Greenhouse gas emissions mitigation in more sustainable agroecosystems in Cerrado

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Introduction

The challenge to produce food and fiber in quantity and quality to sustain the population in the next decades is intimately associated to the need for sustainable agroecosystems (Power, 2010; Strassburg, 2014). 'Business as usual' agriculture is the land use dedicated to the production of commodities like grain (soya and corn) and meat that receives government incentives and relies on nonrenewable resources as land, fertilizers, genetically modified and/or certified seeds and fossil resources (Buller, 2016). On the other hand, the core of sustainable agriculture is the ability to recycle materials and to use more efficiently nonrenewable and renewable resources including the provision of ecosystem services as biodiversity, carbon sink and water production (Power, 2010). The transition from business as usual to a more sustainable agriculture is closely adhered to the reestablishment of ecosystem services by integrated crop-livestock-forestry (Buller et al., 2015) and agroforestry systems to produce high-quality food (Buller, 2016). In this work, we show that the transition to more sustainable rural production can mitigate greenhouse gas (GHG) emissions by agroecosystems without compromising revenues, particularly in the Cerrado region.

Material and Methods

GHG fluxes for sinks and sources were derived for enteric CH_4 and excreta livestock N_2O (Dong et al., 2006; World Bank, 2010), median soils CO_2, CH_4, and N_2O fluxes in integrated agroecosystems (Buller et al., 2015), pasture CO_2 fluxes and soil C fixation (Watanabe and Ortega, 2014), and C uptake of Cerrado forest (Meirelles and Henriques, 1992). Data are expressed in Mg CO_2-eq/hectare/year according to GWP values (AR5-IPCC, 2013). Four levels of agricultural development were considered to a small farm with a productive area of 22.4 hectares: 1) agriculture with high technology in integrated swine-crop-pasture- eucalyptus system (ISCPE) in which about 10 heads/hectare is allowed in pasture-forestry fertigated with biodigester effluent (Buller et al. (2015); 2) ISCPE + 10% SA (Sustainable Agroecosystems providing more diversified food as milk, fruits/nuts, honey, and ecosystem services, where native reforestation and nutrient recycling technologies are adopted as shown in Buller (2016); 3) ISCPE + 30% SA; and 4) ISCPE + 50% SA. The ISCPE considers only 5% area of native forest (Buller, 2016), whereas ISCPE + SA scenarios assume 10%, 30% and 50%, respectively, of reforestation area to include the production of honey and fruits/nuts e.g. pequi *(Caryocar brasiliense*), gabiroba (*Campomanesia sp*), jatobá (*Hymenaea L.*) and cumbarú (*Dpterix alata*). The changes in farm economy translated into sale returns, food energetics, net emissions and profitability, all expressed per hectare, are presented in Table 1, considering mature or well-developed agroecosystems ISCPE and ISCPE + SA.

Results and Conclusions

Figure 1 shows the comparison of sinks and sources strength for ISCPE toward to a ISCPE + SA by adding native forest for natural food production. Nutrient recycling technologies and native forestry recovery in SA are responsible for reduced GHG emissions and for a favorable impact in the net emissions. The relative balance for each system indicate an increase in GHG emissions mitigation along the recovery of the native vegetation, and a decrease in net emissions while including more SA (Table 1). Gradual transition from ISCPE to ISCPE + SA 10% or 30% fits the commitment assumed at COP 21 by fixing the mitigation of GHG emissions respectively in 33 or 66%. Moreover, the native tree species are sources of new production outputs (fruits/nuts and honey) that, in a gradual timeframe related to the trees growth and life cycle maintain farmers' incomes and allow the participation in the very volatile commodities markets (Buller, 2016).

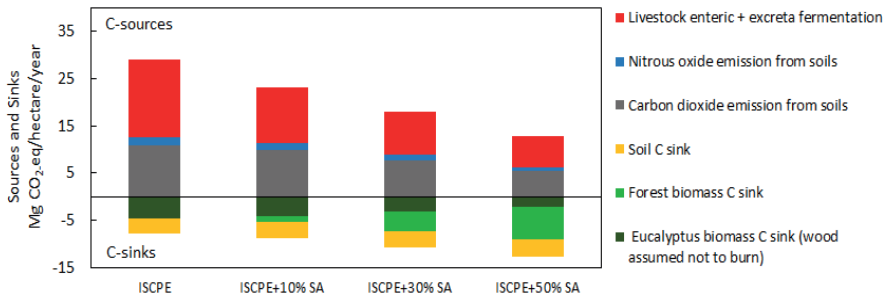

Figure 1. Relative C sources and sinks for different sustainability levels of agroecosystems.

Table 1 presents the calculations of sales, food energetics, net emissions and profitability per hectare for each agroecosystem under analysis. It is clear that the changes from ISCPE to ISCPE + SA do not change significantly farm sales and profitability. Moreover, including SA mitigates net C emissions and recovers vital ecosystem services at the farm level with the production of less energetic but healthier food.

Table 1. Changes in farm sales, food energetics, net emissions and profitability.

	ISCPE	ISCPE+ 10% SA	ISCPE+ 30% SA	ISCPE+ 50% SA
Total sales (USD/hectare)	46962	45856	46682	45365
Food energetics (Gcal/hectare)Net	104.6	99.2	87.0	73.8
emissions (Mg CO_2-eq/hectare)	21.42	14.41	7.20	0.23
Profitability per hectare (%)	51%	54%	61%	67%

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