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ARTIGO

DO AGROECOLOGY PRACTICES HELP SMALL COFFEE PRODUCERS IN INCOME GENERATION? A CASE STUDY IN MINAS GERAIS

As práticas agroecologicas ajudam os pequenos produtores de café na geração de renda? Um estudo de caso em minas gerais

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ABSTRACT

In this paper, a cost benefit analysis has been developed to compare 14 farms in the East Region of Minas Gerais (Brazil) to analyse whether agroecology can stabilize farmers' incomes in comparison with conventional practices. Three price scenarios have been used in order to consider coffee price fluctuations. The study shows that agroecological farms, on average, have a value of Net Present Value (NPV) twice bigger than conventional farmers (US$ 54,060/ha against US$ 19,034/ha) for the average price scenario. For the low price scenario, the conventional small farmers show negative values of NPV, whereas agroecological producers still show positive results (US$ -9,8975/ha against US$ 20,479/ha). Then, four farms with different level of production diversification were compared. Results show diversification matters in generating income with bad market conditions, underlining the agroecological practices could be beneficial for small farming in the entire region of study.

Keywords: Small Farming, Price volatility, Cost Benefit Analysis, Coffee Price Scenarios.

RESUMO

Neste artigo foi desenvolvida uma análise de custo-benefício comparando 14 fazendas na Região Leste de Minas Gerais para verificar se as práticas agroecologicas podem estabilizar a renda dos agricultores em comparação com as práticas convencionais. Três cenários de preços foram utilizados para considerar as flutuações do preço do café. Além disso, quatro fazendas com diferentes níveis de diversificação de produção foram comparadas. O estudo mostra que as propriedades agroecológicas, em média, têm um Valor Presente Líquido (VPL) duas vezes maior que os agricultores convencionais (US$ 54.060/ha contra US$ 19.034/ha) para o cenário de preço médio. Para o cenário de preço baixo, os pequenos produtores convencionais apresentam valores negativos de NPV, enquanto os produtores agroecológicos ainda apresentam resultados positivos (US$ -9,8975/ha contra US$ 20,479/ha). Os resultados mostram, também, que a diversificação é importante na geração de renda com preços baixos, enfatizando como as práticas agroecológicas podem ser benéficas para a pequena agricultura em toda a região de estudo.

Palavras-Chave: Agricultura Familiar, Volatilidade dos preços, Análise de Custo e Beneficio, Cenários de Preço do Café.

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Introduction

Agriculture in Brazil is mostly based on family farms. The vast majority of Brazilian farms are in form of family households, in fact, according to the last agrarian census, 84% of agricultural properties are managed by small holders and, despite small farming represent the majority of agricultural production, land is still concentrated in the hand of large producers (IBGE, 2006). Family farming represents only 24% of the total agrarian land, but it is very important for both, domestic and international agricultural markets, providing great part of the national food security (IBGE, 2006).

Brazil is the biggest producer and exporter of green coffee beans in the world. On average, from 1990 to 2016, Brazil has produced yearly 38.4 thousand of 60kg bags of green coffee corresponding to 32% of the total world coffee production (ICO, 2016). Minas Gerais (MG) is the Brazilian state with the largest production, providing 51% of the Brazilian coffee production (MAPA, 2015), with a big contribution from small farmers, which represent almost 80% of the agricultural units of the state (IBGE, 2006). The Coffee sector is highly dependent on the value chain phases following the harvest (ICO, 2009; ICO, 2011a), small farmers have low bargaining power which strongly reduces their margin of earnings (ICO, 2011c). They are also totally price takers and extremely vulnerable to the high volatility of coffee prices, which depends on the international financial markets and other external factors which are totally out of their control (ICO, 2004; ICO, 2011b).

