coffee farmers in Latin America [7]. The benefits of making these cost models transparent to stakeholders in the specialty coffee supply chain – FTUSA, cooperatives, and coffee buyers – are clear, given a shared interest to define truly fair prices to sustain producers in the long run.

In the spirit of Fair Trade's principle of *transparency* (www.fairtradefederation.org/fair-trade-federation-principles/), we seek to provide coffee farmers with access to these production costs. This could benefit farmers through better monitoring their costs and making more informed business and farming decisions.

Our research and design efforts lie at the intersection of HCI for sustainability and HCI for development. Calls to expand HCI for sustainability and food systems beyond consumers [2] have been responded to by research in communities of food producers and agriculture [e.g., 3]. HCI research on agriculture in the context of developing communities has focused on systems that provide farmers with access to agricultural information [4], seen as necessary for farmers to increase their productivity and continue growing food in the long term; such access is the primary contribution of our research.

CalcuCafé Design

We worked closely with the economics researchers who developed the underlying cost of production model [reported in 7] to simplify and convert an extensive spreadsheet-based model to an interactive producer-facing tool. Based on their economics expertise and first-hand familiarity with producers, they identified the most important input and outputs to be included in the interface (see sidebar), leaving the other variables to be calculated based on previously collected data.

We also held extensive conversations with stakeholders in the specialty coffee industry: cooperative members – managers, technicians, and farmers (teleconferencing to Peru and a field visit to Mexico), and FTUSA representatives. In early meetings we attempted to understand coffee production and business practices, components of coffee production costs, organizational structures, and end-users needs and goals. Later, we shared sketches of design concepts and solicited feedback.

Intended Users and Scenario

Farmers visit the cooperative a few times a year to deliver their harvest and receive payment, participate in cooperative meetings, and attend workshops and training sessions to learn about new agricultural practices. They consult with cooperative technicians to resolve

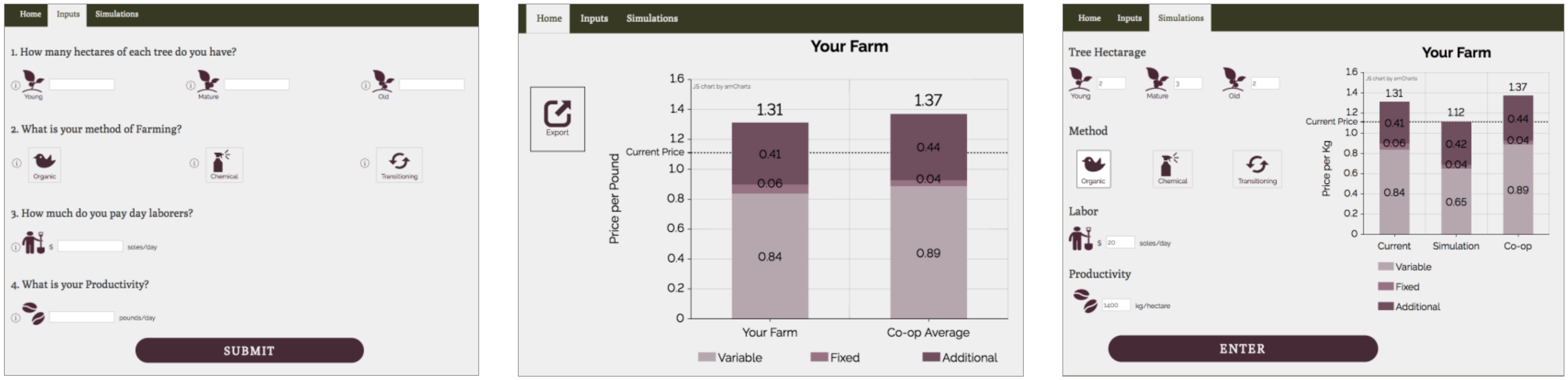

Figure 1. Three primary screens of CalcuCafé: A farmer inputs their cost data (left), retrieves a cost breakdown compared to the cooperative average (middle), and performs simulations to assess cost changes (right). The interface is implemented using HTML/CSS and JavaScript and is entirely in Spanish; here is the English translation.

specific issues in their farms, such as coffee rust, a fungal disease that affects coffee plants in shade-heavy regions. We envisioned integrating CalcuCafé in the context of these consultations.

