Specialty Coffee Association

A Specialty Coffee Association Research Report

Coffee Production Costs and Farm Profitability:

Strategic Literature Review

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1) Introduction

Background

In 2015, a group of volunteer leaders from the Sustainability Council of the Specialty Coffee Association of America (SCAA) selected the profitability of coffee farming as an area of strategic focus. Coffee farmers have struggled for decades— and in some cases, much longer— to consistently cover the costs of producing coffee and make a profit. The acceleration of climate change and rural development in recent years only increases the pressure they experience. Unfortunately, while these struggles have been documented, most of the evidence is anecdotal. What data exists, and has been published, uses different data collection methodologies. Similarly, coffee production practices and costs vary widely, which makes it a challenge to draw conclusions about how to best address the risks facing producers including every business and organization in the coffee sector that depends on their work.

The coffee industry cannot afford to ignore a risk to production on such a global scale, even if the form it takes is still nebulous. In response, the SCAA commissioned RD2 Vision to conduct a strategic review of studies on coffee production costs and write a report that could be used to inform decision-makers, while elevating the dialogue about farm profitability across the entire coffee value chain. This literature review provides a framework of analysis and insight into the costs of coffee growing and makes recommendations into improving the conditions for increasing farm profitability.

Key Findings

This review found that yield increases with higher costs per hectare and, therefore, production yield is not necessarily correlated with farm profitability. **Increasing yield typically *increases* the cost per hectare to produce coffee, especially in the short term, and hence may *decrease* a farm's profitability.** Lowering the input costs into the farming system can often be a better strategy for profitability than increasing yields in coffee production, because low-input farming systems have low production costs. These low-cost, low-yield systems generate a comparatively small amount of income for the farmer, who diversifies their income with other sources of revenue, but it is more profitable than a high-input, high yield system. It is particularly critical for buyers, as well as project funders and implementers, to understand that the Good Agricultural Practices (GAPs) that have been widely disseminated in coffee value chains globally are effective tools for increasing yield but do not automatically translate into more profit for the farming system.

It is also important to note that analyzing costs on a per-hectare basis is a better measure of profitability for a producer than a per-kilogram or cost-per-pound basis— the studies show that farms investing less than $2000/ha can count on making a profit at a variety of yield levels, whereas coffee farms that invest more than $2000/ha require high yields and/or high prices to achieve profitability. On average, production cost per pound should be less than US$2.50, but that figure depends more on the market price for coffee than the cost per hectare.

Conclusions

While this review is a valuable tool, further research is needed to validate the findings presented here and, in the future, to establish a viable process to increase farm profitability. The adoption of a common definition of profitability parameters, common metrics, and consistent methodologies for data collection and implementation of tools, will be important to enabling profitability comparisons between different production systems and geographies worldwide. The review also advocates for further research into farm profitability that considers not only the effectiveness of agricultural practices to increasing yield— which is often used as a proxy for farmer income and profitability— but also their economic efficiency in both low-and high-input farming systems, because the economics of these systems are very different.

This report is published in conjunction with the launch of Avance, the Specialty Coffee Association's first conference on sustainability in October of 2017. Since this report was commissioned, the International Coffee Organization published a study on production costs focusing on four of its member countries (e.g. El Salvador, Brazil, Colombia, Costa Rica) while the World Coffee Producers Forum convened for the first time and established a working group to address the untenable economics of coffee production. Meanwhile, the Global Coffee Platform has created an international collective action network on the economic viability of coffee production. The imperative is clear, and while the challenge is great, the opportunities are, too.

2) Methodology: Document selection

Where possible, peer-reviewed papers were chosen in the analysis of published scientific literature for this strategic review. Due to the lack of recently published peer-reviewed papers on coffee production costs, presentations delivered at various coffee conferences were also considered. It was found that the majority of socio-economics studies conducted into farm production costs were presented as lectures in conferences such as the annual SCA's Coffee Expo in Seattle, US; Ramacafé, Nicaragua; Sintercafé, Costa Rica; and the African Fine Coffee Association (AFCA), East Africa.

Presentations on production costs that include sufficient methodological details and reliable data were included in this review. Other documents often referred to as 'grey literature' were considered. Grey literature does not necessarily follow the usual academic channels or standards, nor does it focus on scientific data collection methodologies, but those selected were found to be relevant in this review of published literature.

Although this review focuses on production costs, it is important to take different socio-economic contexts and farm types into account. For example, some studies considered the impact of both conventional and certified-farming systems on production costs. Although some certification systems do have a quantifiable impact on production costs, they are not directly comparable. Therefore, a decision was made to only undertake a comparison for conventional farming systems.

In summary, 11 documents were reviewed (see Annex 1):

- 9 documents directly addressing production costs;
    - 3 peer-reviewed
    - 3 conference presentations
    - 3 reports
- 2 peer-reviewed documents addressing livelihood and different farm types.

2.1) Methodology: Reviewing method

A grid of analysis in the table below was developed to analyze the main comparable elements of all the documents reviewed.

Item	Description	Analysis
Document type	What kind of document is it?	• Peer-reviewed • Conference presentation • Report
Method	How was the basic data collected?	• Book keeping (e.g. farmers involved in the study were requested to keep record of their expenses and activities) • Questionnaire (e.g. farmers were surveyed and data was collected through a questionnaire) • Expert (e.g. data gathered by agronomic and/or finance experts)
Location	Where did the study take place?	• Regions and countries
Year of study	What year did the data	• Timeframe

	collection take place?	
Cost of production	What actual product production costs are calculated?	• Green coffee • Parchment coffee • Coffee cherries
Number of farms	How many farms are considered in the study?	• Number of farms surveyed or with book keeping • Expert analysis of an ideal farm • No indication (e.g. it is not indicated in the document)
List of variable costs taken into account	List of variable costs include: Inputs (e.g. fertilizers, pesticide etc); Labor (e.g. regular or seasonal hired, family etc), Machinery operation (e.g. fuel maintenance); Transportation	• Yes (e.g. explicitly taken into account) • No(e.g. not taken into account) • No indication (e.g. it is not indicated in the document)
List of fixed costs taken into account	List of fixed costs includes: Machinery depreciation, "Biological depreciation" of coffee trees, Land cost, Administration and overhead, Various taxes, interests, insurance…	
Cost breakdown	Is there a breakdown of the share of different costs?	Yes/No
Separate farm types	Are there different coffee farms taken into account, or is it an average?	Yes/No (e.g. when yes, the grouping of farms is indicated such as the size of farms, countries, regions or socio-economic types)

Table 1: Grid analysis of reviewed documents

Whenever possible, the following variables are estimated (i.e. averaged over the number of farms and/or farm types studied) based on the data provided:

- Coffee area (ha)
- Production cost ($/ha)
- Production cost ($/kg)
- Yield (e.g. equivalent kg of green coffee[1] per hectare)
- Coffee price ($/kg)
- Income ($/ha)

[1] Green coffee weight was calculated from weight of cherry by a factor of 0.167 (e.g. 1 kg of cherry would give 0.167 kg of green coffee)

- Net income $/ha (e.g. income per hectare minus cost per hectare)
- Return on investment (ROI)

Where area units were not expressed, the value is converted in hectares in order to perform a meta-analysis of the data across different documents. When expressed in number of coffee trees, the value was converted into hectares is based on an estimated density of trees per hectare. When costs or prices are given in a local currency, they are converted into USD using the average exchange rate of the year in which the study was conducted. All prices in USD were converted in September 2016 using the USD inflation index[2].

3) Document comparison: Raw data collection

Table 2 below summarizes the analysis of each document according to the grid analysis of reviewed documents outlined in Table 1. In summary:

- The method of collecting raw data is explained in the majority of the documents analyzed. The most common form of data collection is through a questionnaire completed in surveying farms. In one case (Haggar, 2008), some of the raw data is recorded by farmers themselves.
- In two documents (Nasser *et al*, 2012 and Lanna and Reis, 2012), expert data is based on current and theoretical agronomic practices and/or yields. This includes an observed cost of different items. Both documents relate to studies conducted in Brazil.
- In one case (ICO 2016), a detailed methodology of data collection is not documented. Although the document states that, "the ICO has obtained from its members data on production costs and farm gate prices from important producing regions," no further information on how this data was collected in corresponding countries is available.
- The year when data was collected is always clearly indicated. However, in Haggar *et al* (2012), this review infers that data was collected in 2009 despite it not being clearly detailed in the document.
- The breakdown of product categories for which costs were calculated are detailed in the following studies:
    - Parchment coffee: Haggar, 2008; Haggar et al, 2012; Technoserve, 2014; Lundy, 2015
    - Coffee cherries: Stewart (2014)
    - Green coffee: Remaining studies reviewed. However, in ICO (2016), it was not clear which product was considered.
- The number of farms considered in the study is not always indicated. For example, the number is indicated in Haggar (2008) and in Echeverria and Montoya (2013). In Nasser et al (2012) and Lanna and Reis (2012), manual and mechanized farms are indicated respectively. In all other cases, the number of farms are not indicated.
- As far as variable costs are concerned, input is always considered in addition to hired labor and costs associated with maintaining and operating machinery. Transportation costs are included where possible. In Stewart's (2014) smallholder study and ICO (2016)

[2] Exchange rates and inflation were taken from http://fxtop.com/en/historical-exchange-rates.php?MA=1

document, there is no indication of transport costs being included or not.