In Brazil, despite socioeconomic conditions improved steadily during the last twenty years, most of the rural population is still living in poverty and food insecurity (DE SCHUTTER, 2009). During the last decade, the introduction of vast farmer based policies helped in reducing hunger and extreme poverty in both urban and rural areas, highlighting the importance of small farming as an effective driver of change and social development (ROCHA et al., 2012). Brazilian small farming social movement started to focus on agroecology as an alternative paradigm to green revolution since the 70's, when universities, civil society, NGOs, consumers and farmers' organizations started to coordinate themselves as a whole opposition movement to the industrial commodity export approach not suitable to Brazil rural conditions (PETERSEN et al., 2013; LAMINE et al., 2012). The agroecological movement had grown and spread all over Brazil as an alternative model of agriculture, which could improve both small farmers social condition and natural resources management (WEZEL et al., 2009). Agroecology experienced a dramatic expansion in the country, universities and public agriculture agencies institutionalized it as practical method to achieve sustainability in small farming agriculture, while mass farmers' movement placed agroecology as cornerstone of their strategies (ALTIERI and TOLEDO, 2011). However, agroecology growth did not undermine the importance and power of the green revolution based approach systems, being Brazil one of the most important commodity exporters in the world (PETERSEN et al., 2013).

Agroecologists claim that the use of ecological practices, besides conserving the environment, could help small farmers in reducing costs, improving and diversifying production in order to reduce market risks (ALTIERI, 1991; ALTIERI, 2002). NGOs and significant parts of the scientific community have claimed that agroecology represents a viable method of production in low income areas being not capital intensive and with low initial investments (DE SCHUTTER, 2011). The high adaptability of agroecology for different agroecosystems helped to spread its use in various rural development projects with a lot of interesting and important results in terms of productions, income generation, food security and environmental impact reductions (PRETTY et al., 2006; PRETTY et al., 2008; NELSON et al., 2009). Nevertheless, not many economic studies have been developed to examine the economic effects of agroecological practices for small farming. This study tries to do this, analysing whether agroecology could be a good method for generating income for coffee growers of Minas Gerais East Region. This paper presents an economic comparison achieved through a Cost Benefit Analysis (CBA) among different farms comparing agroecological and conventional systems.

Materials and methods

Study area

This study was carried out between 2012 and 2014 in the East Region of the Brazilian state of Minas Gerais (MG), in the municipalities of Simonesia, São João do Manhuaçu, Conceição de Ipanema, Caratinga and Manhuaçu. A few years ago, some small farmers started to experiment agroecology coffee productions to improve their socioeconomic conditions and reduce the anthropogenic impact on the local environment at the same time. Coffee production is well suited to agroecological practices because coffee was traditionally cultivated under shade with agroforestry systems which ensured complex biodiversity and productive agroecosystem (GLIESSMAN, 2008; MOGUEL and TOLEDO, 1999; PERFECTO et al., 2005). Nevertheless, the majority of farmers in the area, both small and large, carried on producing coffee with conventional practices imported to the region with the green revolution, which is characterized by not using shade coffee plantations with intense use of fertilizers and pesticides.

The agricultural composition of the study area is representative for the whole sector of coffee production in the East Region of MG state, which is characterized by the fundamental activity of the small farmers for the regional rural economies. In the municipalities considered in this study, around 60% of the population is employed in agriculture and the local land tenure is characterized by the predominance of small holdings (under 10 ha) (IBGE, 2010a). In 2010 small family farms were almost 85% of the total productive units, 5.899 units compared to 1.046 of large agricultural producers (IBGE, 2006; IBGE, 2010b). The area is highly dependent on coffee production which is grown in the 99% of the cultivated lands (IBGE, 2006; IBGE, 2010b). In 2010, around 97% of the value of total production in the five municipalities was from coffee value chain, to the amount of 147.81 millions of dollars (260 millions of Reals converted using R$ 1,759/US$ as the yearly average exchange rate in 2010) (OECD, 2018) with a total production of 54 thousand tons of green coffee (IBGE, 2006; IBGE, 2010b). The economy of the five municipalities of this case study rely almost totally on coffee production, establishing a situation of high vulnerability for the vast majority of its population due to the strong volatility of the international coffee price.

Cost Benefit Analysis in agroecological studies

The Cost-Benefit Analysis (CBA) is used, mainly to evaluate the choice of different investments or projects in situation of uncertainty on their payback and effects, it is a tool which allows one to choose the best option of investment in business decisions. CBA has a long history in management and economic studies, both for private and public investments, and since the 30's it has been used also for policy and environmental projects (HANLEY and BARBIER, 2009; PEARCE et al., 2006).

