Title:

What is the Difference in Profit per Acre between Organic and Conventional Coffee?

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Abstract:

The research addresses the economic problem of deforestation. A contributing factor to deforestation is coffee production. Coffee is an indigenous plant that is naturally occurring in the native tropical forests. However, conventional coffee is grown on cleared forest soil. In the native forest there is the potential for additional fruits (bananas, mangoes, avocados) and wood products while in the conventional coffee production system the only product is coffee. Conventional coffee production often causes deforestation and soil erosion while the organic coffee production system does not. In addition, the price risk associated with the coffee monoculture is high and has proven disastrous to the sustainability of coffee production in past years. Thus, determining the comparative cost and return between the two methods can provide important information for coffee producers. The purpose of the research is to determine the per acre profitability between conventional and organic coffee. This will be determined by researching the distribution of quantity on representative plots. This will help identify any size or scale economies. Determining the difference in profit per acre between organic and conventional coffee production included identifying and working with production stakeholders, engaging in fieldwork, site and case study selection, and determining measurable, non-market benefits and costs that pertain to environmental and community factors. This included, but is not limited to fertilization, water, pesticide use, and timber harvest.

Problem Statement

Coffee systems around the world have allowed consumers the ability to enjoy their favorite morning brew. However, what are the environmental and socioeconomic ramifications of conventional coffee production? Agriculturists, environmentalists, and economists have asked similar questions. Past research has identified coffee systems in South America as being faced with an issue of ecological and social degradation (Lyngbaek, Muschler, and Sinclair, 2001). Furthermore, the researchers explain that traditional coffee systems are often grown with high chemical inputs that produce significant yields and thus reduce coffee prices.

Coffee production within natural habitat has also provided promising yields. Moreover, organic coffee is grown within the forest system without disturbing the environment. The most customary production method is conventional coffee production that is typically grown on the replacement of natural forest; coffee trees are planted in rows and columns with no other vegetation. Because conventional coffee often causes deforestation and organic coffee does not, determining the comparative cost and return between the two methods may eliminate deforestation. Furthermore, organic coffee production often incorporates soil management that helps prevent erosion. For example, Costa Rican organic coffee producer Gabriel Zuniga explains their farm has 70 drainage holes (known as swails), measured at 65 cm deep x 1 meter 30 centimeters width. The drainage holes hold water in the wet season that ultimately store water for the dry season. Furthermore, the drainage mechanisms prevent nutrient rich soil to rush to the river during the rainy season and ultimately stops erosion and conserve water.

The project specifically addresses an economic problem between organic and conventional coffee. The problem, what is the difference in profit per acre between organic and conventional coffee? Furthermore, determining the comparative cost and return for these two methods can be achieved by determining the distribution of size on representative samples. The results may help determine if organic coffee has as much profit or more as conventional coffee. If this is true, conventional coffee may become limited and the majority of coffee will be planted and harvested in the forest, which will eliminate deforestation. Because deforestation has ill effects on the environment, eliminating this practice can help restore the environment, which in return, is beneficial to society. Furthermore, deforestation has negative economic effects. If organic coffee's benefits and returns are as significant as conventional coffee, then the reduction of conventional coffee production could be beneficial to the environment and Costa Rica's economy. It is important to recognize that deforestation is only one of many problems as a result of coffee production, especially conventional production. Additional problematic factors include the lack of local food production due to the production of an export commodity, an increased risk of financial distress due to a lack of diversification of crops, soil erosion, loss in biodiversity, and loss of fuel wood supplies.

Objectives

The overall objective of this study is to identify the benefits and costs of organic and conventional coffee production in Costa Rica. In order to understand the relative benefits and costs between organic and conventional coffee production, this study sought to accomplish four specific objectives. The first objective was to determine the costs and returns of both organic and conventional coffee production. The second objective was to identify the non-market benefits and costs of all coffee production in Costa Rica, including community and environmental impacts of both organic and conventional coffee production methods. The third objective was to determine and calculate any agricultural outputs produced from the land where the coffee is grown. The final objective was to identify, measure, and define the economies of scale, which is a decrease in the average cost, associated with an increase in the quantity of the output.

Literature Review

Lyngbaek, Muschler, and Sinclair (2001) compared organic vs. conventional coffee farms in Costa Rica in terms of productivity, labor use, production costs, net income, farmer-perceived constraints, farm-defined goals, and research needs for the future. The results stated yields were lower for organic production than the conventional group; however, excluding organic certification costs, mean variable costs and net income was similar for both groups. The article is comparable to my project because it tries to identify the community and environmental impacts of both organic and conventional coffee production methods. Additionally, I sought to determine whether organic coffee's benefits and returns are as significant as conventional coffee.

Vandermeer, Perfecto, and Philpott (2010) prove there is a collection of species known to cause damage in coffee production, specifically *Azteca* ants. Therefore, pest control in organic coffee is detrimental to avoid crop damages. The researchers cited that a host of pest problems can invade the organic coffee system unless a well rounded scientific approach is taken. They explained organic coffee methods are often seen as a natural process, that pests or variables cannot disrupt the harmony. In reality, Vandermeer, Perfecto, and Philpott (2010) found that *Azteca* ants and three additional species create pest problems. This is important since previous studies that compare both organic and conventional coffee methods simultaneously, have not considered ecosystem agroecological conditions.

Previous Research Practices

Lyngbaek, Muschler, and Sinclair (2001) compared ten farm pairs, each consisting of one organic and one conventional farm with less than 7 hectares of coffee that were selected in five regions of Costa Rica with varying agroecological conditions. Due to their proximity, each farm shared a similar biophysical and socioeconomic environment. Organic farms had a history of 3-13 years under organic management, while both organic and conventional coffee farms had the majority of their coffee plants in production. Data was collected for a three-year period (1995-1998) by interviewing farmers and review of farm records. They found organic coffee production yields were 22% lower than conventional yields. Perfecto, et al. (2005) conducted similar studies in northern Latin America and Mexico. Their goal was to guide producers to optimal yields and increased production through new scientific information. More specifically, they researched and focused on determining the yields solely from shade density. They concluded that yields maximized between 35 – 65% shade cover. This study was similar to my project since organic coffee is grown within the forest, but different because this literature compared the differences in shade, between dense and very dense.