- In Stewart (2014) and Technoserve (2014), no fixed costs have been taken into account. Haggar (2008) do not consider fixed costs but financial costs are included.
- Land costs are never explicitly considered in any of the documents reviewed, except Echeverria and Montoya (2013) where all fixed costs are considered. In ICO (2016), all fixed costs are considered with the exception of land costs.
- In the Brazilian studies (Nasser et al, 2012; Lanna and Reis, 2012), it is not clear if administration wages are included in labor costs.
- In Haggar et al (2012), biological depreciation is not considered. In Lundy (2015), it is not clear if biological depreciation and administration costs are taken into account.
- In Echeverria and Montoya (2013), and ICO (2016), biological depreciation (see glossary) is included along the average lifespan of a coffee plantation (e.g. 20-25 years). This additional cost relates to land preparation and the installation phase. For the Brazilian studies (Nasser et al, 2012; Lanna and Reis, 2012), the different phases of preparation, installation and production are separated out.
- In most studies, a detailed breakdown of costs is available.

Table 2- Description of the different reviewed documents according to the grid of analysis

							Variable costs						Fixed costs						
Document	Document type	Method	Location	Year of study	Cost for	# farms	Inputs	Regular hired labor	Seasonal Hired labor	Family labor	Machinery operating	Transport	Machinery depreciation	Biological depreciation of coffee	Land	Administration / Overhead	Taxes, interests, insurance...	Cost Breackdown	Separate farm types
1. Haggar J. 2008. **Manejando los costos de produccion de café en fincas organicas y convencionales**. Ramacafé, Nicaragua 2008.	Conference presentation	Expenses and activity Book keeping + Questionnaire	Honduras	2003	Parchment coffee at dry mill	53	yes	Yes	Yes	No indication	Yes	Yes	No	No	No	No	Yes	No	No
		Expenses and activity Book keeping + Questionnaire	Honduras	2004	Parchment coffee at dry mill	No indication	yes	Yes	Yes	No indication	Yes	Yes	No	No	No	No	Yes	No	No
		Expenses and activity Book keeping + Questionnaire	Nicaragua	2006	Parchment coffee at dry mill	No indication	yes	Yes	Yes	No indication	Yes	Yes	No	No	No	No	Yes	No	No
		Expenses and activity Book keeping + Questionnaire	Nicaragua	2007	Parchment coffee at dry mill	No indication	yes	Yes	Yes	No indication	Yes	Yes	No	No	No	No	Yes	Yes	Yes (3 size groups)
2. Haggar, J., Jerez, R., Cuadra, L., Alvarado, U., & Soto, G. (2012). **Environmental and economic costs and benefits from sustainable certification of coffee in Nicaragua**. Food Chain, 2(1), 24-41.	peer review paper	Questionnaire	Nicaragua	2009 (?)	Parchment coffee at dry mill	42	Yes	Yes	Yes	No indication	Yes	Yes	Yes	No	No	Yes	Yes	No	yes (2 Size groups)
3. Nasser, M.D., M. A. A. Tarsitano, M. D. Lacerda and P. S. L. Koga, 2012. **Análise Econômica da Produção de Café Arábica em São Sebastião do Paraíso, Estado de Minas Gerais**. INFORMAÇÕES ECONÔMICAS, v. 42, n. 2, p. 5-12.	peer review paper	"Average farm" according to Expert Saying. Detailed economic study	Brazil (Mina gerais)	2011	Green coffee	1 theoretical farm	Yes	Yes	Yes	yes (Cost = hired cost)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No
4. Lanna G.B.M and R.P. Reis, 2012. **Influência da mecanização da colheita na viabilidade económico financeira da cafeicultura no sul de Mina Gerais**. Coffee Science, Lavras, v. 7, n. 2, p. 110-121	peer review paper	"Average farm" according to Expert Saying. Detailed economic study	Brazil (Mina gerais)	2008	Green coffee	2 theoretical farm	Yes	Yes	Yes	yes (Cost = hired cost)	Yes	Yes	Yes	Yes	No	No indication	Yes	Yes	No
5. Echavarría, J. J., E. C. Montoya, (2013) **La Competitividad Regional de la Caficultura Colombiana**, en J. J. Echavarría, P. Esguerra, D. McAllister, C. F. Robayo, Misión de Estudios para la Competitividad de la Caficultura en Colombia.	Report	Questionnaire	Colombia	2012	Green coffee	1050	Yes	Yes	Yes	yes (Cost = hired cost)	Yes	Yes	Yes	Yes	yes	Yes	Yes	Yes	Yes (regions)
6. Stewart, P., 2014. **The Business Case for the African Coffee Farmer. Can Smallholder Farmers Become Coffee Farmer Entrepreneurs?** AFCA Conference, 2014.	Conference presentation	Questionnaire	Smallholder: Ethiopia, Kenya, Rwanda, Tanzania	2012	Cherries	No indication	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	yes	Yes (countries)
		Questionnaire	Estates: Brazil, Kenya	2012	green coffee	No indication	yes	Yes	Yes	No family labor	Yes	No indication	No indication	No indication	No indication	Yes	Yes	Yes	Yes (countries)
7. Technoserve, 2014. Colombia: A business case for sustainable production. Sustainable Coffee Program, IDH.	Report	Interviews of stakeholders / "Expert Saying"	Colombia	2012	Parchment coffee at dry mill	1 theoretical farm	yes	Yes	yes	Yes: Two hypothesis: with ot without	Yes	Yes	No	No	No	No indication	No	Yes	No
8. Lundy, M. 2015. **Production Costs: Evidence from Colombia**. SCAA 2015 Lectures.	Conference presentation	Questionnaire	Colombia (Nariño)	2013	Parchment coffee at dry mill	No indication	Yes	Yes	yes	No indication	Yes	Yes	yes	No indication	No	No indication	Yes	Yes	Yes (farm types)
9. ICO, 2016. **Assessing the economic sustainability of coffee growing**. Doc ICC, 117-6, 23 pp.	Report	No precise indication	Brazil, Colombia, Costa Rica, El Salvador	2006-2015	Unclear	No indication	Yes	Yes	Yes	No indication	Yes	No indication	Yes	Yes	No	Yes	Yes	No	No
10. Morris K.S. , V. Ernesto Mendez & Meryl B. Olson (2013) **'Los meses flacos': seasonal food insecurity in a Salvadoran organic coffee cooperative**. The Journal of Peasant Studies, 40:2, 423-446, DOI: 10.1080/03066150.2013.777708	peer review paper	Questionnaire	El Salvador	2008		29	Adressing livelihood issues through hunger in household living from coffee growing												
11. Bongers, G., Fleskens, L., Van de Ven, G., Mukasa, D., Giller, K. E. N., & Van Asten, P. (2015). **Diversity in smallholder farms growing coffee and their use of recommended coffee management practices in Uganda**. Experimental Agriculture, 51(04), 594-614	peer review paper	Questionnaire	Uganda	2012		210	Exploring the different farm types and their strategies												

3.1) Variable and fixed costs

From the detailed analysis of different documents outlined in Table 2, variable costs are generally comparable. Moreover, basic differences in overall costs are so wide that the differential between green, parchment or cherries production cost should not hinder any comparisons overall.

The differences in comparing fixed costs are greater. As a general rule, studies that address smallholder producers consider very few fixed costs, whereas studies that address bigger farms or single estates do include this data. Overall, it seems to be accepted that fixed costs are close to zero for smallholder farmers. However, it must be noted that the biological depreciation of coffee trees - which could be considered as a fixed cost - is a reality for smallholders too.

3.2) Family labor and net income

If we consider a large coffee farm or an estate where all costs are monetized, employee wages are included in the variable (e.g. labor) and fixed (e.g. manager wages) costs. This means that net income is calculated once every cost, including labor and management is accounted for.

If we consider a coffee farm that involves family labor, net income includes:

- Remuneration of family field labor
- Management costs (often neglected)
- Eventual benefit

When family labor is translated into a cash cost, the average local daily wage is taken into account.

This literature review considers that when family labor is present, the equivalent daily wage (EDW) from coffee growing is more informative than production costs. EDW is calculated as follows:

$$\text{EDW} = \frac{Gross\ Income - (cash\ costs)}{Number\ of\ days\ dedidated\ to\ coffee\ growing}$$

A calculation for EDW (see glossary) might also take into account field labor and management remuneration. Therefore, EDW is considered an important parameter for smallholder producers whose main asset is family labor, not financial capital. In the main, smallholders will invest their time rather than money.

In four studies (Haggar, 2008; Haggar *et al*, 2012; Lundy, 2015; ICO, 2016) analyzed, the way family labor is considered is not made explicitly clear. In Stewart (2014), family labor is not included in costs for smallholder and is absent in large or single estate farms. In three studies (Nasser et al, 2012; Lanna and Reis, 2012; Echeverria and Montoya, 2013), labor cost is translated into cash using the average local daily wage.

Only Technoserve (2014) explicitly addresses the importance of family labor. The study evaluates the cost of production of one pound (lb) of green coffee to be $1.66 including family labor according to local daily wage, and $1.10 without this cost respectively. As the farm gate price is calculated at $1.39/lb, it therefore becomes unprofitable when family labor is monetized. Interestingly, the same study considers an EDW approach outlined in Figure 1.

In the study, an EDW approach to assessing income highlights the importance of labor productivity, and advocates for introducing technologies that reduces the number of days for any given operation.