In presence of several choices of projects, a CBA helps in the selection of the most profitable one, which maximizes the value of the investment. CBA works by the comparison of net cash flows (benefits minus costs) generated along a selected time frame, those values are expressed in monetary terms and discounted at present values, a rational decision maker should select the investment with the highest return (PEARCE et al., 2006).

This private sector point of view was extended to the public sector. Welfare economics theories provided information for policy makers to evaluate policies and social investment from a societal point of view (HANLEY and BARBIER, 2009). CBA for environmental project adds estimations of environmental benefits and costs of a project or investment, counting positive and negative externalities (PERMAN et al., 2003). For agroecological studies, this approach would be the most suitable one, in fact these practices involve social and environmental aspects that conventional agricultural paradigm does not. Unfortunately, it is still very difficult to evaluate all the aspects that agroecological practices provide to both, the society and the environment, such as improving working conditions, pollution reductions, carbon storage, water preservation, biodiversity forest and biodiversity conservation (TOMICH et al., 2011). Other studies carried out in Brazil have used CBA to evaluate

different agricultural practices or the different returns of crops, but none of them had considered environmental factors of agricultural activities (CAMPOS DOS SANTOS and DE PAIVA, 2002; DONIZETTE DE OLIVEIRA et al., 2000; RODIGHERI, 1997).

In this study, due to the extreme difficulties in evaluating externalities of agroecology and conventional agriculture, it has been chosen to focus the CBA from a private point of view excluding wider environmental or societal effects. Well aware that agroecology is more than a set of productive techniques, it was chosen to carry out the analysis with the aim of testing the direct effects on income generation of agroecological and conventional practices on various tested farms in situations of high market price volatility.

Materials and Methods

During this study, 14 farms involved in coffee production were analysed in detail to appraise their economic resilience, defining it as their capacity to generate income even with bad market conditions, simulating changes in coffee market price and analysing their economic performances with a CBA. 12 small farms have been assessed with agricultural land of less than 15 hectares, of which 8 used agroecological practices and 4 used conventional practices, a medium size coffee producer with a production area of 30 hectares and a large producer of coffee with a productive area of 180 ha. The definition of an agroecological farm has been assigned to producers who have undertaken agroecological practices in their properties for at least 3 years; such as agroforestry systems, intercropping, no-tillage, integrated pest control, no use of pesticides, reduction of chemical fertilization and crop rotation; while producers categorized as conventional were those using principally monoculture, massive use of chemical inputs and other conventional techniques. For each farm a CBA was made, considering all economic values generated in it, envisioning the agricultural production value of coffee, vegetables and fruit production, livestock breeding, aquaculture, secondary products and forestry products. Those values have been evaluated as to whether or not they were sold on the marketplace using regional, national or local prices to give a real appraisal of the total economic value created in the farm, underlining the importance of self-consumption production for family farming (WOJTKOWSKI, 2008).

Data was collected through direct and in-depth interviews of farmers using a semi structured questionnaire. Each farm was visited before the interview in order to understand its condition by observations. Basing on farmers' declaration, the most relevant economic factors of each property have been extrapolated.

The CBA was conducted with three different coffee prices for each property to estimate the behaviour of each farm with price variation, dividing the economic values obtained as *cash flows* (all benefits minus all costs) by the productive area of each farm (PERMAN et al., 2003). The purpose was comparing the *Net Present Value* (NPV) with different levels of prices for each farm, simulating the present income generation in units of utilized agricultural area (each productive hectare) and observing whether agroecological practices could help the small farmers of the analysed area in stabilizing incomes over price volatility.

The CBA is based on Perman et al., (2003) (Equation 1), with the aim of producing comparable results with other studies on the same issue carried out in Africa and Latin America (CAMPOS DOS SANTOS and DE PAIVA, 2002; DONIZETTE DE OLIVEIRA et al., 2000; REICHUBER and REQUATE, 2012; RODIGHERI, 1997; VIEIRA, 2007).

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+i)^t}$$

Equation 1-Net Present Value Formula (PERMAN, 2003).

Where:

Rt = It is the total value of benefits divided for each productive hectare in the period t. They are determined from direct revenues and values of goods for self-consumption produced in the farm.

