# Supplementary Materials

# Measurements of analysis divided by the sustainability dimensions

## Economic dimension

* The *productive area UAA (ha)* is represented by the coffee area, other productive area and pasture area; in addition, there are data for the forestry area but not the productive area. The latter was considered the area of the farm not used for productive or environmental purposes, such as fallow or uncultivated lands and residential or storage facility areas.
* The *productivity* of coffee farms is measured by the coffee average yields per UAA: it is the number of green coffee bags of 60 kg/ha of UAA cultivated with coffee (cf., Zinck et al. 2004). The average coffee yield of each farm was assessed as the arithmetic mean between the average coffee productivity obtained between 2008 and 2012 and the average coffee production declared by the farmer.
* *Total Revenues* (TR) represents the total average earnings of each farm generated from agricultural activities in Reals (i.e., Brazilian currency, hereafter R$) in a regular season. Total revenues are the sum of the revenue of coffee; revenue of secondary products (from horticulture, fruit growing, and animals breeding); revenue of processed products; and revenue of forest products. TR are the average monetary revenue from agricultural activities in R$ over the last 5 years of activity considering all the productive areas of the farm divided as follows: Coffee, secondary products (horticulture, fruits, and animals breeding), processed products and forestry products. The equation is given by:

 [1]

Where

Pc=average net daily coffee price of a bag of Bebida Dura quality traded at the São Paulo marketplace in nominal values from 01-01-2008 to 29 -06 -2012 (Data source: Cepea/Esalq 2012)

Qc= average coffee quantity produced between 2008 and 2012 of 60 kg green coffee bags

Ps= average market price of each secondary product in the local market of Caratinga, Belo Horizonte, Conceiçao de Ipanema e Uberlandia from 2010 to 2012 (Data source: CeasaMinas 2012; pecuaria.com 2012; Cepea/Esalq 2012; Conab 2012)

Qs= average production of horticulture, fruits and livestock

Ppp= average price of processed products (Conab, 2012); if the prices of specific products were not available (honey of native bees, roasted coffee, chicks, plants and green pesticides), the values were based on local market prices and declarations of the interviewees

Qpp=average quantity of processed goods usually produced by the farm; the value of raw materials used for processing was not double counted and was inserted only in this category of revenue

Pf= average prices of forestry products (Data source: CIFLlorestas 2012; Ematers–MG 2012)

Qf = quantity eucalyptus extracted for selling or self-consumption or wood for burnings and heating in m3

* *Total Costs* (TC) in R$ are the total average expenditures occurring in a farm during a regular agricultural season. Data source: Conab (2012). TC are the total average expenditures that usually occur on average in the coffee farm during an agricultural season of normal activity (values are expressed in R$). TC were divided among productive areas as for TR (Total revenues); for each area, all the costs related to materials, pesticides, fertilizers, animal care and feeding were assessed. Official data were available only for pesticides and fertilizers using the Conab (2012) database; for other costs, the value declared by the farmers was used. For every productive area, the costs related to labour were assessed for each activity of the farm in terms of the total hours of labour, considering both external salaried jobs and not-salaried family work. The cost of labour was evaluated using the minimum hourly salary of 3,925 R$ per hour as established by the Brazilian labour law as the opportunity cost of work for family work (Presidência da República Brasileira 2011).
* *Profit per UAA* for single area (PPA) is the difference between the (Ri) and costs (Ci) of each productive area *i* per ha of UAA: PPAi = (Ri – Ci)/UAAi (with *i*= coffee, secondary products, breeding and forest). The quantities, prices and assessment of costs used in the estimation of PPA are the same used for TR and TC.
* *Profit per UAA* for each single productive area (cash crop, secondary products, breeding and forestry) represents the profitability of each productive area consideringall the revenues and all costs strictly related to it for each UAA in R$/ha.
* *Income generation* is measured according to the agricultural net income (ANI) per UAA for a rural smallholder. It is: (TR-TC)/UAA in R$/ha (cf., Beuchelt and Zeller 2011).
* *Income stabilization* is measured considering the Net Present Value (NPV) in R$/ha over 23 years of coffee production[[1]](#footnote-1) (cf., Perman et al. 2003).

 [2]

Where:

C1=starting costs

C2=TC- (costs of picking and processing of coffee, e.g., washing, drying, sorting, polishing and other processes).