Exhibit 4: Farmers will increasingly weigh the opportunity cost of coffee farming, both in terms of land and time (labor)

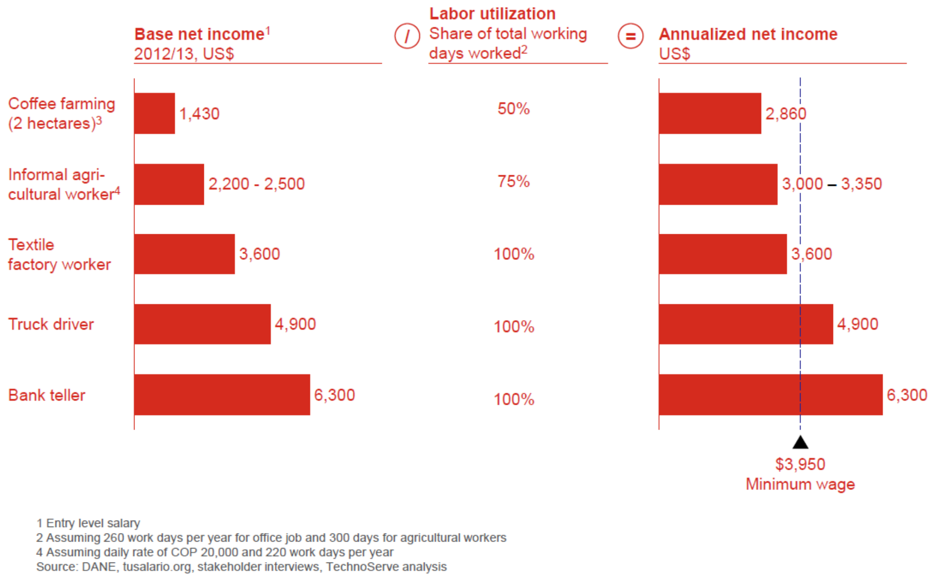


Figure 1 – Attractiveness of coffee growing based on the Equivalent Daily Wage

(Technoserve, 2014)

3.3) Distinguishing between averaged farms or different farm types

Echeverria and Montoya (2013) distinguish farm types according to different Colombian regions. In this study, farm averaged figures are given for each region. Other studies which include several countries (Haggar, 2008; Stewart, 2014; OIC, 2016), also present averaged farm figures. In two studies (Haggar, 2008; Haggar et al, 2012), costs are calculated for different farm sizes.

One of the best analyses of different farm types according to business model is presented by Lundy (2015). Even though it is not made explicit in the study, Lundy runs a clustered analysis from a baseline survey and concludes the following:

- Coffee specialists generated more than 75% of their revenue from coffee
- Diversified coffee farmers generated 51% of their revenue from coffee
- Off-farm income farmers generated 15 % of their revenue from coffee

In the study, Lundy (2015) provides a comprehensive description of each cluster and calculates production costs for each cluster separately.

A good example of of differentiating between farm types[3] is highlighted in the the peer-reviewed article presented by Bongers *et al* (2015). Although it does not focus on productions costs, their analysis is outlined below.

Table 3 – Description of different coffee farm types (clusters) in Uganda

Table 4. Descriptive statistics (mean ± standard error) for system characteristics including availability of the resources land (farm size), labour (family labour) and cash (total household revenue), of farms in each of the five farm types.

System characteristics	Farm type (n) 1 (41)	2 (20)	3 (45)	4 (72)	5 (20)	Average	F-test Sign.
Farm size[AHC] (hectare)	3.1[a] (±0.3)	2.2[ab] (±0.5)	1.8[b] (±0.2)	2.7[a] (±0.2)	3.1[a] (±0.6)	2.6 (±0.1)	0.001*
Number of plots	4.5[a] (±0.5)	3.5[ab] (±0.5)	2.9[b] (±0.2)	3.9[a] (±0.3)	2.6[b] (±0.3)	3.6 (±0.2)	0.002*
Household size (# people in the household)	10.9[ab] (±1.1)	9.0[ab] (±0.8)	8.7[b] (±0.4)	11.5[a] (±0.8)	9.0[ab] (±0.6)	10.3 (±0.4)	0.040*
Family labour (# people >18 year working full-time on farm)	3.5[ab] (±0.4)	2.4[b] (±0.3)	3.3[ab] (±0.3)	4.0[a] (±0.3)	2.6[b] (±0.4)	3.4 (±0.2)	0.003*
Income from coffee [AHC] (%)	58[b] (±2)	26[c] (±2)	85[a] (±2)	53[b] (±1)	21[c] (±3)	55 (±2)	0.000*
Income from banana [AHC] (%)	3[c] (±1)	4[c] (±1)	4[c] (±1)	16[b] (±1)	44[a] (±4)	12 (±1)	0.000*
Income from off-farm labour [AHC] (%)	26[b] (±1)	60[a] (±2)	1[d] (±0)	1[d] (±0)	14[c] (±3)	13 (±1)	0.000*
Income from livestock (%)	3[ab] (±1)	0[b] (±0)	4[ab] (±1)	5[a] (±1)	5[ab] (±3)	4 (±1)	-^
TLU†	2.9 (±0.6)	1.6 (±0.2)	2.0 (±0.2)	2.3 (±0.3)	2.5 (±0.6)	2.3 (±0.2)	0.119
Number of coffee trees	2059[a] (±348)	989[b] (±343)	1505[ab] (±231)	1500[ab] (±145)	844[b] (±268)	1499 (±114)	0.057
Total household revenue (USD/yr)	2406[ab] (±370)	2533[ab] (±816)	1365[b] (±220)	2289[b] (±341)	4396[a] (±2437)	2324 (±287)	0.049

†Tropical livestock unit: sum of the animals with loading cow = 0.7/goat = 0.1/chicken = 0.01/pigs = 0.2/sheep = 0.1.
*Significant difference with $p < 0.05$. Different letters indicate statistically significant differences between farm types to Post-Hoc LSD test.
[AHC]This variable was used in the agglomerative hierarchical clustering.
^Test of equality of means could not be performed because at least one group has 0 variance.

In the study, five different farm types are identified:

1. Large coffee farms
2. Farms with off-farm activities
3. Coffee dependent farms
4. Diversified farms
5. Banana / coffee farms

Given the description of different business models, farming practices and decision-making processes that are specific to each farm, Bongers et al (2015) suggest different technology adoption patterns. Although not explicitly addressed in this paper, production costs and labor productivity will no doubt vary amongst different farm types.

[3] It is the approach of RD2 Vision with comparable results but studies are not published.

3.4) Focus on the Echeverria and Montoya document

This literature review chooses to focus on this document (2013) because it is more comprehensive from a methodological perspective. Based on more than 1000 farms, it allows comparisons between different regions – despite the fact that farm type is not considered. In this document, profitability is measured against the ratio between guaranteed price and production cost.

Furthermore, Echeverria and Montoya explore the main agronomic factors impacting yield, production costs and profitability. This review has attempted to process the data in order to explore the relationship between yield, production costs (e.g. per hectare and per unit) and profitability.

3.5) Yield, profitability and production costs across Colombian regions in 2012

The table below summarizes the figures of yield, profitability, production cost per kg and production cost per hectare. It shows that figures vary significantly between different coffee producing regions. For example, production yield ranges from 360kg/ha to 1,410 kg/ha of green coffee while cost of production ranges from $1.84/kg to 3.08/kg. Meanwhile, production costs can range from anything between $1,405 and $4,595/ha. Profitability also varies widely and can range between $0.62 to $1.20. The table shows that only two Colombian regions are profitable (e.g. Cauca and Nariño). Coefficients of variation (see glossary) show that Yield and production cost per hectare vary the most.

Table 4 – Yield, Profitability and coffee costs of production in different regions of Colombia (after Echeverria and Montoya, 1993)

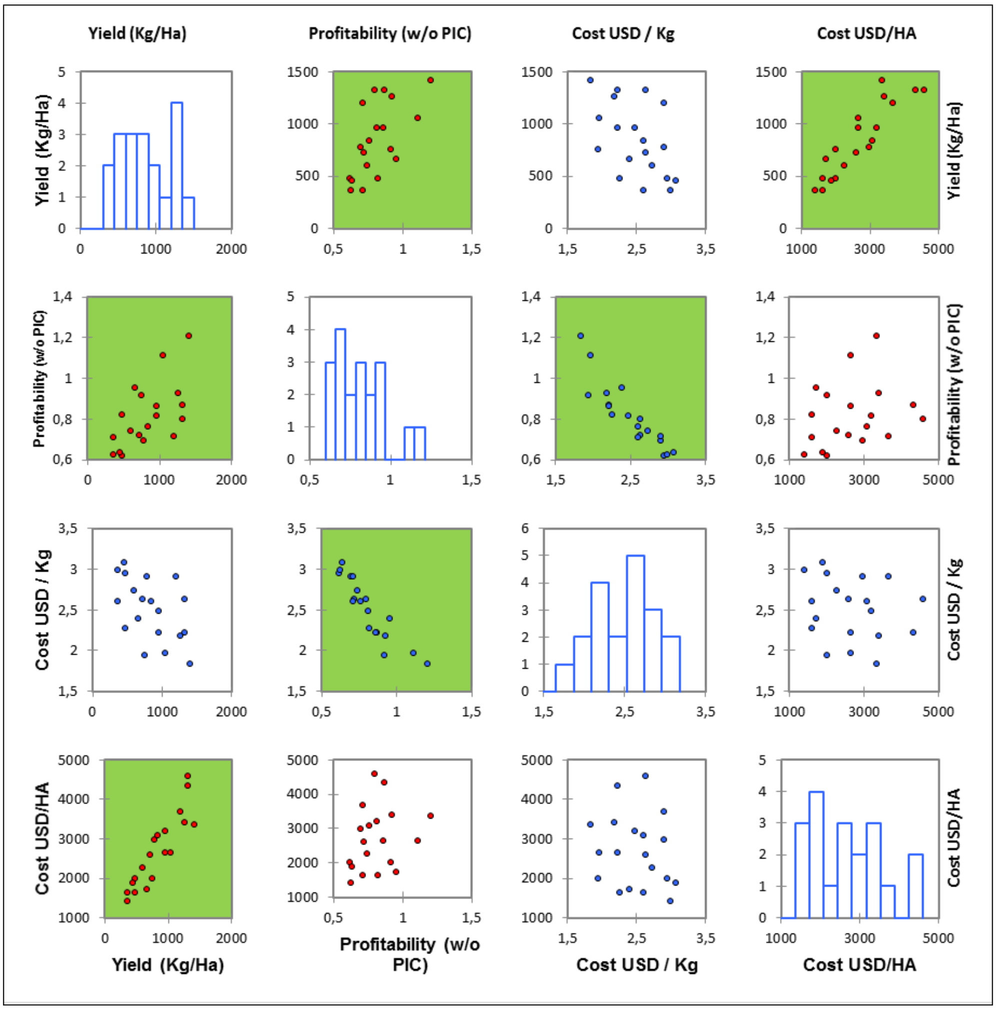
Zona	Region	# farms	Yield (Kg/Ha)	Profitability (w/o PIC)	Cost USD / Kg	Cost USD/HA
Centro Norte	Antioquia	151	1 320	0,87	2,22	4 324,32
Centro Norte	Boyaca	10	780	0,69	2,91	2 972,97
Centro Norte	Casanare	21	660	0,95	2,39	1 729,73
Centro Norte	Cundinamarca	42	600	0,74	2,73	2 270,27
Centro Norte	Metia	21	480	0,62	2,95	2 000,00
Centro Norte	Santander	64	720	0,72	2,63	2 594,59
Centro Sur	Caldas	71	840	0,76	2,61	3 081,08
Centro Sur	Calle del Cauca	40	960	0,86	2,22	2 648,65
Centro Sur	Quindio	9	1 320	0,80	2,63	4 594,59
Centro Sur	Risaralda	39	1 200	0,71	2,91	3 675,68
Centro Sur	Tolima	137	960	0,81	2,48	3 189,19
Norte	Cesar	40	480	0,82	2,26	1 621,62
Norte	La guajira	17	360	0,71	2,61	1 621,62
Norte	Magdalena	28	750	0,92	1,94	2 000,00
Norte	Norte Santander	14	360	0,63	2,99	1 405,41
Sur	Caqueta	17	450	0,64	3,08	1 891,89
Sur	Cauca	104	1 050	1,11	1,97	2 648,65
Sur	Huila	165	1 260	0,93	2,18	3 405,41
Sur	Narino	43	1 410	1,20	1,84	3 351,35
Total		**1 033**	**995**	**0,87**	**2,36**	**3 050**
		CV	35%	18%	16%	30%
		Min	360	0,62	1,84	1 405
		Max	1 410	1,20	3,08	4 595