Ct = It is the total cost divided for each productive hectare in the period t.
n = It is the lenght of the time frame considered. The total number of period considered was 23 years.
t = Single time period (Year), t= 0,1,2, …,22.
i = It is the discount rate used to have present values of farm *cash flows*. There have been used discount rate of 0.06, 0.08, 0.1 to simulate different investment opportunities.

With the purpose of simplifying the simulation it was supposed that each single farm production would begin from time zero such as each farm would start its production process at t=0. The time frame selected was 23 years in order to appraise 21 years of production, because the first two years following the coffee implantation are unproductive and only on the third year the production starts. This long time frame was selected with the aim of appraising the income generation ability of each farm in the medium-long run (21 productive years).

For the NPV evaluations three discount rates have been used: 0.06, 0.08, and 0.1. This choice was made in order to evaluate the different results over several opportunity costs in terms of different hypothetical alternative investments. The discount rate(*i*) selection is tricky, because *i* is able to influence the CBA results. Indeed, the higher the *i,* the lower the weight of cash flows occurring in the medium and long run periods privileging cash flows of the short periods and vice versa. The choice of *i* used in this study is derived from socio-environmental studies considering the farm activity not only in a business management sense, but focusing on farm economic sustainability and income generation (PERMAN et al., 2003). So it was chosen *i*=0.06 to consider long run income generation, *i*=0.08 to evaluate economic performance in the medium periods and *i*=0.1 to focus on the farms ability to create value in the short term. The CBA considered all costs and revenues generated in the farm, both for coffee and for other productions which have taken place in the farm. All these values were divided as Benefits and Costs.

Benefits

Considering that coffee plantations are unproductive for the first two years following the implantation (t=0 and t=1), the revenues derived from coffee production were counted only from the third period of the time frame (t=2) until the last one (t=22). For each time period greater than the second year (t>1) coffee revenues were evaluated as the average production that occurred in the last five years multiplied by the price selected for the simulation. The average coffee production value of each farm was assessed as the arithmetic mean between the average coffee production of the last five years and the average coffee production declared by the farmer. Because of the high volatility of international coffee price (ICO, 2009) three different levels of price have been used to simulate several market scenarios in order to evaluate the farm's ability to create economic value and to defend income in situation of price fluctuation. The historical data set of "Bebida Dura" quality of 60kg green coffee bags prices quoted in the market of São Paulo have been used. The data used refers to the daily nominal prices net of taxes expressed in Real, (the Brazilian currency), from 03-01-2000 to 29-06-2012 provided by *Centro de Estudos Avançados em Economia Aplicada* (CEPEA) and converted into dollars using the average exchange rates of the same period provided by the Organization for the Economic Cooperation and Development (OECD). To create the different scenarios of prices, the maximum and the minimum price of the time frame above mentioned, respectively US$ 249,96 and US$ 45,69 have been used (R$ 555.19 and R$ 101.48; converted using R$ 2.22 / US$ the average exchange rate in the period 2000-2012) (OECD, 2018), then the medium price US$ 184,73 (R$ 340.57; converted using R$ 1.844/ US$ the average exchange rate in the period 2008-2012) (OECD, 2018) was chosen as the arithmetic average of the last 5 years of the same time frame.

- Scenario 1: NPV in 23 years time frame with average coffee price (US$ 184,73).
- Scenario 2: NPV in 23 years time frame with high coffee price (US$ 249,95).
- Scenario 3: NPV in 23 years time frame with low coffee price (US$ 45,69).

During the whole time frame of the CBA, from t=0, farmer benefits such as the total value of non-cash crop production like fruits, horticulture, forestry goods, animal production and products

grown and processed in the farm such as milk, cheese, honey or other secondary products have been included. Those values have been assessed as the average production declared by farmers multiplied by their average market prices of the last 3 years (from 2010 to 2012) available from public and private agricultural agencies, mostly data provided by Embrapa and the Brazilian Ministry of Agriculture (MAPA) was used. When national data was not available, local market prices surveys using local market data of both Minas Gerais and Local Municipalities (Caratinga, Simonesia and Manhuaçu) provided by Ceasa Minas were used. If data was not available on Ceasa Minas database, prices were collected directly from local markets. For some processed food such as honey, ground coffee and jam, prices were not available, so the selling price declared by the farmer was used. Revenues which occurred cyclically such as animal sales were counted in the specific year when the event happens. For two farms, which at the time of this study some fruit trees were not yet productive, the average fruit productivity has been calculated as the average productivity declared by *todafruta.com.br,* putting these values in the CBA only after the seventh year, which was chosen as the first year of fruit plant productivity.