We designed the first version of CalcuCafé as a desktop web application, because computers are often available in cooperative offices and not all farmers have smartphones. Some producers never used a computer, supporting our intended technician-producer consultation scenario. In addition to computer support, technicians could help farmers interpret the cost model toward making decisions on their farming and business practices to improve profitability. For instance, a farmer might decide to uproot older, less productive coffee plants and invest in a nursery for new coffee plants. This involves large short-term expenses, but increases long-term productivity and income.

User Interface

The interface allows smallholder coffee farmers to input key variables related to their production and receive reports of their cost structures. After logging in, the input screen prompts the farmer with questions about four input variables (Fig. 1, left): hectares per plant age category, farming method, day labor wage, and average productivity per hectare. After entering these details, the output screen presents the farmer's costs of production in the form of a stacked bar chart (Fig. 1, middle). The bar is divided into variable, fixed, and additional costs per kilogram in the local currency. A second bar on the same graph shows a comparison of the farmer's costs to the average of all farmers in the cooperative.

A "current price" line across the bar chart helps understand at what level the farmer's current production is economically viable; producers often meet their variable and fixed costs but fail to meet additional costs that are important for long-term viability [7]. Popups appear upon hovering over each element in the cost model in both the input and output screens, explaining their meanings in plain language and local terminology. Reports can be printed out for the farmer to take when leaving the cooperative offices.

To estimate potential cost changes in response to changes in production practices, we included a simulations screen (Fig. 1, right). The farmer can manipulate the four input values and see real-time changes in the cost outputs. For example, they could switch their farming method from chemical to organic or adjust the day labor rate. The cost bar chart changes accordingly, presenting side-by-side current (actual) costs, projected (simulated) costs, and cooperative averages to allow comparisons of various scenarios.

Evaluation in Peru

In summer 2017 we visited two coffee cooperatives in Jaén, Peru. Both are Fair Trade-certified, chosen based on their advanced infrastructure, financial stability, member support, and technical savvy. Both have advanced facilities with warehouses, quality control labs, and administration offices.

Cooperative profiles

Coop1:
Founded 1999
2500 members

Coop2:
Founded 2008
1700 members

Onsite, we recruited 11 technicians and 7 farmers who came in with their harvest (all but one participant were male, ages 30-50). Most farmers had secondary education or non-university post-secondary education; all technicians had university degrees in agriculture or engineering. We first familiarized the technicians with CalcuCafé in technician-only sessions, then carried out a total of seven sessions for a producer and technician interacting together with the interface.

Each session began with informed consent and a set of background questions, and current methods for tracking expenses and production costs. We then asked participants to interact with CalcuCafé to complete a series of tasks while "thinking aloud": setting up an account and logging in, inputting production variables, interpreting the cost bar chart, and simulating changes in their cost structures by removing a plot of old coffee plants and increasing the plot size of young plants. We then asked for feedback on the design and on integrating it into their current farming and business practices.

We also held two group sessions for 10 additional participants: technicians, administrative staff, and producers (2 female: 1 admin, 1 technician). We projected CalcuCafé on a large screen, walked the group through its functions and features, and facilitated a discussion about the tool's opportunities and limitations.

A Spanish-speaking researcher facilitated the sessions, while another researcher observed and took notes. Sessions lasted 40-60 minutes and were audio-recorded with permission from all participants.

We supplemented these sessions with tours of the cooperatives, informal conversations with coffee producers, technicians, and cooperative employees, and visits to coffee farms. During these tours and conversations, we took extensive notes and photos with permission.

Data consisted of translated transcripts from the evaluation sessions, fieldnotes and photos. We analyzed the data by iteratively reading transcripts and fieldnotes and extracting and discussing insights from the data. We anonymized the data, referring to cooperatives by coop#, to farmers by F#, and to technicians by T#.

Design Feedback

The evaluation sessions focused on the interface design in order to improve it in future iterations. Overall, we found that the cost model generally matched participants' views on the most important components of coffee production costs. The popups helped technicians

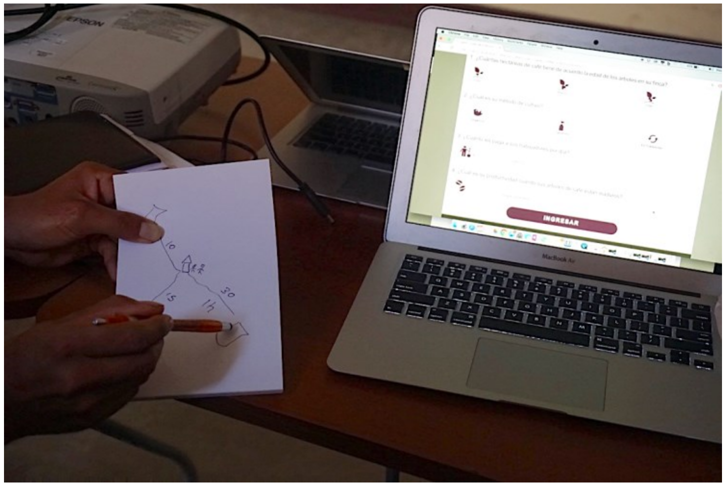

Figure 2. A technician explaining the complexity of farmer transportation costs in distributed farm plots during an evaluation session.