Ecological and Socioeconomic Aspects

Perfecto et al. (2005) explore the ecological and economic importance of coffee in northern Latin America. The article seeks to establish an alternative market to enhance the relatively low coffee prices, which is a producer-defined constraint that reappears in many of the literature articles. The coffee market has been in a state of economic crisis for most of the twentieth century and well over the last decade. Jeffrey (2003) explains the coffee crisis is because there is an over abundance of coffee production and not enough consumers. For example, in 2000, the average consumer drank 17 gallons of coffee and 53 gallons of soft drinks per year. Due to the economic constraints, Costa Rica has paid close attention to quality in order to be competitive in the market place. For example, farmers who use shade trees find an environmental niche and appeal to organic consumers.

The Food and Agriculture Organization (FAO) (2009), explain fair-trade coffee is produced from shade-grown and hand-picked Arabica beans. The beans are considered better and higher quality than conventional coffee beans. This trade accounts for more than "20 percent of the market for specialty coffees, which was worth $12 billion in 2006 and the fastest growing segment of the United States coffee market." This is similar to my research because if organic coffee must have a niche in the market, otherwise I would not have been willing to determine the benefits and costs of this production method.

Comparatively, Sundig (2003) cites various product quality regulations can affect consumer welfare. Labeling the product as organic or fair trade, for example, may increase the consumer's willingness to buy and pay higher costs for the product. The research related to my project because I searched past agricultural products that have been labeled by the government as organic, which will allowed me to determine if consumers' willingness to pay increased. If consumers are more likely to purchase organic products, including coffee, then lower yields may be off set with potentially increased market prices. Furthermore, the review explains public goods are affected by regulations directed at production methods; which is similar to my project – conventional vs. organic coffee production. Is organic coffee a better production method?

Factors that Influence Net Income and Yield

Lyngbaek, Muschler, and Sinclair (2001) calculated productivity from farmers' harvest records. In addition, the project determined farm net income (NI) from coffee that was calculated as gross income minus variable costs including hired and family labor, which were both set as $8.25 per day, excluding fixed costs. The conventional group spent more on harvesting, while the organic group spent more on labor for management, including fertilization, and planting and pruning of trees. Because Nitrogen is a limiting nutrient for organic coffee, additional nutrients such as sunn hemp organic fertilization, which is a combination of nutrient rich biomass, has been added to the external growth and nutritional status (dos Santos Freire Ricci, et al. 2005).

Additional foreseen factors that influence net income and yield include pruning of trees. Conventional coffee production has an accelerated rhythm because trees are often pruned to provide more sunlight. Also, enhancements such as fertilizer are placed into the soil to boost the growth and productivity of the coffee. Organic coffee and/or shade grown coffee allows a species rich community of trees to provide a cooler environment – avoiding light to beam directly on the plants – and in return providing a higher end product that is sold above current market value. In shade, plants are relaxed and do not get tired; therefore, they are pruned every 9-11 years. Shade grown areas and species rich trees are more uncommon in conventional coffee production farms, leaving coffee plants to get pruned every 6 years. However, too much shade creates less production; therefore, all trees in organic production are moderately pruned every year.

Concerning species rich habitats, a recent study suggests that shade-grown coffee farms support native bees that help maintain the health of biodiverse tropical regions. Specifically, "A concern in tropical agriculture areas is that increasingly fragmented landscapes isolate native plant populations, eventually leading to lower genetic diversity," said Dick. "But this study shows that specialized native bees help enhance the fecundity and the genetic diversity of remnant native trees, which could serve as reservoirs for future forest regeneration” (Jha and Dick, 2010).

Conceptual Framework and Hypotheses

I hypothesized the annualized output from long term production is greater in conventional coffee than organic coffee. The conceptual framework indicating why I expected to find increased production in conventional coffee versus organic coffee production relied on the realism that coffee is an indigenous plant that is naturally grown on native tropical biodiversity in forests; however, the forest has been cleared to create a higher yield for conventional coffee production. Therefore, since coffee cultivation has lead to displacement of native forest, conventional coffee production must be more productive. Assuming the price is the same for organic and conventional coffee, increased yields lead to an increase in profit, which is quantified as yield x price.

Regarding conventional coffee methods, costs included, but not limited to, inexpensive inputs and synthetic fertilizers that are more readily available. Furthermore, research has implied organic farms have spent more money on labor for weed and pest control management, fertilization, and planning and pruning trees (Lyngbaek, Muschler, and Sinclair 2001). Therefore, the second hypothesis was the cost to produce conventional coffee is less than the cost to produce organic coffee. In addition to relative economic theories, an important non-measureable and non-economic risk to producers that grow and harvest organic coffee is snakes. More specifically, poisonous snakes in Latin America affect the general well being of organic coffee producers and harvesters.

Chavez Arce, et al. (2009) explains conventional coffee processing is energy intensive. However, conventional coffee production is less labor intensive and maintains more feasibility and accessibility to the plants, which is more economically desirable than organic coffee plants and production. In addition, conventional coffee practices do not require shade protection or organic fertilizers. The hypothesis was testable through production records; including yields, labor costs, and overall productivity. Considering the overall profitability, the third hypothesis was organic coffee will yield less net income than conventional coffee.

Research Procedures and Methodology

This section explains the procedures and methods used to determine the difference in profit per acre between organic and conventional coffee production. More specifically, I determined the cost per acre between these two methods by identifying and working with production stakeholders, engaging in fieldwork, site and case study selection, and determining measurable, non-market benefits and costs that pertain to environmental and community factors. This included, but not limited to fertilization, water, pesticide use, and timber harvest. Finally, result methods have been established that include quantitative methods, such as producer surveys and marginal analysis for both organic and conventional coffee production.