Costs

Implantation and initial investment costs were counted in t=0. Variable costs related to coffee production in t=0 and t=1 considered only conservation activities, such as fertilization and crop control (pest and disease). Coffee harvesting and manufacturing process costs such as washing, sorting, drying polishing and grain processing (*beneficiamento*) have not been considered in the first two years (t=0 and t=1), while those costs have been counted together with conservation costs in all the periods after the second year (t>1), considering the third year as the beginning of coffee production. During the all CBA time frame, from t=0 to t=22, all costs related to fruit, horticulture and animal production have been considered, also the costs of forestry and processed products were counted in the CBA. Costs which occur cyclically in specific years, such as animal care, coffee pruning or plantation renovation have been considered only in the specific years declared by the farmer.

All costs were evaluated as unit costs multiplied by their amounts. Both for initial investments and variable prices of materials and chemical inputs available in the data base and report of Embrapa, Ceasa-Minas, Conab and MAPA have been used. If prices were not available, prices of local markets gathered directly by the author were used. The workforce costs were calculated as the quantity in man-hours multiplied by US$ 2,34 (R$ 3.92; converted using R$ 1.844/ US$ the annual average exchange rate in 2011) (OECD, 2018) used as opportunity cost of labour based on the hourly minimum wage established by the Brazilian federal law *Lei nº 12.382, de 25 de Fevereiro de 2011* (BRAZIL, 2011).

Results and discussion

CBA results

The CBA results shown that, on average, agroecological practices are able to produce higher economical returns for farmers. On average, considering NPV obtained from each group of farms analysed with *i*=0.06, for each level of price, agroecological producers have obtained remarkable NPV values, much higher than conventional producers (Table 1).

Agroecological farmers, for average price scenario (US$ 184,73/Coffee Bag), obtain US$ 54,060/ha, whereas conventional small farmers obtain US$ 19,034/ha (around 35 thousand dollars less), the big coffee producers obtain US$ 17,615/ha and the medium conventional coffee producers make only US$ 1,323/ha. This differences between NPV are smaller with high level of prices (US$ 249,95/Coffee Bag) where agroecological farmers obtained on average US$ 59,897/ha, whereas conventional farmers respectively obtained US$ 38,224/ha for small farms, US$ 35,327/ha for the medium-size farms and US$ 48,395/ha for the big farms. Conversely in the scenario with low prices, the NPV obtained by the conventional group is negative, US$ -9,8975/ha for small farmers; US$ -37,032/ha for the medium size farm and US$ -16,049/ha for the big farm, whereas the average NPV of

agroecological producers is positive and equal to US$ 17,615/ha. So, it indicates that agroecology practices help farmers in price falls conditions, by stabilizing income specially by products diversification. This highlights that in the evaluated groups of farmers who were using agroecological practices would gain better economic results in the considered time frame independently on the fluctuation of the coffee price. The best three results were obtained by three agroecological farmers which achieved, for the average price scenario, US$ 124,745.61/ha, US$ 114,613.59 /ha and US$ 85,138.35/ha, respectively, as NPV average values.

Table 1- Average NPV for type of farm with different level of coffee prices (Dollars for green coffee bag) and discount rate of 0.06(*i*). The values of NPV are expressed in Dollars on productive hectares (US$/ha).