and farmers understand the input and output variables, while the simulation sparked conversations about applying changes in the field.

The technicians expressed an interest in including more input variables. T4 indicated that transportation sometimes greatly contributes to a farmer's costs, especially if the farm is distributed across distant plots not accessible by road, requiring animals (e.g., mules) to carry supplies in and harvests out (Fig. 2). T2 expected to see labor and supply costs for weeding and fertilization, two major cultivation activities. These details, technicians asserted, would provide a more accurate picture of the costs associated with coffee production. While CalcuCafé's underlying logic takes these factors in computing the cost structure based on defaults, in hiding them for simplicity we traded off the model's reliability. In the spirit of *transparency*, these variables should be made explicit and exposed.

Barriers to Transparency

Our intended technician-farmer scenario implicitly assumed a power dynamic between the two. This dynamic brought up tensions, which highlighted barriers to realizing transparency at the production level. One source of tension was technicians' and farmers' respective levels of computer skills. Some technicians doubted that farmers would be capable of using CalcuCafé on their own: *"They wouldn't know how to log onto any webpage or anything, because of their level of education"* (T3). Indeed, farmers initially struggled with basic computer operations, and some asked the technician to operate the interface on their behalf. This discomfort was in sharp contrast to our observation of farmers' high proficiency in using mobile devices. While not all farmers we met had smartphones, a sizeable number of them did.

Second, we observed differing levels of engagement with CalcuCafé. Both technicians and farmers appreciated how it could help farmers understand cost structures and improve profitability. However, while technicians were excited and voiced ideas for future versions of CalcuCafé and how it could be incorporated into cooperative operations, farmers did not express such enthusiasm. This marked a wider divide between technicians' and farmers' perspectives: whereas producers focus on their own farm and immediate costs and income, technicians see the cooperative's organizational complexity, with long term, wide-ranging objectives to collectively benefit farmers beyond one year's harvest. For example, T10 told us about the cooperative's 5-year facility expansion plans. This does not mean that the goals of farmers and the cooperative are at odds, but that farmers don't necessarily see their individual roles in the long-term, broader cooperative goals.

These observations prompted a critical reflection of our own design decisions, inadvertently contributing to the cooperative-farmer information asymmetry. When farmers to the cooperative offices, work on cooperative computers to enter their cost data, and merely receive a printout of their cost results to take home, this perpetuates a knowledge gap where farmers focus on their individual costs and farming practices, but do not own their data and are generally unaware of how the cooperative uses these data. We fell into the trap of interpreting *transparency* as *traceability*, which encourages an upward direction of information flow from producers to consumers, but not vice versa [6].

Current Efforts and Next Steps

Our first effort to address these barriers is to expand farmers' perspective toward the collective view, showing not only how their individual data compare to, but also contribute to the cooperative's aggregate data and how the data are used up the supply chain. Further, cooperative stakeholders envisioned rolling out this tool in conjunction with a training program to familiarize technicians and producers with the tool and the underlying cost model. In addition to promoting independent use, these sessions could be combined with member meetings to discuss cooperative goals around production costs and what individual farmers could do to help achieve them. We are in the process of developing these training sessions. We are also developing a responsive design that incorporates feedback we received, and will be visiting the same cooperatives to evaluate the mobile version together with the training program.

Conclusion

The coffee producers we met in Peru know that consumers value the high-quality coffee they produce, and take pride in their agroforestry practices that maintain biodiversity and environmental sustainability. This stands in striking contrast to their subsistence-living conditions where few see profits from coffee. Going forward, it is imperative to find whether a cost of coffee production calculation tool can fulfill its promise to contribute to the economic sustainability of coffee farming via accurate cost data for cooperatives to negotiate fair prices. Our long-term plans to deploy CalcuCafé will reveal its viability within the constraints of everyday business and farming practices and goals set by farmers, technicians, and cooperative stakeholders.

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