Table 5 – Correlations between Yield, profitability and production costs (after Echeverria and Montoya, 1993)

Bold = Highly significant correlation (p<0.01)

Variables	Yield (Kg/Ha)	Profitability (w/o PIC)	Cost USD / Kg	Cost USD/HA
Yield (Kg/Ha)	**1**	**0,614**	-0,511	**0,902**
Profitability (w/o PIC)	**0,614**	**1**	**-0,910**	0,266
Cost USD / Kg	-0,511	**-0,910**	**1**	-0,189
Cost USD/HA	**0,902**	0,266	-0,189	**1**

Highly significant correlations are highlighted in green (p<0.01)



(after Echeverria and Montoya, 1993)

Figure 2 – Correlation graphs between yield, profitability and production costs

3.6) Correlations between yield, profitability and production costs

The study shows that there is a highly significant correlation between profitability and production cost per kilogram (see Table 5 and Figure 2). This link is based on the calculation which stipulates that profitability is the value of guaranteed price against production costs.

The relationship between yield and cost per hectare also shows a high correlation (e.g. r = 0.902). On average, every $1000 of investment is equivalent to 310kg of green coffee. As can be seen in Figure 2, the relationship between cost per hectare and yield is fairly linear. However, two points above $4000/ha seems to indicate a plateauing of yield after $3500/ha.

Meanwhile, the relationship between yield and profitability is significant but loosely correlated (e.g. r=0.614). A closer analysis of the the graph in Figure 2 shows that yields below 500kg/ha would not deliver much profit. This finding demonstrates that higher higher yields are not necessarily sufficient to ensure farm profitability.

Table 6 – Agronomic factors impacting yield, production costs and profitability (from Echeverria and Montoya, 1993)

Cuadro 5
Determinantes de la Productividad, los Costos y (del inverso de) la Rentabilidad

	Productividad	Costos	Costo total/Precio de Grantía	
	Sacos por Ha	$ por Carga	%	%
	(1)	(3)	(5)	
Area en Café	0.3562*	-1982.9239	-0.0064	
	(1.77)	(-0.52)	(-0.81)	
Área de la Finca	-0.0700	672.5489	0.0027	
	(-1.20)	(0.62)	(1.16)	
Fertilizante kls	0.0222***	-116.4809	-0.0002	
	(5.72)	(-1.37)	(-1.15)	
Fertilizante kls^2	-0.0000***	0.1279**	0.0000*	
	(-4.30)	(2.10)	(1.94)	
Edad del Cafetal	0.3954***	-3520.0064	-0.0077	
	(2.69)	(-1.25)	(-1.38)	
Edad del Cafetal^2	-0.0047***	39.9142	0.0001	
	(-2.98)	(1.30)	(1.45)	
Edad del Cafetal^3	0.0000***	-0.1331	-0.0000	
	(3.07)	(-1.33)	(-1.47)	
Densidad	0.0017***	-14.7215*	-0.0000*	
	(3.21)	(-1.72)	(-1.75)	
Altura	0.0438*	-511.7080	-0.0013	
	(1.80)	(-1.07)	(-1.23)	
Altura^2	-0.0000*	0.1896	0.0000	
	(-1.96)	(1.20)	(1.36)	
Zona				
Centro Sur	0.0355	20970.8207	0.0154	
	(0.03)	(1.14)	(0.39)	
Norte	-5.0210***	5695.7968	0.0208	
	(-3.82)	(0.17)	(0.31)	
Centro Sur	1.7062	-3.913e+04*	-0.1469***	
	(1.42)	(-1.95)	(-3.48)	
Variedades*				
Caturra	1.1759	17515.5122	0.0361	
	(0.88)	(0.73)	(0.75)	
Colombia	-0.9560	10196.2309	0.0128	
	(-0.79)	(0.48)	(0.31)	
Tabi	0.0000	0.0000	0.0000	
	(.)	(.)	(.)	
Típica	-1.4743	8078.6585	0.0751	
	(-0.79)	(0.17)	(0.74)	
Constante	-36.5629**	1.111e+06***	2.4932***	
	(-1.97)	(3.10)	(3.18)	
N	631	619	620	
R^2	0.1415	0.0475	0.0713	

Graph legend:: Highlighted in green = Highly significant ($p<0.01$); in blue = Significant ($p<0.05$); others = non-significant ($p>.05$)

Studies show that production costs per kilogram and yield are not correlated, and neither are production costs per kilogram versus costs per hectare correlated. This means that the extra cost invested per hectare is not automatically compensated by achieving extra yield. If every $1000 invested in one hectare of productive land ensures an extra 310kg of green coffee, the farm gate price would be $3.22/kg which is the very upper limit of observed farm gate prices. The maximum farm gate price observed by Echeverria and Montoya (2013) was $2.38/kg in Casanare, followed by Cauca, Quindio, Nariño and Huila with $2.14/kg.

3.7) Agronomic factors impacting yield, profitability and production costs

Echeverria and Montoya (2013) use multi-linear regressions in order to identify agronomic factors impacting yield, profitability and production costs (see Table 6). A multiple linear regression is a predictive analysis which is used to explain the relationship between one continuous dependent variable and two or more independent variables.

Their analysis indicates that fertilizers, coffee age and coffee density all impact on yield but not necessarily on production costs or profitability. On the other hand, the quadratic term (see glossary) applied to fertilization is found to be significant and does impact on the cost of production. For example, standard fertilization has no impact on production costs because extra fertilization cost is not necessarily covered by extra yield. However, if a high level of fertilizer is used, the quadratic term is high which might suggest increased production costs. The analysis in Table 6 shows that, on average, yield is lower in the North and profitability higher in Center South regions in Colombia.

4) Conclusion: Meta-analysis of different studies

As indicated earlier in this review, methods differ between studies and any direct comparison between documents can be difficult. Nevertheless, a meta-analysis of the data has been conducted because it still provides useful insights in spite of the methodological limitations. In light of this, readers should consider this meta-analysis as indicative.

4.1) Valuing the cost of production and profitability across different documents

A summary of the mean values for each parameter taken from the studies is outlined in Table 7. However, a range of observed values can offer more insight than taking each parameter at its full value. For example, in Echeverria and Montoya (1993), the average value and two extremes is taken from Norte Santander and Quindio regions.

The first observation is the high range of values for each parameter as indicated by the coefficient of variation (see glossary). Interestingly, profitability parameters are the most variable (e.g. net income per hectare and return on investment expressed as gross income / cost

Box 1 – Net Income

Net Income is defined as the difference between gross income and costs:

Net Income = Income – costs

It can also be expressed as equivalent to:

$Net\ Income = Cost.\ [\frac{Income}{Cost}\text{-}1]$

While $[\frac{\text{Income}}{\text{Cost}}\text{-}1]$ is an expression of return on investment:

Net Income = Cost. ROI

This expression of Net Income shows that it can be increased through investment in cost and/or by a high return on investment. Smallholders with few resources often play with a high ROI from low investment (low input). Estates will accept a lesser ROI from a higher investment (high Input) per hectare).

Production costs per hectare and per kilogram also vary greatly between studies and their specific situation. For example, the situation faced by Ethiopian smallholder farmers is described by Stewart (2014) and presents a significantly low production cost by land area ($44/ha) and weight ($0.15/kg) respectively.
This results in an average net income of $561/ha due to its low yield but delivers an extremely high ROI value of 1283%. Therefore, for each invested dollar, Ethiopian smallholder farmer earns nearly $13. It can be inferred from this example that there is almost no annual maintenance in the coffee plots with the only exception of picking the coffee cherries during harvest. This is an extreme example of a strategy that relies on a high ROI from a very low-input investment level (see Box 1).