				Coffee Prices (US$/ Coffee Bag)					
Type of farm	N	Average Cofprod (Bag/ha)	SD	Average (US$ 184,73)	SD	High (US$ 249,95)	SD	Low (US$ 45,69)	SD
Agroecological	8	23.70	17	54,060	47,905	59,897	52,043	20,479	23,418
Conventional (Small)	4	26.84	7	19,034	18,698	38,224	18,992	-9,8975	15,444
Conventional (Medium)	1	33.83	-	1,323	-	35,327	-	-37,032	-
Conventional (Big)	1	24.79	-	17,615	-	48,395	-	-16,049	-

In the scenario with high prices, conventional producers perform better even if agroecological producer obtain higher NPV values. In the low price scenario (US$ 45,69/Coffee Bag) all of the conventional producers suffered high losses with negative average NPV, US$ -9,8975/ha for small farmers; US$ -37,032/ha for the medium size farm and US$ -16,049/ha for the big farm, whereas agroecological farmers have all shown positive NPV and on average equal to US$ 20,479/ha, even if those values are lower than the results obtained in the average and high coffee price scenario (Figure 1). This highlights the high risk of price volatility which coffee producers of East MG region are exposed to. Agroecology practices seem to be useful for small farming coffee production in stabilizing income with high price volatility. Generally, agroecological farmers have shown better results of NPV values. All of them obtained positive results per productive hectare in all scenarios analysed with all discount rates used. The results do not change much with the other discount rates considered (Table 2), indeed NPV with *i*=0.08 and *i*=0.1 mark similar trends of *i*=0.06 with the only difference that amount of NPV are smaller and declining the higher the value of *i* is, in line with CBA literature (PERMAN et al., 2003). These results highlight that agroecology practices in this case study are cost-effective, considering all the alternative investments.

The analysis results have shown that, for the tested farms, the total income created in 23 years in terms of present value is higher for those who practice agroecology than for those who use conventional coffee production techniques. It occurs, mostly, for medium and low price scenarios and in all the three discount rates used, while in the scenario with high prices also conventional techniques appear to be cost-effective. Looking at the results with different values of discount rate, agroecology practices seem to be cost-effective as income generator in each weighted time period choice, short term (*i*=0.1), medium term (*i*=0.08) and long term (*i*=0.06).

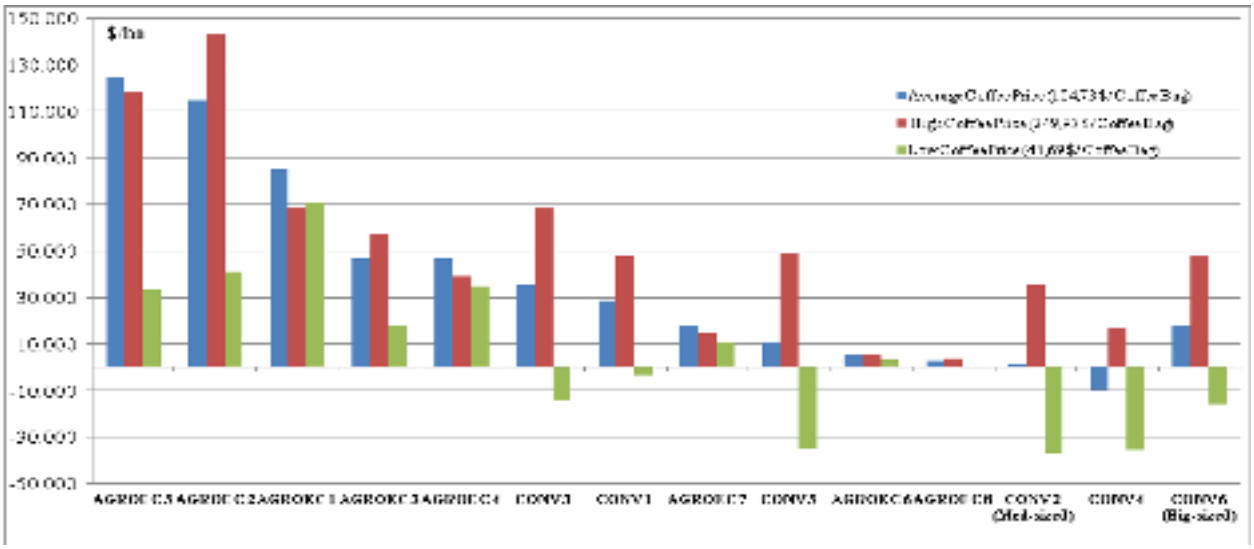

Figure 1- NPV of each farm with different coffee price scenarios: average, high and low. The discount rate is 0.06, the values are expressed in Dollars per productive hectare (US$/ha).