TC = Total cost from t=3 onwards

i= discount rate = 0.06

The rate i=6 percent is used to balance all the annual cash flows over the long run (cf., Pearce et al., 2006; Perman et al. 2003). The data used for the NPV were from assessments of the future economic value of income for each farm based on the projections of the average data of the revenues and costs collected and related to the current situation of the farm at the time of the study. NPV analysis could be used roughly as an assessment of agricultural income creation in the farm if all the current farm conditions were replicated over the time frame analysed. NPV analysis is an estimation of the future flow of income in terms of the present values (using the discount rate *i*) of the net cash flows generated in the farm considering that the farm production condition would last over time under the same conditions. NPV analysis could be considered unrealistic, but for the comparison of the agricultural income generated in the absence of accountancy data, this method is satisfactory. For a better explanation of the methods used, see Pronti (2018). To assess the positive gains of smallholder farms, this study hypothesizes three scenarios:

* *Pessimistic.* Income generation over time with an assumed low coffee price: from 03 January 2000 to 29 June 2012 equal to 101.48 R$ per coffee bag (Cepea/Esalq 2012). This scenario indicates market turbulence.
* *Optimistic.* Income generation over time with a high coffee price: from 03 January 2000 to 29 June 2012 equal to 555.19 R$ per coffee bag. This scenario indicates market growth.
* *Regular.* Income generation over time with the average coffee price from 01 January 2008 to 29 June 2012. This scenario indicates a steady-state market.

## Social dimension

* *Return to labour* is the total revenue in R$ per hour worked (hw);whereas *return to land* is the total revenue in R$ divided by hectares of UAA.
* *Labour Intensity* *per UAA* (hw/ha) is the total time spent on the farm by the family; the lower this value is, the less time there is for leisure or other economic activities for the external income of the family.
* *Revenues diversification* (RD) indicates how income is generated from different sources. RD is calculated as the percentage of the revenues of each productive area (Ri, i= coffee, secondary productions, processed products and forest) of the total revenue (TR). Hence, RD=Ri/TR, which is considered the diversification of smallholder farms’ income; in this area, RD has an important social aspect because farmers mainly rely on coffee production and are dependent on coffee value chains and international market prices. In recent times, this complete economic dependency on coffee has brought poverty to many rural families.

## Environmental dimension

* *Agrobiodiversity* (AgrBioDiv) is the total quantity of different species (and varieties) of vegetables and animals grown or bred on the farm for productive aims (cf., Clergue et al., 2005). AgrBioDiv measures the level of production diversification of the farm and its level of resilience over market price volatility due to exogenous factors and seasonality shocks (cf., Fabusoro et al., 2010; Bottazzi et al. 2014). *AgrBioDiv* is the sum of total plant, tree and animal species cultivated and bred for production purposes; all species were counted independently according to their total quantity of production. Biodiversity of trees has been separated from that of vegetables to divide the biodiversity of the agroforestry systems on the farm and the biodiversity of crops and other plant varieties.

The equation is:

 [3]

Species were counted separately among plants (AgrBioVeg=agrobiodiversity vegetables), trees (AgrBioTree=agrobiodiversity trees) and animals (AgrBioAni agrobiodiversity animals); a single variety used in a specific farm was counted as an additional variety (cf., Bottazzi et al. 2014).

* *Use of pesticides per UAA[[2]](#footnote-2)* is an indirect evaluation measure of the anthropic external impact on the environment and health due to the use of synthetic pesticides (cf., Girardin et al., 1999). This factor is the sum of the total average quantity of pesticides in kg/ha used by a farmer per each hectare of UAA. The principal pesticides used were antiparasitics, fungicides and herbicides commonly used in the area.
* *Use of fertilizers per UAA*[[3]](#footnote-3) indicates the quantity in kg/ha of synthetic fertilizers used for agricultural activities for each hectare of UAA. The principal fertilizers used were NPK (nitrogen N, phosphorus P and potassium K), additional micronutrients and leaf fertilizers.
* *Use of soil correctors per UAA* indicates the quantity of materials used to correct the acidity of soil in kg per hectare of UAA.
* *Percentage of forestry area of the total area* is a measure of the natural resources conservation for each analysed farm. This factor is the percentage of the total area of forest present on the farm relative to the total area. The forest conservation area is used as an indicator of natural resources management for comparing agroecological and conventional practices and is computed as the percentage of natural forest area present in the farm over the total area of the property. The areas of agroforestry, silviculture and fruit trees are not considered part of the forest area.