Generally, the studies show that cost per hectare ranges from a few hundred dollars to $4,000 - $5,000/ha. Meanwhile, production costs range between $0.50/kg to more than $4.00/kg. Net revenue per hectare ranges from a negative $1890/ha to a positive $2400/ha.

Figure 3 shows similar groupings of smallholder farmers from Nicaragua, Honduras and East African countries with production costs of less than $1400/ha. On the other hand, farms from Colombia, Brazil and Costa Rica have production costs greater than $2000/ha.

Figure 5 shows that most smallholder producers from Central America and East Africa face productions costs that range from $0.50 to $1.50. According to OIC, Brazilian Estates and Average Colombia incur production costs that range from $1.70 to $2.40/kg. Other Colombian regions, El Salvador-OIC, Costa Rica-OIC and Kenyan Estate (Steward, 2014) can vary between $2.40 to more than $5.00/kg. The same figures show that net income is positive for the main coffee producing countries.

Table 7 – Summary of coffee production costs values from reviewed documents

Reference	Country	ID in graph	Year	Coffee area (Ha)	Yield (Kg/Ha)	Cost / Ha (USD)	Production cost (USD/Kg)	Coffee price (USD / Kg)	Income / Ha (USD)	Net Income / Ha (USD)	ROI
Haggar J. 2008	Honduras	Honduras 2003	2003	4,90	474	335	0,70	1,07	506	173	51%
Haggar J. 2008	Honduras	Honduras 2004	2004	5,00	483	410	0,84	2,14	1 032	622	152%
Haggar J. 2008	Nicaragua	Nicaragua 2006	2006	7,60	1 319	807	0,60	1,25	1 244	640	54%
Haggar J. 2008	Nicaragua	Nicaragua 2007 small	2007	1,3	660	423	0,63	1,31	865	442	104%
Haggar J. 2008	Nicaragua	Nicaragua 2007 med	2007	5,3	1 076	1 174	1,09	1,53	1 646	472	40%
Haggar J. 2008	Nicaragua	Nicaragua 2007 Large	2007	16	2 150	2 039	0,94	1,70	3 659	1 620	79%
Haggar J. 2012	Nicaragua	Nicaragua 2012 Small	2009	5,60	840	1 192	1,42	2,51	2 113	920	77%
Haggar J. 2012	Nicaragua	Nicaragua 2012 Large	2009	40,00	872	1 312	1,50	2,55	2 228	912	70%
Lana 2012	Brazil	brazil La	2011	Big	1 650	2 816	1,71	1,79	2 955	139	5%
Nasser et al	Brazil	brazil Na	2011	Big	2 100	3 746	1,81	1,93	4 051	305	8%
Echeveria 2013	Colombia	Colombia av	2012		995	3 172	2,46	2,39	2 381	-790	-25%
Echeveria 2013	Colombia	Colombia N Santander	2012		360	1 461	3,12	1,98	707	-753	-52%
Echeveria 2013	Colombia	Colombia Quindio	2012		1 320	5 715	2,58	2,18	2 889	-1 890	-49%
Paul Stewart AFCA 2014	Ethiopia	ethiopia Stew	2012	0,43	288	44	0,15	2,09	604	561	1283%
Paul Stewart AFCA 2014	Brazil	Brazil Estate Stew	2012	Big	1 920	4 533	2,36	2,77	5 311	780	17%
Paul Stewart AFCA 2014	Kenya	Kenya Estate Stew	2012	Big	1 190	5 512	4,63	4,75	5 668	156	3%
Paul Stewart AFCA 2014	Rwanda	Rwanda Stew	2012	0,08	800	471	0,62	2,86	2 080	1 609	342%
Paul Stewart AFCA 2014	Kenya	Kenya West Stew	2012	0,12	1 185	780	0,66	2,68	3 179	2 399	308%
Paul Stewart AFCA 2014	Tanzania	Tanzania Stew	2012	0,33	470	416	0,88	2,77	1 304	888	214%
Technoserve Colombia	Colombia	Colombia Tns	2012	2,00	1 134	4 246	3,74	3,14	3 564	-682	-16%
OIC	Colombia	Colombia OIC	2015		1 100	2 323	2,11	2,53	2 778	455	20%
OIC	Costa Rica	Costa Rica OIC	2015		1 050	3 782	3,60	2,96	3 255	-527	-14%
OIC	El Salvador	El Salvador OIC	2015		300	1 313	4,37	1,75	524	-789	-60%
OIC	Brazil	Brazil av OIC	2015			3 201					
OIC	Brazil	Brazil Min OIC	2015			3 948					
OIC	Brazil	Brazil Max OIC	2015			2 267					
Lundy 2015	Colombia	Colombia Lundy Spe	2013	1,66	905	3 172	3,50	4,27	3 870	697	22%
Lundy 2015	Colombia	Colombia Lundy Div	2013	0,97	787	2 442	3,10	3,93	3 089	647	27%
Lundy 2015	Colombia	Colombia Lundy Off	2013	0,63	360	1 902	5,28	3,60	1 297	-604	-32%
				Mean	992	2 240	2,09	2,48	2 415	323	101%
				min	288	44	0,15	1,07	506	-1 890	-60%
				max	2 150	5 715	5,28	4,75	5 668	2 399	1283%
				cv	53%	72%	69%	37%	59%	281%	259%

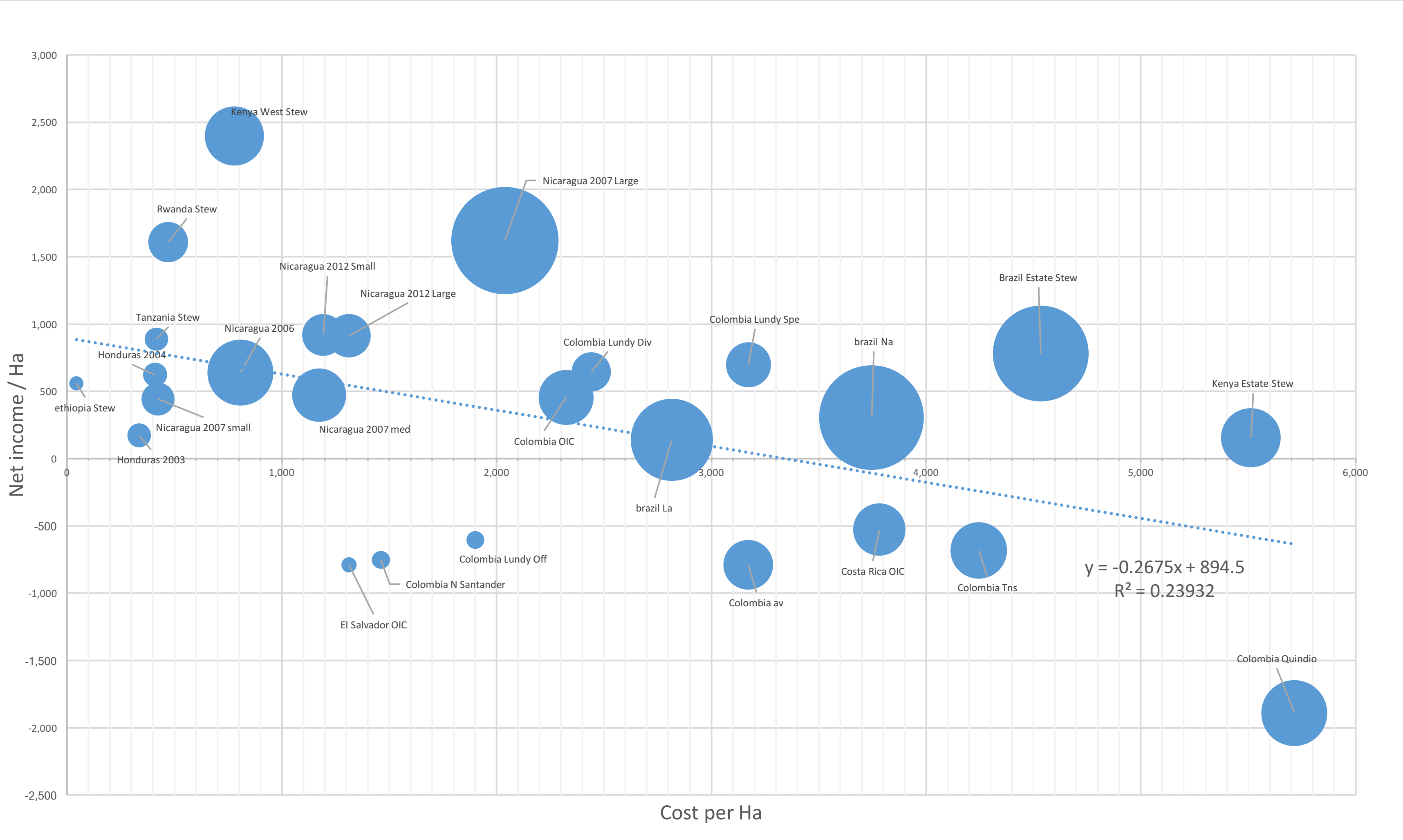


Figure 3 – Net Income per ha versus cost per hectare from the different reviewed studies

(Please note the size of circle-points is proportional to yield)