Agroecology practices help in reducing production and crop control costs compared to conventional agriculture practices, especially in regards to diminishing costs from external inputs, such as pesticide, fertilizers, machines and workforce. Coffee yields for agroecological farming are less than conventional ones, but the CBA shows that what it is gained from reducing costs with agroecology is higher than what it is gained with the high productivity related to conventional practices. The highest NPV values are obtained by agroecological farmers (Agroec 5, Agroec 2, Agroec 1) who reduce costs by diversifying revenues and not depending on only cash crop productions, but by producing other goods such as livestock, vegetables, fruits, forest goods and processed products. Agroecological farmers who showed the worst results are located in marginal areas where coffee productivity is difficult. The best NPV obtained by a conventional producer (Conv 3) depends mostly on his high knowledge on chemical products use. Other conventional producers spend a big part of their revenues in workforce and chemical inputs for crops control, one of them (Conv 4) shows positive NPV only with high price levels (Table 2).

Table 2- NPV with different discount rate for the scenario with average coffee price (US$ 184,73/Coffee Bag). Values are expressed in Dollars per productive hectares (US$/ha).

	Discount Rate (r)		
	0.06	0.08	0.1
Agroec 5	124,745.61	78,622.69	65,968.78
Agroec 2	114,613.59	58,922.89	49,908.01
Agroec 1	85,138.35	86,353.69	73,153.10
Agroec 3	46,765.64	31,347.74	25,674.38
Agroec 4	46,655.88	23,339.45	27,640.70
Conv 3	35,492.04	32,459.63	18,681.12
Conv 1	28,404.74	19,030.83	15,560.89
Agroec 7	18,008.86	12,425.12	8,379.44
Conv 5	10,751.69	5,996.61	3,791.49
Agroec 6	5,057.03	3,525.49	3,007.30
Agroec 8	2,662.81	1,941.96	1,732.85
Conv 2 (Med-Sized)	1,323.38	-568.94	-1,805.91
Conv 4	-9,675.66	-7,395.74	-6,887.23
Conv 6 (Big-Sized)	17,615.36	11,058.99	8,358.63

Land use optimization and products diversification

The results of the CBA have shown that NPV are on average higher for small farmers than for the medium and the big coffee producer. All values of NPV for small farms are higher than the medium-size and large coffee producers for the all scenarios considered apart for Agroec 6, Agroec 7, Agroec 8, Conv 4 and Conv 5, which did not have low NPV values. On average, small agroecological farms have 5.9 ha of productive land and conventional small farms on average have 7.4 ha, while the medium-size farm and the big farm have, respectively, 30 ha and 180 ha of productive area. In this case study the values of NPV suggests that small farming, either with agroecology or conventional practices, seem to be more efficient in land use than extensive and industrial farming. This does not mean that extensive productions are not profitable, but that, at the level of unit of production, small farmers maximize their limited resources and land areas. Agroecology seems to help even more in this cost-effective use of land with resources constraints. One of the most important results of this study is in regards to the low price scenario, where the CBA showed that agroecological farms obtain positive NPV even with low price levels, while conventional farms loose economic value. This result underline the importance of the use of Agroecology in stabilizing incomes even with price downfalls. The coffee price volatility is one of the biggest risks which affects local farmers, the greater the farm dependent on coffee production is, the greater will be the risk of losing income if prices fall. Farmers who used agroecological practices showed higher diversified production than conventional coffee monocultures.

In order to focus on the effects of product diversification on income generation, the NPV value prices of four farms with different levels of products diversification have been assessed and compared. The change in income generation for each price scenario (Low, Average and High price) was observed.

The level of diversification chosen of each farm depends on the percentage of income created by each type production: A - coffee; B - horticulture, fruits and livestock; C - processed products; D - arboreal products.

The farms chosen were:

- Agroec 1: agroecology farm with high level of diversification (A 17%, B 63%, C 13%, D 7%);
- Agroec 2: agroecology farm with good coffee production but low level of diversification (A 60%, B 37%, C 3%, D 0%);
- Agroec 3: agroecology farm with high dependence on coffee production and very low level of diversification (A 78%, B 9%, C 12%, D 1%);
- Conv 3: small conventional farm with monoculture coffee production and good knowledge of conventional practices techniques (A 100%, B 0%, C 0%, D 0%).