**References**

Beuchelt, T. D., and Zeller, M. 2011. Profits and poverty: Certification’s troubled Link for Nicaragua’s organic and Fairtrade coffee producers. Ecological Economics 70(7):1316–1324.

Bottazzi, P., Reyes-García, V., Crespo, D., Marthez-Stiefel, S. L., Galvarro, H. S., Jacobi, J., Clavijo, M., and Rist, S.2014. Productive Diversification and Sustainable Use of Complex Social-Ecological Systems: A Comparative Study of Indigenous and Settler Communities in the Bolivian Amazon. Agroecology and Sustainable Food Systems 38(2):137-164.

Ceasa Minas. 2012. Centrais de Abastecimento de Minas Gerais S.A. CEASAMINAS www.ceasaminas.gov.br (accessed December 5,2017).

Cepea/Esalq. 2012. Centro de Estudos Avançados em Economia Aplicada, Departamento de Economia, Administração e Sociologia (CEPEA), Escola Superior de Agricultura Luiz de Queiroz (ESALQ), Universidade de São Paulo(USP). https://cepea.org.br/br (accessed December 3,2017).

CIFLlorestas. 2012. Centro de Inteligência em Florestas (CIFLORESTAS). http://www.ciflorestas.com.br (accessed on December 15,2017).

Clergue B., Amiaud, B., Pervanchon, F., Lasserre-Joulin, F. and Plantureux, S. 2005. Biodiversity: function and assessment in agricultural areas. A review. Agronomy for Sustainable Development 25:1-15.

Conab. 2012. Companhia Nacional de Abastecimento. www.conab.gov.br (accessed December 14,2017)

Emater 2012. Empresa de Assistência Técnica e Extensão Rural do Estado de Minas Gerais Emater–MG. http://emater.mg.gov.br (accessed December 5,2017).

Fabusoro E., Omotayo, A. M., Apantaku, S. O. and Okuneye, P. A. 2010. Forms and Determinants of Rural Livelihoods Diversification in Ogun State, Nigeria. Journal of Sustainable Agriculture 34:417–438.

Girardin P., Bockstaller, C. and Van der Werf, H.1999. Indicators: Tools to Evaluate the Environmental Impacts of Farming Systems. Journal of Sustainable Agriculture 13(4):5-21.

Pearce D., G. Atkinson, and S. Mourato 2006. Cost-Benefit Analysis and the Environment. Recent Developments. Paris, France: OECD Publishing.

Pecuaria.com. 2012. www.pecuaria.com.br (accessed December 8,2017).

Perman R., Ma, Y., Mc-Gilvray, J. and Common, M. 2003. Natural resource and Environmental Economics. Harlow, ES, United Kingdom: Pearson Education Limited.

Presidência da República Brasileira. 2011. Lei Nº 12.382, De 25 De Fevereiro De 2011. http://www.planalto.gov.br/ccivil\_03/\_Ato2011-2014/2011/Lei/L12382.htm (accessed December 20,2017).

Presidência da República Brasileira. 2012. Lei Nº 12.651, De 25 De Maio De 2012. http://www.planalto.gov.br/ccivil\_03/\_Ato2011-2014/2012/Lei/L12651.htm (accessed January 9,2018).

Pronti, A. 2018. Do agroecology practices help small coffee producers in income generation? A case study in minas gerais, Revista Brasileira de Agroecologia,13(3):48-59.

Zinck, J. A., Berroteràn, J. L., Farshad, A., Moameni, A., Wokabi, S. and Van Ranst, E. 2004. Approaches to Assessing Sustainable Agriculture. Journal of Sustainable Agriculture 23(4):87-109.

1. A period of 23 years was chosen to assess the NPV over the long term (coffee is productive for 20 years, whereas for the first three years after planting, coffee is not productive). [↑](#footnote-ref-1)
2. The use of pesticides, fertilizers and soil correctors per UAA are simple indicators used to analyse potential negative externalities due to the use of chemical and synthetic agricultural inputs on ecosystem and human health (cf., Girardin et al., 1999). The real impacts soil and air pollution, contamination and eutrophication of water, biodiversity reduction and human diseases caused by chemical inputs were not directly estimated. Pesticides are measured as the average quantity in kg/ha of chemical pesticides per UAA. [↑](#footnote-ref-2)
3. Quantity in kg/ha of chemical fertilizers used per UAA and quantity in kg/ha of soil correctors per UAA provide an indirect evaluation of potential negative effects on the environment. [↑](#footnote-ref-3)