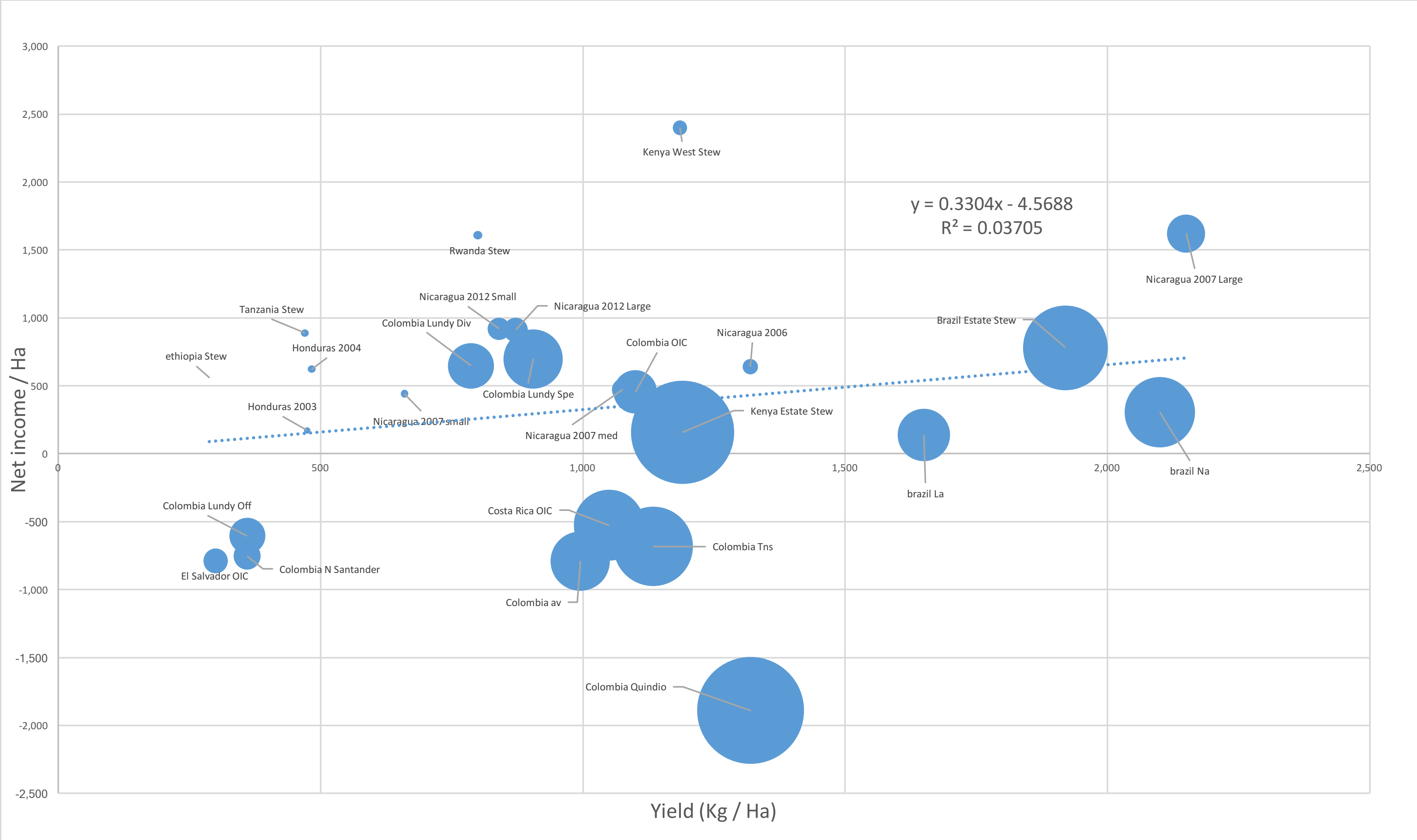


Figure 4 – Net Income per hectare versus yield from the different reviewed studies

(Please note the size of circle-points is proportional to yield)

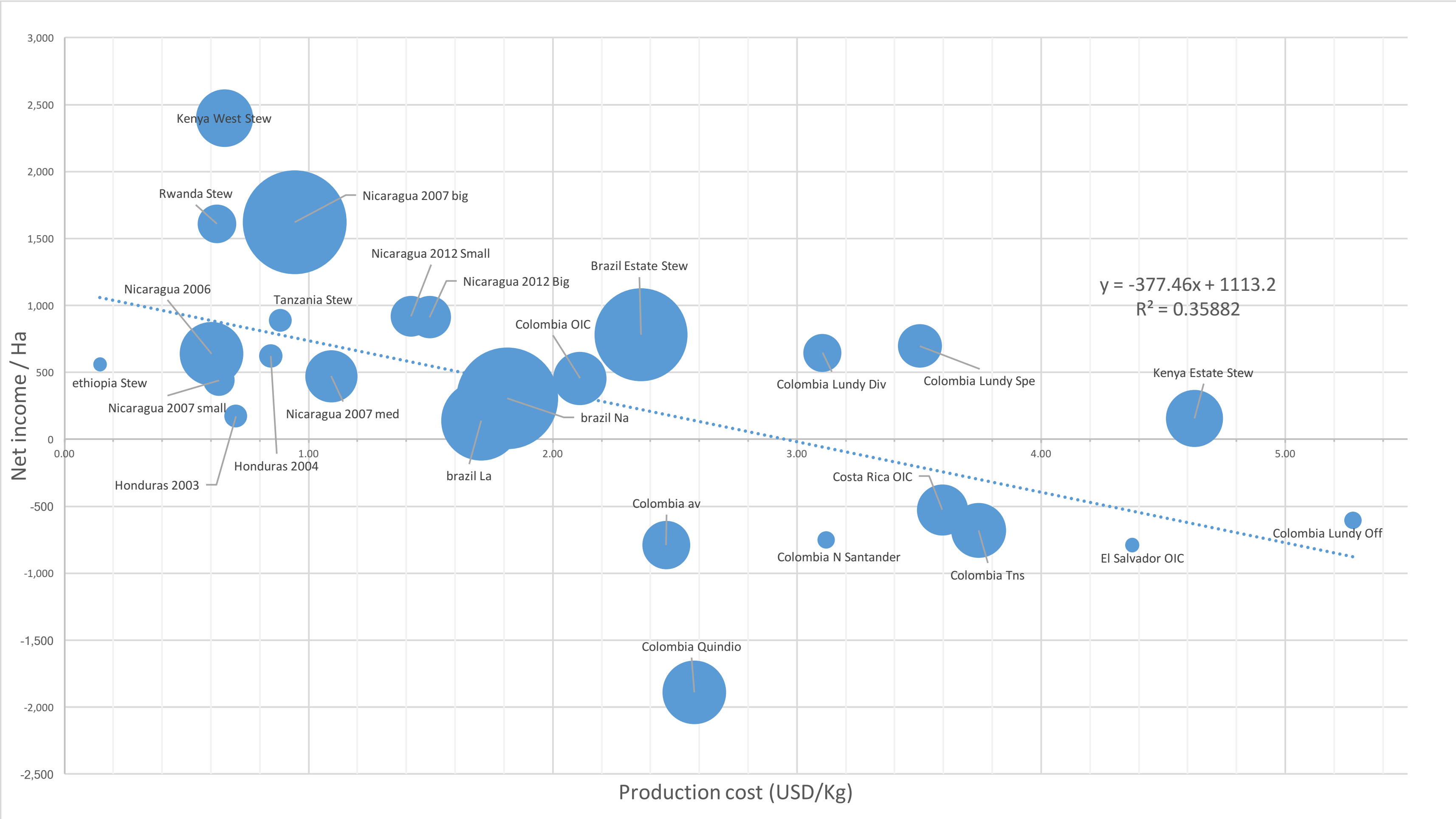


Figure 5 – Net Income per ha versus Cost per Kg from the different reviewed studies

(Please note that size of circle-points is proportional to yield)

4.2) Analyzing the meta-relationship between profitability, cost per hectare, cost per kilogram and yield

Table 8 shows the correlation of coefficients between economic parameters and gives an indication of the relationship between these parameters.

Table 8 – Meta-correlation matrix of economical parameters across studies

Bold figures correspond to significant correlations ($p<0.05$)

Variables	Yield (Kg/Ha)	Cost / Ha (USD)	Production cost (USD/Kg)	Coffee price (USD / Kg)	Income / Ha (USD)	Net Income / Ha (USD)	ROI
Yield (Kg/Ha)	**1**	**0,552**	-0,093	-0,055	**0,741**	0,192	-0,280
Cost / Ha (USD)	**0,552**	**1**	**0,617**	**0,475**	**0,797**	**-0,489**	**-0,450**
Production cost (USD/Kg)	-0,093	**0,617**	**1**	**0,621**	0,332	**-0,599**	**-0,502**
Coffee price (USD / Kg)	-0,055	**0,475**	**0,621**	**1**	**0,581**	0,024	-0,088
Income / Ha (USD)	**0,741**	**0,797**	0,332	**0,581**	**1**	0,128	-0,280
Net Income / Ha (USD)	0,192	**-0,489**	**-0,599**	0,024	0,128	**1**	0,355
ROI	-0,280	**-0,450**	**-0,502**	-0,088	-0,280	0,355	**1**

In this table, yield is related to income per hectare but not to profitability expressed as either net income per hectare or ROI. However, yield is positively correlated to cost/ha.

As observed earlier in this review for Colombian figures (Echeverria and Montoya, 2013) investment in Good Agricultural Practices (GAP) helps to increase yield but not profitability.

It shows that production costs per kilogram increase with cost/ha but are not influenced by yield. As expected, greater production costs lead to lower profitability.

Profitability parameters (e.g. net Income per ha and ROI) are negatively correlated to cost per hectare and production cost per kilogram.

The meta-correlation matrix of economical parameters shown in Table 8 shows that lowering production costs per kilogram and decreasing investment in the the cost per hectare will increase profitability.

It is worth noting that the cost per hectare is significantly correlated to all other variables which makes it an important parameter to consider. Similarly, cost per hectare is positively correlated to yield, production costs, coffee price, and income per hectare but is negatively correlated to profitability.

Interestingly, production costs per kilogram and coffee price are positively correlated which might reflect an acknowledgement by the market of different production costs.

Figure 3, 4 and 5 provide a complementary visual way of comparing these correlations.