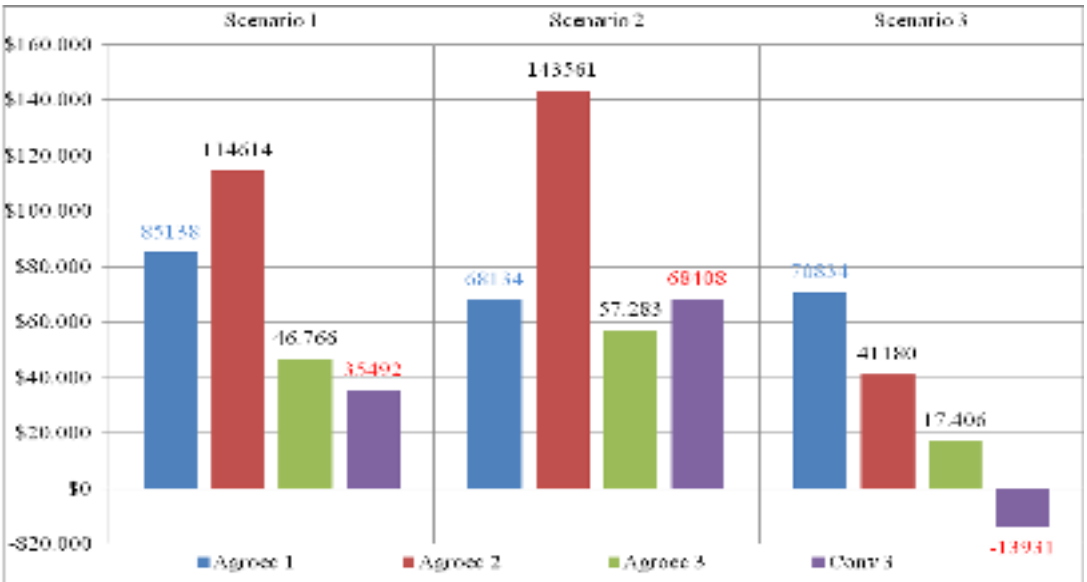

Figure 2- Comparison of four NPV in dollars per productive hectares (US$/ha) of small farmers with different level of production diversification in the three scenarios of coffee prices medium, high and low.

The results of the comparison indicate that the farm which generates the most stable level of economic value in all three scenarios of prices is that with the highest level of production diversification, while the NPV of the other three depends highly on coffee price with high differences in NPV for each scenario. The higher the diversification is, the more stable the farmer income is. The only farm subjected to losses in the scenario of price downfall is the conventional farm, while all agroecological farms generate income also in this situation (Figure 2).

Results of NPV point out that agroecology and product diversification give more profitability for small farmers with low availability of land, stabilizing income and reducing dependence on coffee production. Agroecology and diversification allows farms to improve economic resilience against external shocks, stabilizing income independently on coffee price volatility. Diversification reduces the dependence of farmers' income on coffee and the farm vulnerability on price fluctuations, stabilizing income in the medium-long term. Conversely, product diversification through agroecology provide a higher variety of food grown in the farm, both can be sold in the local market, for income diversification, and for self-consumption. So food production diversification improves local food security and acts for small farmers like a risk protection against adverse price fluctuation.

Conclusions

In spite of the relative limited number of assessed farms, the results of this study highlight that agroecology could represents a good alternative to conventional agriculture in small farming coffee production for East MG Region. The results of the CBA have pointed out that small farmers use land in a more efficient way than bigger coffee producers and that the use of agroecological practices improve economic results for each hectare of productive land. The CBA results also pointed out that agroecology helps income generation with coffee price volatility giving positive returns even with price downfalls. The main benefits of agroecology derive from cost reductions and product diversifications. Agroecology is suitable and convenient for regional small coffee producers of the region, other economics studies would be important to raise awareness on agroecology as a tool for sustainable development for Brazilian rural areas. Further similar studies should include also environmental and social aspects, considering to gather quantitative and qualitative methods in order to give a better understanding the benefits of agroecology.

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