Production Stakeholders

Identifying and working with production stakeholders coincides with the projects first objective. That is, to determine the costs and returns of both organic and conventional coffee production. This objective was researched through production records; including yields, labor costs, and overall productivity. Various technological aspects of coffee cultivation include preparing the land, planting coffee trees, maintenance, and finally harvesting and preparing the ripe beans. Specifically, the first phases include cultivation, soil sampling and testing, then planting the coffee tree, followed by ground maintenance. Maintenance for conventional coffee production includes weeding, pruning of trees, and fertilizing, while maintenance for organic coffee production includes weeding, pruning (on average less than conventional), and using organic compost to provide nutrients to the coffee trees. Finally, harvesting practices include selecting the ripe beans, then drying and processing, which includes cooking, grinding, and de-husking. Depending on the operation, drying may be as simple as laying the beans in the sun, or washing and fermenting the beans. While these production practices were investigated, costs were not included because the research took place during the winter season, harvest was not occurring.

Fieldwork

Lyngbaek, Muschler, and Sinclair (2001) compared organic vs. conventional coffee farms in Costa Rica in terms of their productivity, labor use, production costs, and net income. This research follows closely with my project objectives; therefore, I compared these factors between pre-selected organic and conventional coffee farms. Fieldwork consisted of traveling to Costa Rica from July 1 – August 1, 2011 to collect data from various sized organic and conventional coffee plants coffee farms in Atenas, Alajuela, Costa Rica. Because it was not the harvest season, determining distribution of size on representative samples was not available. Therefore, the objective of the project was to compare types of data. The following steps determined data collection:

1. Identify the selected plot location within the farm
2. Establish 10 x 10 x 10 x 10 M plots, relatively
3. Determine number of coffee plants and number of trees within the plot**;** measuring the width of the tree, at chest height, and calculating the average per tree width, cm, from the plot
    a. Per organic farm, determine average coffee plant height, cm
4. Determine the average amount of organic matter within the plot, cm
5. Based on the total number of plants, randomly select 10% of coffee plants to determine how many plants have leaves with spots or leaves with holes.
    a. Spots identify overall health of plants, or lack thereof, which may pre-determine a deficiency, disease, or pest risk; the same is true for identifying holes in leaves.

Pre-arrangement of an organic farm located in San Isidro, Alajeula, Costa Rica was made by Dr. Nolan Quiros, University for International Cooperation. Additional relationships were established by visiting the local farmer's market to meet and established rapport with several other agriculturalists, including Oscar Hernandez. Upon completing research at Oscar's farm, Oscar directed me to his colleague, Mr. Louis Belecario Lopez Guzman – organic coffee producer. Because the goal of the project was to determine which coffee production method is more profitable and provides more variance, collecting data from representative plots allowed me to test my hypothesis. The hypothesis, annualized output from long term production is greater in commercial coffee than organic coffee.

Identifying Site and Case Study Selection

Finca de Hernandez

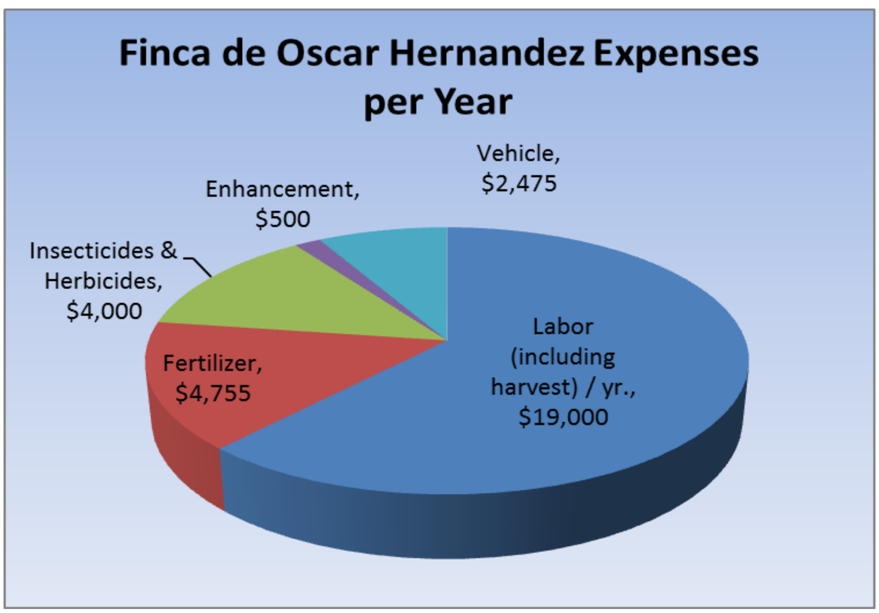
The project involved of selecting one conventional farm and two organic farms. The conventional farm consisted of 10 hectares, and the two organic farms were three and five hectares, respectively. The conventional farm, Finca de Oscar Hernandez, is owned and operated by Oscar and Lucracia Hernandez. The farm is 1250 meters above sea level outside of Morazan, Alajuela, Costa Rica. The farm was initially a tobacco farm, but changed to coffee approximately 40 years ago. The Hernandez farm is 18 hectares total, including two other brothers, but Oscar independently owns and operates 10 hectares. Regarding additional income from the property, wood from trees is never sold, while the fruit from any fruit trees is either sold or used for their own consumption.

Inputs such as fertilizer, insecticides, and herbicides were gathered to determine per crop outputs. Regarding fertilizer, Oscar applies seven bags, per hectare, of Enlasa fertilizer after the rain in April. Similarly in May, Oscar applies five bags, per hectare, of NovaTec for coffee plant growth enhancement. For insects, Oscar uses a more organic method with cups, which attracts the 'broca' bug. 'La broca' creates fungi and wreaks havoc on the plants. To treat the pest, he applies 250 home-made units to 10 hectares to attract and kill the bugs. Specifically, the scent of alcohol, in the first cup, attracts the bugs that ultimately fall into the second and third cups to drown. Figure 1 charts plant data based on conventional coffee production elements.

Figure 1: Hernandez conventional plant data from selected plots:

Finca de Hernandez	Size of Plot m^2	Location	Slope %	Total Coffee Plants	Number of trees	Average tree width cm	Observed				Pest Mgmt.
							Avg. Organic Matter cm	leaves w/ holes	leaves w/ spots	Shade	
Plot 1	10x10x10x5	Corte 7 En Guache Pelin	60%	57	2	73	20	2	8	Below Average	No
Plot 2	10x10x10x3	El Sapo	60%	37	2	70	36	5	8	Below Average	No
Plot 3	10x10x10x5	Corte Guache Pelin	60%	93	4	85	22	5	3	Average	No
Plot 4	10x10x10x10	El Sapo	60%	65	7	78	16	15	10	Above Average	No
Plot 5	10x10x10x10	N 10 ◦ 00'29.3 / W 084◦ 25'29.8	60%	64	6	81	17	3	10	Average	No
Plot 6	10x10x10x10	Las Piedras	60%	69	7	71	16	5	7	Above Average	Yes
Plot 7	10x10x10x10	Corte Guache Pelin	60%	55	1	74	10	4	9	Below Average	No
Plot 8	10x10x10x10	Las Piedras	60%	81	4	111	14	5	21	Average	No
Averages			60%	65.13	4.13	80.38	18.88	5.50	9.50		

Figure 2: Conventional Expenses per year



According to Oscar's records, in 2010, he and his brothers grossed nearly $101,000 USD from their 18 hectare conventional coffee production farm. Specifically, outputs included 480 total fanegas (1.4 bushels) at $210 per fanega. Oscar owns 10 hectares of land; therefore he grossed nearly $60,000. Calculation:

- 480 fanegas / 18 hectares = 27 fanegas per hectare
- 27 fanegas x 10 hectares = 270 fanegas x $210 / fanega = $56,700

CoopeAtenas R.L.: Commercial Coffee Associates' Benefits

CoopeAtenas R.L. is a local coop that has industrialized the coffee business for conventional coffee producers in Atenas, Alajuela, Costa Rica. Currently more than 1300 cooperative member's place their product in a competitive coffee market through the organization. Members enjoy benefits that include keeping good quality coffee that is free of disease, and members stay current with markets and technology to maintain value coffee beans, per director and operator Didier Mora. Furthermore, Mr. Mora explained and re-iterated CoopeAtenas associates practice and promote the growth of ecological and social affairs both nationally and internationally. The beneficio – Spanish for mill, which refers to the entire process of the coffee cherry up to the green coffee bean – obtains five specific certifications that are awarded to producers:

- ✓ Fair Trade certification, held since 2006 by the Coop, establishes that all economic activities developed by CoopeAtenas R.L. come from a fair commercial relationship between the producers and consumers, specifying certain requirements like dignity, respecting human rights, respecting the environment, and at the same time avoiding the middle man between the producers and consumers, among others.
- ✓ UTZ certification, held since 2000 by the Coop, is only obtained by a select group of cooperative associates. The certification is described as friendly to the environment, respecting the principles of the quality of the product and respecting the integrity of those who are producing it by using a process of tracking in order to satisfy the expectations of the consumer.

    - Oscar Hernandez holds this certification.
- ✓ C.A.F.E Practices, registered in the CoopeAtenas program since 2005, declares the consumer is guaranteed to taste a coffee that has been respectful to the environment and to who produced it, and has been produced with techniques that safeguard the integrity of the producer and his family through "good agriculture practices".
- ✓ Specialty Coffee Association of Costa Rica, certification obtained since 2004, states the Coop only provides the finest cup of coffee to very demanding clients like the Starbucks chain.
- ✓ ISO (International Organization for Standardization) 14001, certification obtained since 2001, has possessed the implementation and certification of these efforts in their coffee mill called the "Diamond of CoopeAtenas R.L."

Organic Farms

Finca de Zuniga

The organic farms were selected to include a minimum three years organic production, with most coffee plants in production, and accurately follow organic farming guidelines. Many researchers and organizations have defined and described organic agriculture. Currently, the uniform definition is given by International Federation of Organic Agriculture Movements (IFOAM), which defines organic agriculture as "*a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved*" (IFOAM 2009).

Finca de Zuniga is a family farm that consists of 25 hectares in its entirety, but Geraldo and his son Gabriel independently own and operate three hectares of organic coffee production. Notably, the additional 22 hectares are operated as conventional coffee production by Geraldo's brothers. A deep groove in the ground merely separates the two production methods. The organic farm has been natural for 14 years and has been certified organic for 11 years; hence the three year difference for transition from conventional to organic. The farm is located 1100 meters above sea level. The farm is certified organic, and according to Gabriel, the certification costs $4000 USD / year. Fair Trade certification costs $8000 USD, which they do not have due to the high fee.

The operators do not use any pest management, but instead manage with a symbiotic relationship with nature. Therefore, the farm does not accrue additional input production costs, such as fertilizer, insecticide, or herbicides. Regarding factors such as labor and local economies, Gabriel explained conventional farms apply approximately 20% chemical that is imported and does not support the local economy, while organic producers will purchase and apply approximately 20% of local manure to their crop; hence the additional 80% of investments applied as hand labor and nearly no money spent to buy products.

Regarding expenses and net income, I was unable to retrieve a set of records; however, the owners explained they spend approximately $2065 in labor each season. This includes five employees during harvest (December – February) for two weeks; additional labor is family at no charge. Gabriel and Geraldo's gross income is $9000 per seasonal crop. This originates from 40 fanegas (1 fanega = 1.4 bushels) at $225 per fanega. Figure 2 charts plant data based on conventional coffee production elements.

Figure 2: Zuniga organic plant data from selected plots

Finca de Zuniga	Size of Plot m2	Slope %	Total Coffee Plants	Number of trees	Average tree width cm	Observed					Pest Mgmt.
						Average height of plants cm	Avg. Organic Matter cm	leaves w/ holes	leaves w/ spots	Shade	
Plot 1	100	60%	57	14	45	274	24	10	3	Above Average	No
Plot 2	100	60%	67	12	27	183	30	14	4	Above Average	No
Averages	100.00	60%	62.00	13.00	36.00	228.50	27.00	12.00	3.50		

Finca de Louis Belecario Lopez Guzman

Mr. Guzman has a five hectare farm that is completely organic, contains minimal slope, and the farm is immaculately trimmed; twigs and branches piled and minimal to no organic matter. Exact years as to how long the farm had been organic were unknown, but the farm had been in the family for several generations (current age of Belecario is 67 years old). The farm consists of an abundance of trees and species variation. Specifically, Belecario explained there are 46 species of trees that occupy his farm. Regarding pest management and potentially infected or nutrient deficient coffee plots do not use herbicide, insecticide, or fungicides. Instead Belecario uses 'Mahi Grin', which is coffee fruit waste pulp. Van Der Vossen (2005) explains that Phosphorus and Potassium and other plant nutrients are mined from natural deposits. The ores are further processed to make them more soluble and concentrated for a better plant uptake and serve as an organic pest management mechanism. Approximately 6 ounces of Mahi Grin are poured into a make-shift bomb and applied to the crop. Figure 3 charts plant data based on conventional coffee production elements.

Figure 3: Belecario organic plant data from selected plots

Finca de Belecario	Size of Plot m2	Slope %	Total Coffee Plants	Number of trees	Average tree width cm	Observed					Pest Mgmt.
						Average height of plants cm	Avg. Organic Matter cm	leaves w/ holes	leaves w/ spots	Shade	
Plot 1	121	0%	74	9	64	122	5	2	3	Above Average	Yes
Plot 2	100	0%	80	4	61	165	5	8	8	Average	No
Plot 3	100	0%	58	5	29	173	1	2	6	Average	No
Plot 4	100	0%	96	5	86	183	6	9	3	Average	No
Plot 5	100	7%	64	7	55	152	8	5	5	Above Average	No
Average	104.20	1%	74.40	6.00	59.00	159.00	5.00	5.20	5.00		

Figure 4: Organic (Belecario) expenses per year

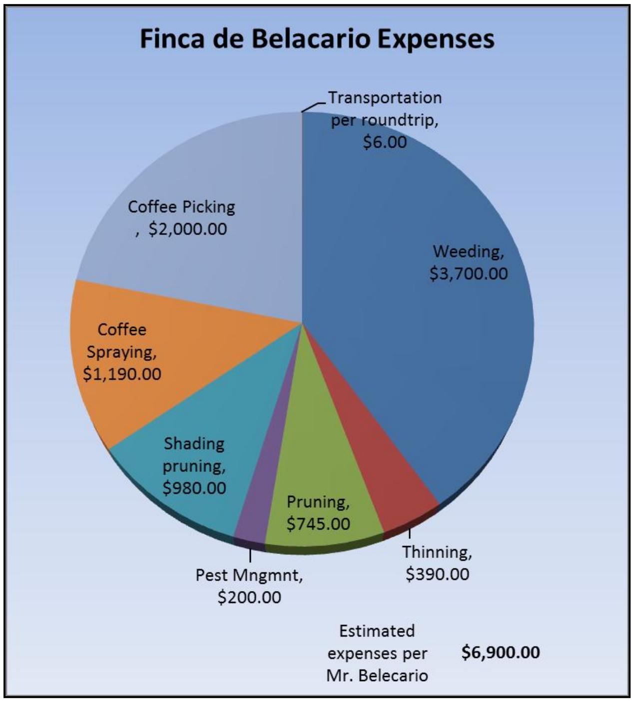
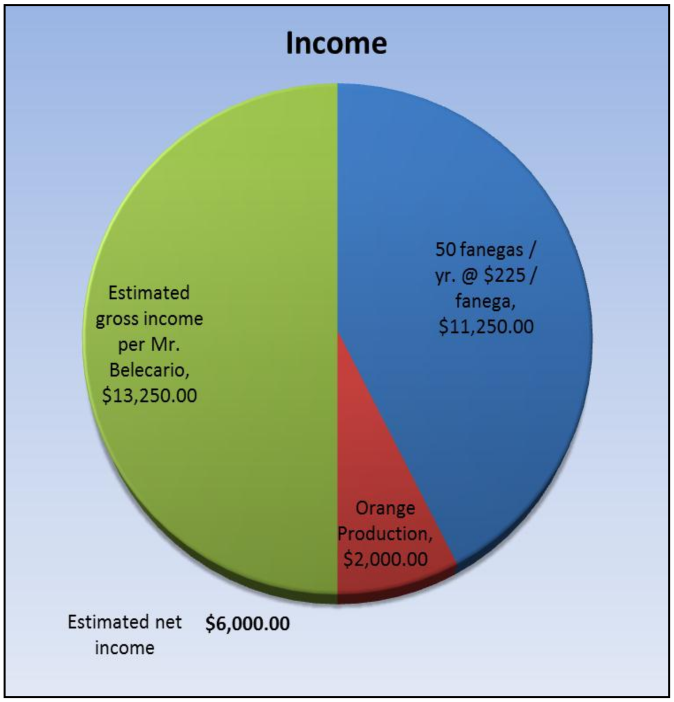


Figure 5: Organic (Belecario) income per year



Results

Primary data was collected by interviewing farm owners and analyzing their production records (based on availability) from both conventional and organic farms. This was achieved by identifying production practices, such as weeding, pruning, spraying, and picking, then seeking specific financial costs for each of the attributes. If a plant or series of leaves were identified as ill, an observation was made to determine the pest management method(s) within the plot. Noteworthy, many of the conventional farmers had actually begun more chemical and pesticide free methods. The conventional agriculturalist sited his reasoning as wanting less water contamination and added requirements from organizations have increased environmental safety requirements, such as International Just Commerce. The conventional agriculturalist, Oscar, was highly concerned with the environment. Mr. Hernandez referenced that all fungicides, pesticides, and herbicides were given to them by an engineer and the engineer, usually from CoopeAtenas, assists with application methods. Moreover, Mr. Hernandez explained compared to previous years, he has currently used less chemical to manage pests. Techniques similar to the broca trap – simply using alcohol and drowning the bug – are favored. Records for gross income were also sought and obtained. Several lengthy visits and questions were asked to help determine why farmers had chosen conventional or organic coffee production methods.

In order to understand the relative benefits and costs between organic and conventional coffee production, quantitative research can be achievable by marginal analysis to determine the net income (NI) of organic and conventional farms in Costa Rica. For both organic and conventional coffee production methods, farmers want to maximize their Net Income, which is achieved by determining Total Benefits less Total Costs. Hence, Net Income = Total Benefits - Total Costs.

The chosen method to analyze this data is marginal analysis. This method will economically analyze the net benefits and costs because the control variable (*cv*) is interchangeable for both organic and conventional coffee production. The control variables (*cv*) includes fertilization, pruning of coffee bushes, weed control, planting and pruning of shade trees, replacement of coffee bushes, and pest control. For example, in conventional coffee production, the control variables include application of fertilizer. In organic production, fertilization includes collection, production, and application of organic material – solely for Finca de Belecario, as the compared organic farm is symbiotic with nature. Each of the variables would be the marginal cost since more, less, or none of the variable can accompany the control variable. Correspondingly, the economic model used will be:

Average Revenue (AR) / Q_{cv} = Marginal Revenue (MR). *Q* will be the controlled variable and be either conventional or organic coffee production, depending on the production method being tested. Evaluating the benefits and costs of organic vs. conventional coffee production is based on short term results, less than one year. With these models and charting data, the study confirms organic coffee production can be as productive as conventional coffee production while providing economic and environmental gain.

Discussion

Post research relationships have been built to compare the average of organic and conventional plots. For example, organic plots have on average more trees than traditional plots. Determining tree species proved inaccurate and unreliable due to unfamiliarity of tropical forest and time constraints to identify. Nevertheless, the organic farm, Finca de Zuniga, had nearly double the amount of trees of the conventional farm. Comparatively, with three fewer plots for comparison, Finca de Belecario had 30 trees while Finca de Hernandez had 33 trees (eight total plots). Appropriately, the average circumference of the trees has been determined. The conventional farm has on average, the most tree width than the two organic farms, and may be loosely deemed the healthiest. Relatively, the mass of organic matter within both organic and conventional production was compared – see charts in Appendices for comparison. Regarding fruit trees, the production of fruit proved more abundant in the organic plots and sales proved lucrative. The organic farm, Finca de Belocario, reaps nearly $2000 USD per year from orange revenue, which was the only farm of the three researched to obtain financial fruit revenue.

Pertaining to water usage, Didier Mora, director and operator at CoopeAtenas, R.L., explained the amount of water used during the conventional coffee milling process is 450 liters per fanega, or 1.4 bushels. While Belecario Guzman explained the amount of water used during the organic coffee milling process is 26-30 liters per fanega. Comparatively among all farms, no agriculturalists irrigated, they simply relied on rainfall. Regarding pests, each agriculturalist was concerned with a problematic disease in coffee leaves known as ‘roya’. Roya is yellow in color and will often cluster the leaves with these spots, leaving your finger to be covered in a light yellow powder from holding the back of the leaf. Other, more non-invasive deficiencies in leaves will produce the powder.

Revenue costs that I was not able to measure included annual growth and value of wood, soil loss, and agriculturalists potentially saving on loans because organic farms can grow food in the coffee trees. Finally, rapport has been established with the agriculturalists and contact has been maintained, especially through social media. A special thank you to Oscar Hernandez, Gabriel Zuniga, Louis Guzman, and their families for many hours of visiting, drinking coffee, and letting me research their coffee farms. I look forward to returning in late 2012.

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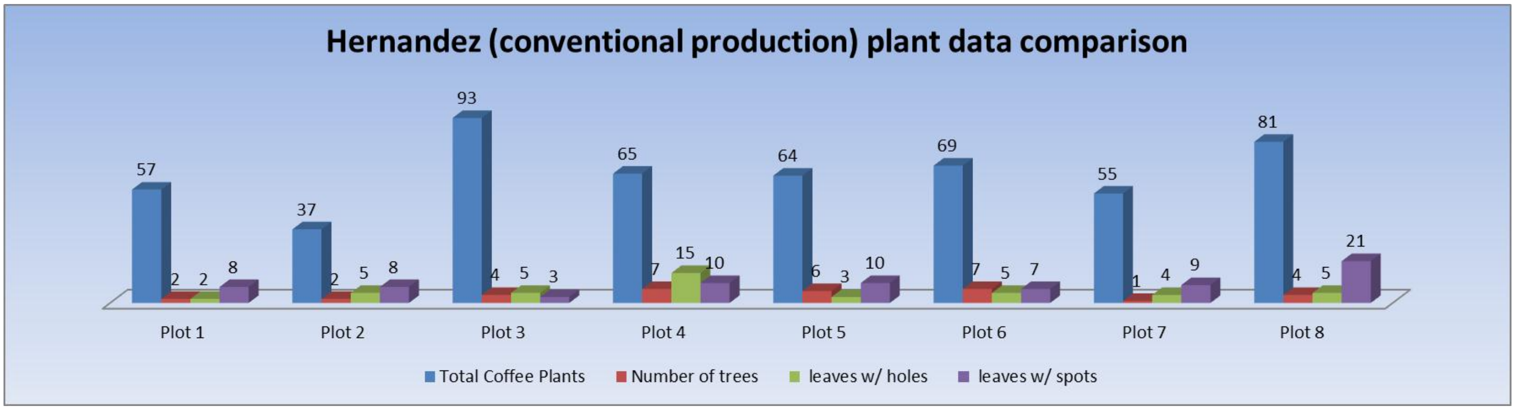
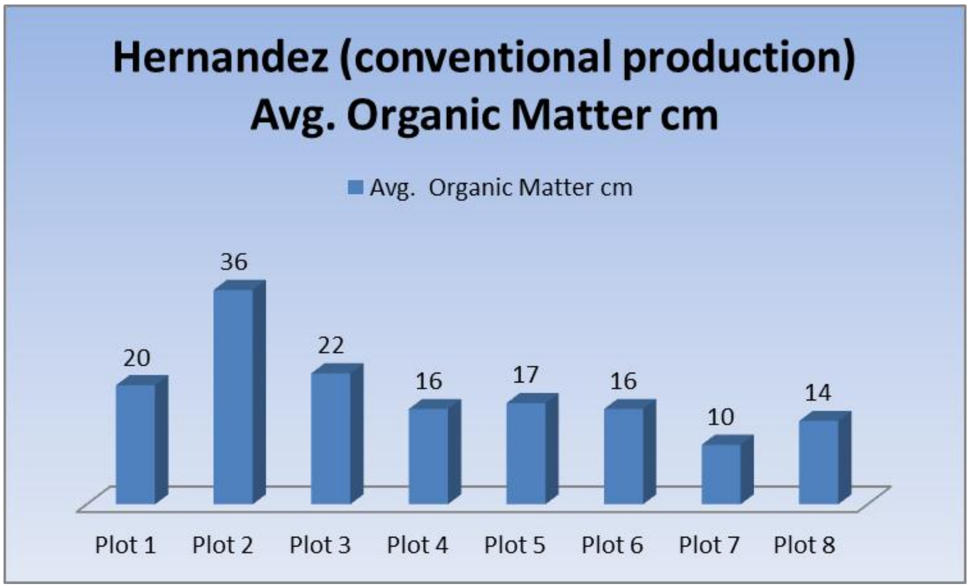
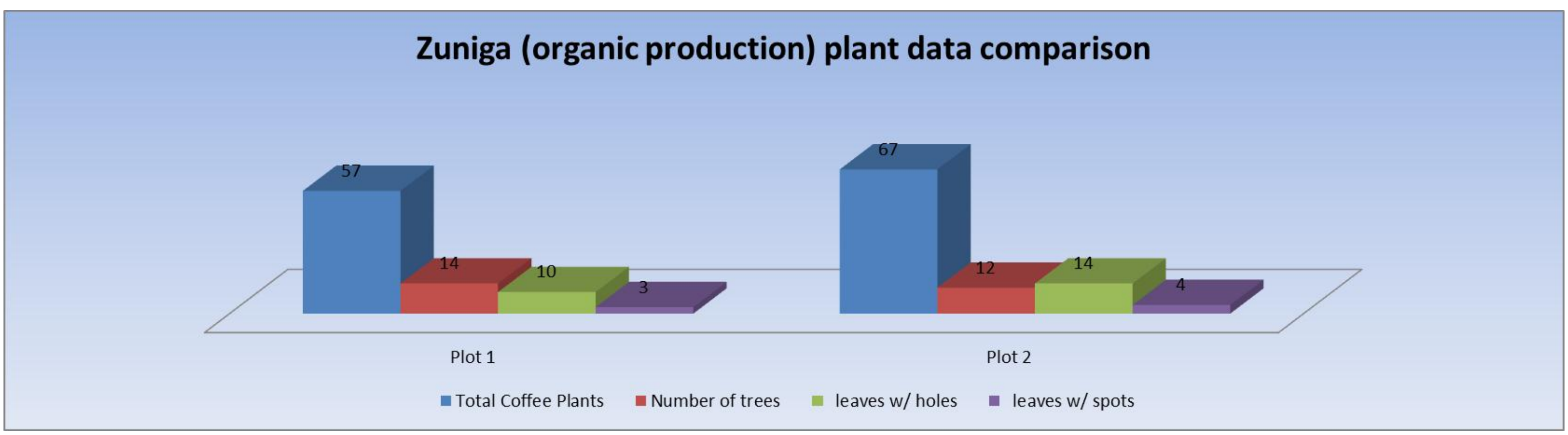
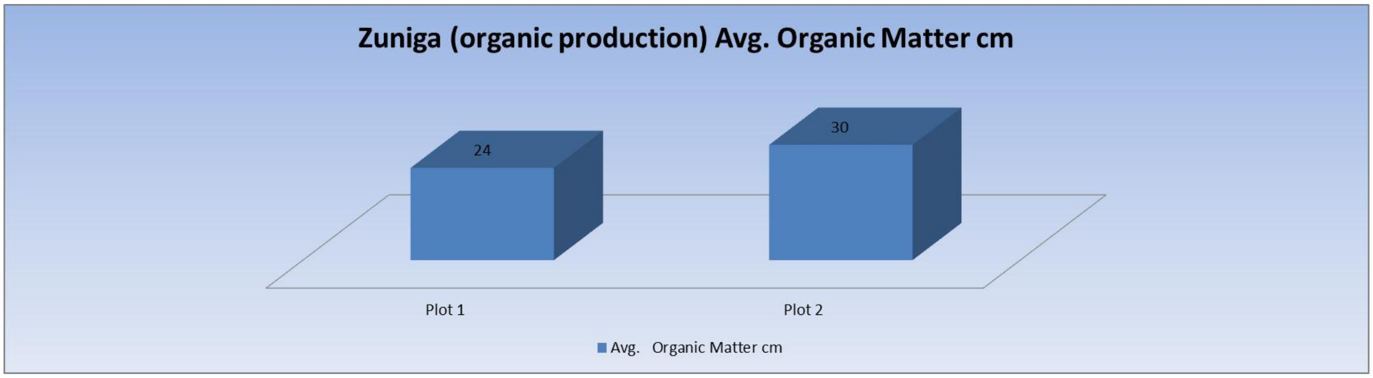
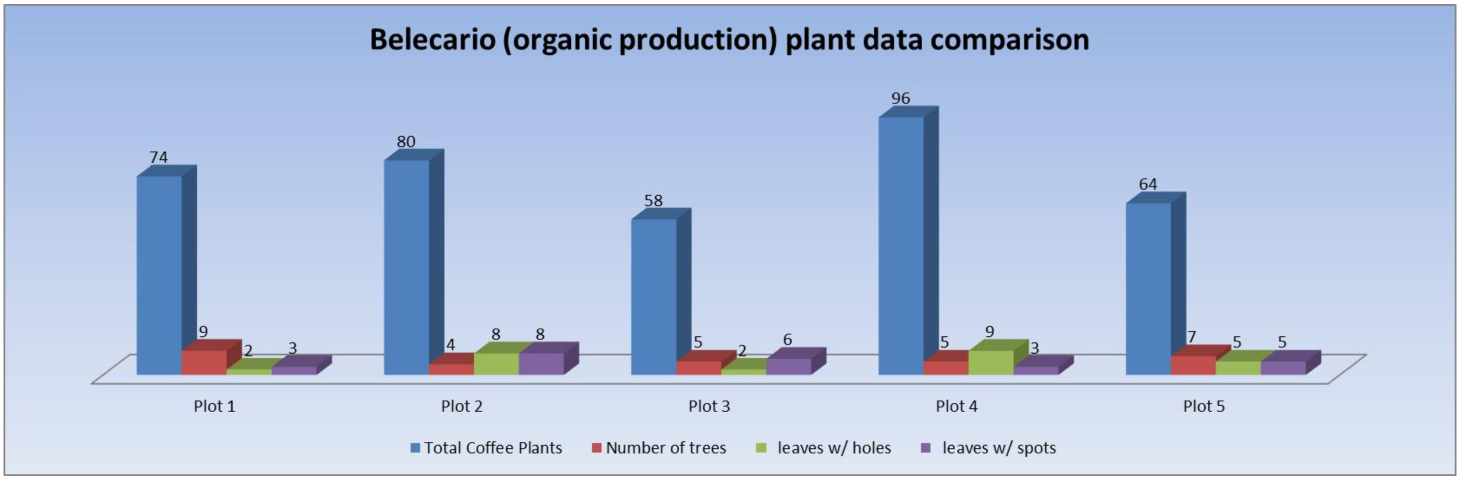
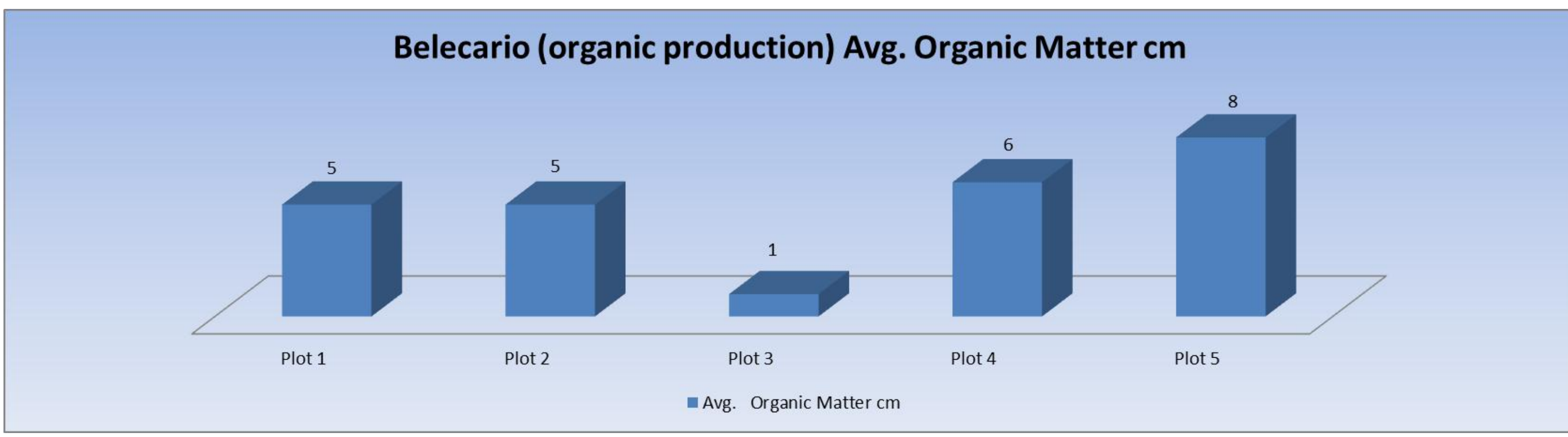

Hernandez (conventional production) plant data comparison
57
2
2
8
37
2
5
8
93
4
5
3
65
7
15
10
64
6
3
10
69
7
5
7
55
1
4
9
81
4
5
21
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Plot 6
Plot 7
Plot 8
Total Coffee Plants
Number of trees
leaves w/ holes
leaves w/ spots


Hernandez (conventional production)
Avg. Organic Matter cm
Avg. Organic Matter cm
20
36
22
16
17
16
10
14
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Plot 6
Plot 7
Plot 8


Zuniga (organic production) plant data comparison
57
14
10
3
67
12
14
4
Plot 1
Plot 2
Total Coffee Plants
Number of trees
leaves w/ holes
leaves w/ spots


Zuniga (organic production) Avg. Organic Matter cm
24
30
Plot 1
Plot 2
Avg. Organic Matter cm


Belecario (organic production) plant data comparison
74
9
2
3
80
4
8
8
58
5
2
6
96
5
9
3
64
7
5
5
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Total Coffee Plants
Number of trees
leaves w/ holes
leaves w/ spots


Belecario (organic production) Avg. Organic Matter cm
5
5
1
6
8
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Avg. Organic Matter cm