Figure 3 and Figure 4 both illustrate the relationship between net income per hectare, cost per hectare and yield. The graphs show how a low input and low to medium yield strategy is mainly occupied by smallholders.

El Salvador, Colombia Norte Santander and the 'off-farm revenue' farm types of Nariño show that their yields are too low to compensate for $1300-1900/ha (see Figure 3). A review of the studies suggest that $3000/ha represents a threshold. Farms below this threshold are mostly profitable. Above this threshold, farms with high yields (e.g. Brazil) or high prices (e.g. Kenya) can only become profitable. For example, the Quindio region of Colombia has a high cost per hectare with low yield and coffee prices, making it difficult to become profitable.

Figure 4 illustrates if a farm's yield is above 1500kg/ha it is very likely to be profitable.

Figure 5 illustrates the relationship between net income per hectare and production cost per kilogram. In this graph, it seems that a production cost of $2.50/kg is an important threshold. All farms with a lower production cost per kilogram than the threshold are profitable, while only those benefiting from higher prices are profitable if production cost is higher than $2.50/kg. This does not come as a surprise given that the average coffee price across the reviewed documents is $2.46/kg.

It is interesting to note that the Nicaragua 2007 study (Haggar, 2008) focuses on three different farm sizes; small, medium and large. Figure 3 shows that small and medium farms detailed in the study have the same net income of around $450/ha but with a cost per hectare of $1174/ha and $423/ha respectively. However, large farms are transforming their higher investment (e.g. $2039/ha) into higher net income of $1620/ha thanks to a significantly higher yield of more than 2000kg/ha. This reinforces the idea that small or large farms are both more efficient than medium farms[4].

Likewise, Lundy (2015) points out that 'coffee specialized' and 'diversified' farm types are profitable while 'off-farm revenue' farms are not[5].

4.3) Main conclusions of the meta-analysis

Since coffee is a tree crop, a low-input strategy can be profitable because there will always be production of fruit (see Box 2).

A high input–high yield strategy is uncertain because extra yield will not necessarily compensate for the extra cost invested to achieve the extra yield.

A widely accepted hypothesis is that good agricultural practices are effective in increasing yield but are not necessarily economically efficient enough to improve profitability. A reason for this may be that GAPs were efficient when they were defined; often decades ago. Since then, labor and fertilizer costs have significantly risen. Therefore, profitability is more related to nutrient uptake efficiency or labor efficiency. This literature review recommends that GAPs should be revised accordingly in order to become Safe and Profitable Agricultural Practices (see Annex 2). For example, it

Box 2: Advantages of coffee as a tree crop

Coffee is a tree crop producing fruit every year. Once it is planted, coffee will produce cherries even if very low input, if any, is invested. This means that the return on investment can be very high with coffee in a low input system.

This is different for annual crops like rice or maize which require significant investment in fertilizers and labor for production.

[4] Also observed by RD2 Vision, unpublished data
[5] Also observed by RD2 Vision, unpublished data

Box 3:The production curve

The curve that relates the amount of input to produce coffee and the corresponding production is called the production curve.

If this curve is flat, it means that production is not responding to extra input. The properties of the curve might be different in its complexity and constituent parts (see Annex 3).

seems that good agricultural practices in Brazil are ensuring profitability even with a high cost per hectare. This would suggest that agricultural practices in Brazil are effective for increasing yield and profitability.

A complementary hypothesis is that GAPs have mostly been defined in controlled research stations that benefit from a controlled and high-input environment. Corresponding GAPs have been defined for the high input part of the coffee production curve (see Box **3** and Annex 3). However, no information is available in the literature reviewed about the shape of the curve in the low to medium input area. It could be that different GAPs need to be implemented at different times in order to climb the production curve.

Another important conclusion is the wide variability of situations in coffee production. When production costs and profitability figures are given as an average, this high degree of variation is not being accounted for.

In this review, it is observed that considering Colombia as an average does not provide a helpful point of reference. Furthermore, considering regional variations (Echeverria and Montoya, 2015) and farm type (Lundy, 2015) is more illustrative than comparing against country-wide assumptions.

A more efficient way of approaching the next generation of coffee farms will see profitability go hand-in-hand with a better understanding of the diversity of farm types and their associated business models.

4.4) Causes of household food insecurity

Most studies define net income as a benefit once labor costs and management of people have been factored into costs. This is often the case for companies and farm owners whose own capital is invested into the maintenance of coffee plots.

For smallholders, net income is often defined as what capital is available for household expenses. Therefore, it is important to make the distinction between accounting for immediate basic needs and investment into fertilizers or other products for the cultivation of crops.

Furthermore, a coffee estate will often have a company status that focuses mainly or solely on coffee production. This will be the case also for smallholder 'coffee specialists' (Lundy, 2015; Bongers et al, 2015). However, it must be noted that most people growing coffee have different sources of income which is derived from either on-farm (e.g. diversified) or off-farm revenue.

As the coffee industry is working to improve the livelihoods of coffee producers, profitability can be seen as a proxy to achieve this goal where production cost is related to profitability. However, understanding coffee production costs is also a means to know more about the livelihoods of those people who earn a living from coffee growing. For this reason, the peer-reviewed paper by Morris *et al* (2013) explores the 'meses flacos' - or hunger period - of household living from coffee growing. Although this review does not focus on production costs, some of its conclusions resonate with Morris et al's findings.

Some interesting observations by Morris et al (2013) are detailed below:

- *"Mean gross income for households of the coffee cooperative was $2037 (n = 29; min =$1425; max = $9680), or $298 per capita based on the average of seven household members. El Salvador's annual mean income per capita was $3547 for 2007 (Department of State 2010)."*

  A gross income of $2037 is considered to be the threshold when compared to the cost per hectare of coffee production.

- Farmers insisted that they cannot afford growing food crops (e.g. annual crops) without fertilizers. This is never cited for coffee (e.g. tree crop)

- When asked about the causes of household food insecurity (see Figure 6), half of farmers interviewed farmers said "lack of work" and only 7 % mentioned the low coffee price.

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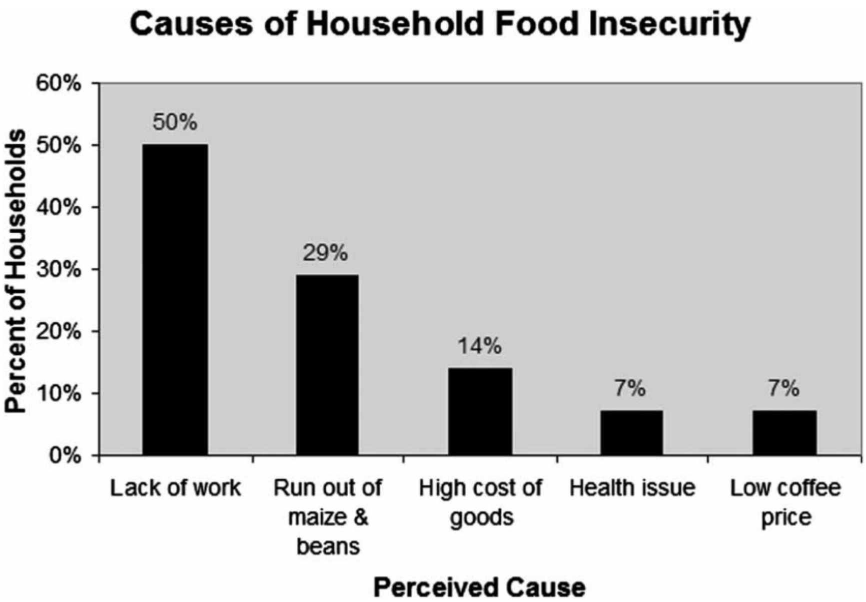

Figure 6 – Perceived causes of household food security amongst coffee farmers
(From Morris et al, 2013)

This review suggests that poor coffee smallholders are not poor because they grow coffee; they are poor and they happen to grow coffee. This is partly because it is a tree crop sustaining low-input farming system and partly due to the seasonal nature of coffee production. However, coffee production might help lift smallholders out of poverty, but it might also be that they will continue to grow coffee when they are out of poverty by other means.

This observation does not, however, apply to all coffee farmers – especially large, specialized farms or estates for which income is directly generated from coffee as the sole source of income.

4.5) Limitations and recommendations of this literature review

As the peer-reviewed papers and supporting documents do not use a standardized methodology that allows for a direct comparison between different situations, there are limitations to the conclusions that this literature review can draw.

In light of this, future assessments in production costs as they relate to farm profitability would benefit from mutually defined and common guidelines. This literature review recommends the following:

- Agreed common definitions of costs to be taken into account and related key parameters to be evaluated. For example, labor days should be included so that labor productivity can be accurately calculated.
- List of options for taking into account family labor and management costs to establish clear references
- The need to clearly define the population of studied farms and, as much as possible, consider separately different farm types[6].
- Data presented in conference presentations or grey literature be published by authors as peer-reviewed papers.
- A coffee standardized farmer clustering (typology) approach is required in order to make direct comparisons.

5) Next steps: A strategic approach

The analyses conducted in this literature review suggests the following strategic next steps:

1) Guidelines for common definitions and evaluation of coffee profitability parameters

There is a need for common definitions and evaluation of profitability parameters. For example, yield is often recorded together with different costs which does not help direct comparison. Often, labor quantity (e.g. number of days) is missing, which makes it impossible to assess labor productivity as well as equivalent daily wages The EDW term might be regarded as one of the most important coffee profitability parameters for many farms. It is suggested that cost of production is also regarded as a proxy for profitability.

It is therefore recommended that a task force including an economist, socio-economist and agronomist are convened to develop guidelines for common definitions to support the

[6] See Lundy, 2015 and Bongers et al (2015) as excellent examples amongst published studies.

evaluation of coffee profitability.

2) Systematization of a farm clustered approach

Average coffee profitability parameters are difficult to analyze accurately as the underlying variability is so wide. To achieve meaningful data, it is recommended that a farm typology (e.g. clustering) approach based on socio-economic and agronomic data is developed. This will allow for a more accurate mapping of profitability parameters for different clusters; it will also allow the identification of specific limitations or barriers to achieving more profitability in each cluster. Additionally, this approach will help to support and fine-tune more efficient technical assistance strategies.

Baseline surveys into socio-economic and agronomic data may already exist but if this is not the case, further research needs to be conducted. It is important to note that clusters (i.e. farm types) can vary across different countries and regions.

This review recommends the set up of pilot farm cluster analysis in different countries. For each pilot, the output could include:

- Identification and description of the clusters
- Evaluation of main profitability parameters by cluster
- Identification of the main limitations to profitability for each cluster
- Action plan for an efficient technical assistance strategy based on the cluster analysis, profitability and specific limitations to more profitability.

3) Advocating for agronomic research on effectiveness and efficiency

It is observed that GAPs are effective in increasing yield but are not necessarily economically efficient. Therefore, agronomists should be able to prove the economic efficiency of any new, or even existing, coffee agronomic practices.

Moreover, agronomists should work along the coffee production curve and find adapted profitable practices in low-input and high-input farming systems. It is therefore recommended that the coffee industry should challenge coffee research institutions to commit resources and conduct further research into:

- Economic efficiency of agronomic practices, and;
- Economic efficiency in the context of low or high-input farming systems.

7) Annex 1: List of reviewed documents

1. Haggar J. 2008. **Manejando los costos de produccion de café en fincas organicas y convencionales**. Ramacafé, Nicaragua 2008.
2. Haggar, J., Jerez, R., Cuadra, L., Alvarado, U., & Soto, G. (2012). **Environmental and economic costs and benefits from sustainable certification of coffee in Nicaragua**. Food Chain, 2(1), 24-41.
3. Nasser, M.D., M. A. A. Tarsitano, M. D. Lacerda and P. S. L. Koga, 2012. **Análise Econômica da Produção de Café Arábica em São Sebastião do Paraíso, Estado de Minas Gerais**. INFORMAÇÕES ECONÔMICAS, v. 42, n. 2, p. 5-12.
4. Lanna G.B.M and R.P. Reis, 2012. **Influência da mecanização da colheita na viabilidade económico financeira da cafeicultura no sul de Mina Gerais**. Coffee Science, Lavras, v. 7, n. 2, p. 110-121
5. Echavarría, J. J., E. C. Montoya, (2013) **La Competitividad Regional de la Caficultura Colombiana**, en J. J. Echavarría, P. Esguerra, D. McAllister, C. F. Robayo, Misión de Estudios para la Competitividad de la Caficultura en Colombia.
6. Stewart, P., 2014. **The Business Case for the African Coffee Farmer. Can Smallholder Farmers Become Coffee Farmer Entrepreneurs?** AFCA Conference, 2014.
7. Technoserve, 2014. Colombia: A business case for sustainable production. Sustainable Coffee Program, IDH.
8. Lundy, M. 2015. **Production Costs: Evidence from Colombia**. SCAA 2015 Lectures.
9. ICO, 2016. **Assessing the economic sustainability of coffee growing**. Doc ICC, 117-6, 23 pp.
10. Morris K.S, V. Ernesto Mendez & Meryl B. Olson (2013) **'Los meses flacos': seasonal food insecurity in a Salvadoran organic coffee cooperative**. The Journal of Peasant Studies, 40:2, 423-446, DOI: 10.1080/03066150.2013.777708
11. Bongers, G., Fleskens, L., Van de Ven, G., Mukasa, D., Giller, K. E. N., & Van Asten, P. (2015). **Diversity in smallholder farms growing coffee and their use of recommended coffee management practices in Uganda**. Experimental Agriculture, 51(04), 594-614

Annex 2: Definition of Safe and Profitable Agricultural Practice (SPAP®)

Safe and Profitable Agricultural Practices SPAP®

Good Agricultural Practices	SPAP®
Background: Farmers ignore GAP. They need to be trained	Background: Farmers make rational decision. They need to be understood Interactive learning process.
Corresponding extra input (cash and labor) is not well referenced	Corresponding extra input is referenced. Extra Input are Available and Affordable
Extra output has been established in on station controlled trials.	Extra output has been confirmed on farm
Often consider optimal other factors. Fine-tune optimal production curve (Eg fertilization while pruning is optimal)	Holistic / systemic approach (Eg starting point might be an overall low input situation)
Yield is often the very target, regardless of extra profit	Extra yield must turn into extra profit. It needs to be checked
Often expectation of a drastic and quick improvement (Eg: double, triple yield)	Expect reasonable step by step increase of net income.
Supposed to be universal	Relevance depends on farmers business model / local conditions. SPAP are farmer types specific.

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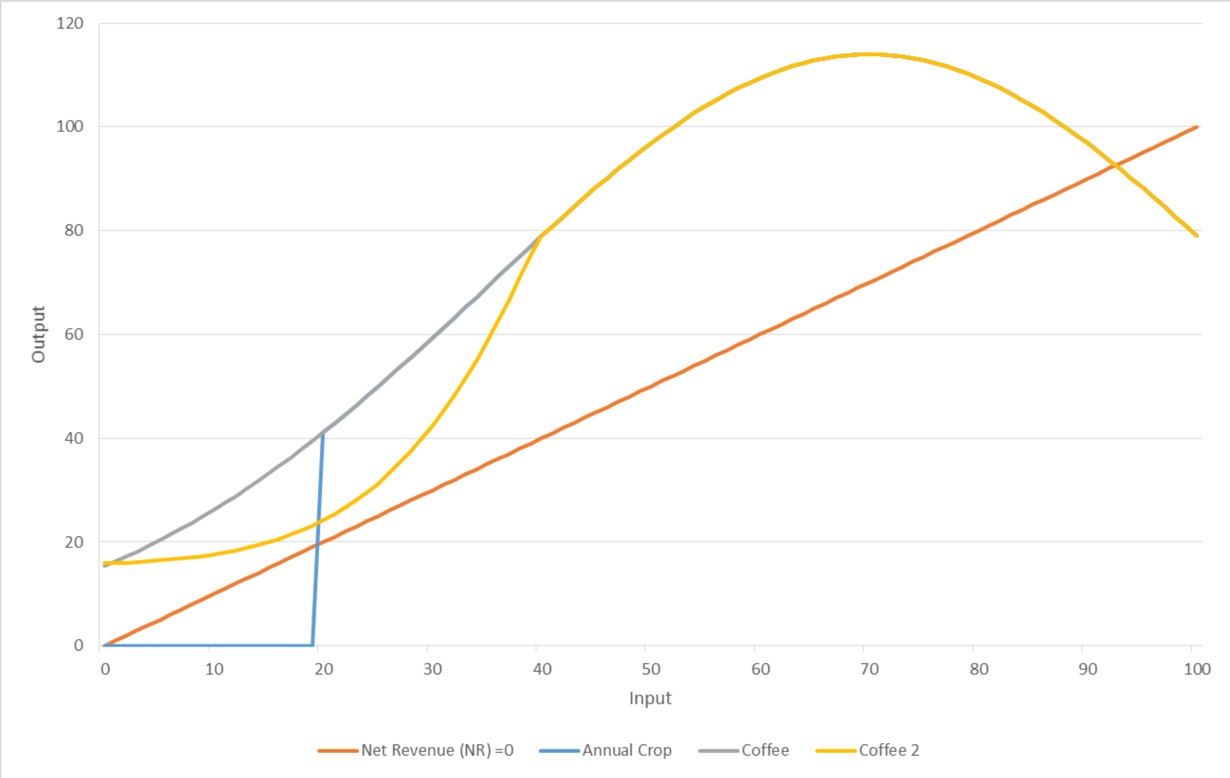
Annex 3: The coffee production curve



- The X axis is the input (e.g. cost) per unit area; the Y axis is the output per unit area.
- In red is the output/input line where net revenue is zero.
- The grey and yellow lines are two hypothesized coffee production curves. (Note that both coffee curves have a positive output even if the input is close to zero; this is because coffee is a tree crop).
- The blue line is a hypothesized annual crop production: If output is zero when input is zero, a given minimum amount of input is required to yield and output.

In this graph, the optimal input for coffee is around 70 for an output of 115; giving a value of 45 in net revenue. This correlates with the high input area of the curve.

For an input ranging from 0 to 30, the grey curve is almost parallel to the NR=0 line. This means that an investment of 0 or 30, a net revenue of 20 is delivered which does not deliver much economic benefit. Only when the investment input passes a threshold of 40 does this start to translate into a net revenue increase.

The yellow curve shows that a producer will need to go through a zone where net revenue is decreasing. This is because extra investment is translated in a decreased net revenue in this area of the curve – illustrating the classic example of a 'poverty' or'low-input trap'.

Currently, nothing is known about the shape of the curve in the low-medium input zone.

6) Glossary of acronyms and terms

Biological Depreciation: This term reflects the fact that coffee trees do not bear fruit forever and need replanting over time.

Coefficient of variation (CV): This term is a measure of relative variability and therefore is the ratio of the standard deviation to the mean average.

Equivalent Daily Wages (EDW): Annualized net income is EDW times the number of coffee working days in a year.

Good Agricultural Practices (GAP): These are voluntary audits that verify that fruits and vegetables are produced, packed, handled, and stored as safely as possible to minimize risks of microbial food safety hazards.

Multi-linear Regression (MLR): A multiple-linear regression is a predictive analysis which is used to explain the relationship between one continuous dependent variable and two or more independent variables.

Net Income: This term is defined as the difference between gross income and costs.
Quadratic Term: A term that contains the variable raised to the power two.

Return of Investment (ROI): A performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments.