Impact of management practices in the gas emission of sugarcane areas of São Paulo state, in Brazil

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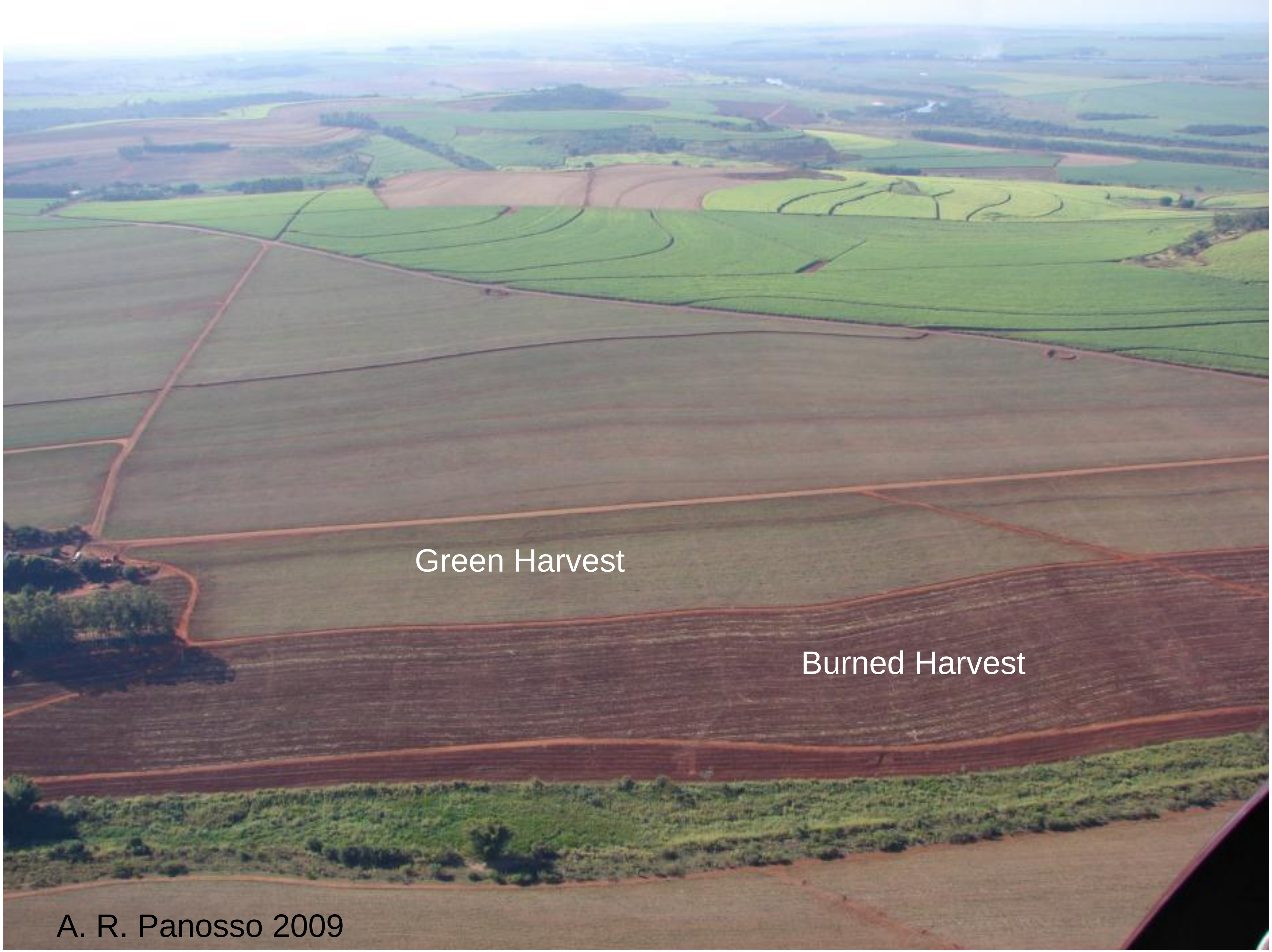
May - 2014


Green Harvest
Burned Harvest
A. R. Panosso 2009

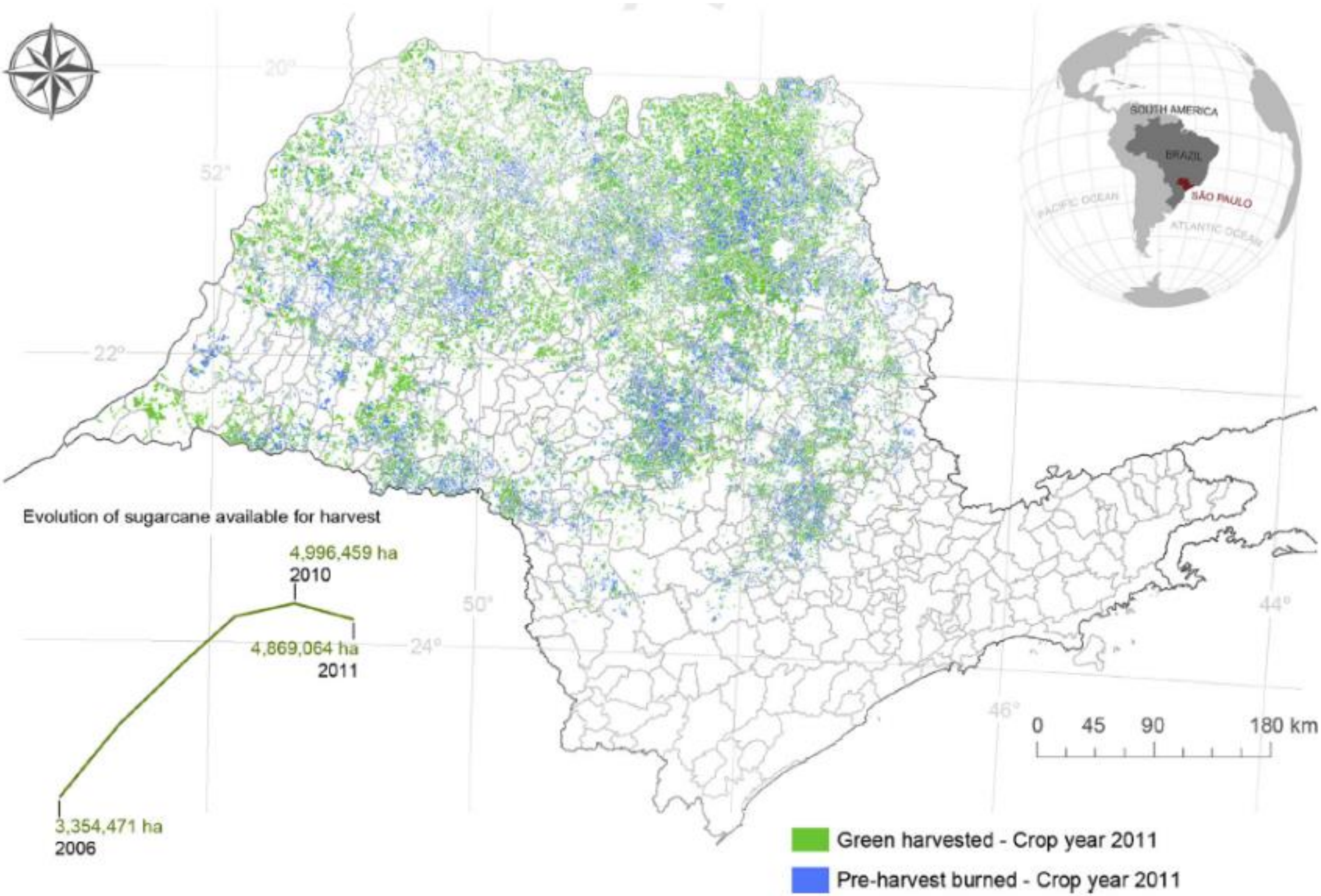


Fig. 1 – Map of the sugarcane areas harvested with and without the burning practice in São Paulo State – 2011 harvest season, and evolution of the total area available for sugarcane harvest in the past six years (Source: www.dsr.inpe.br/laf/canasat).

Bordonal et al. 2013

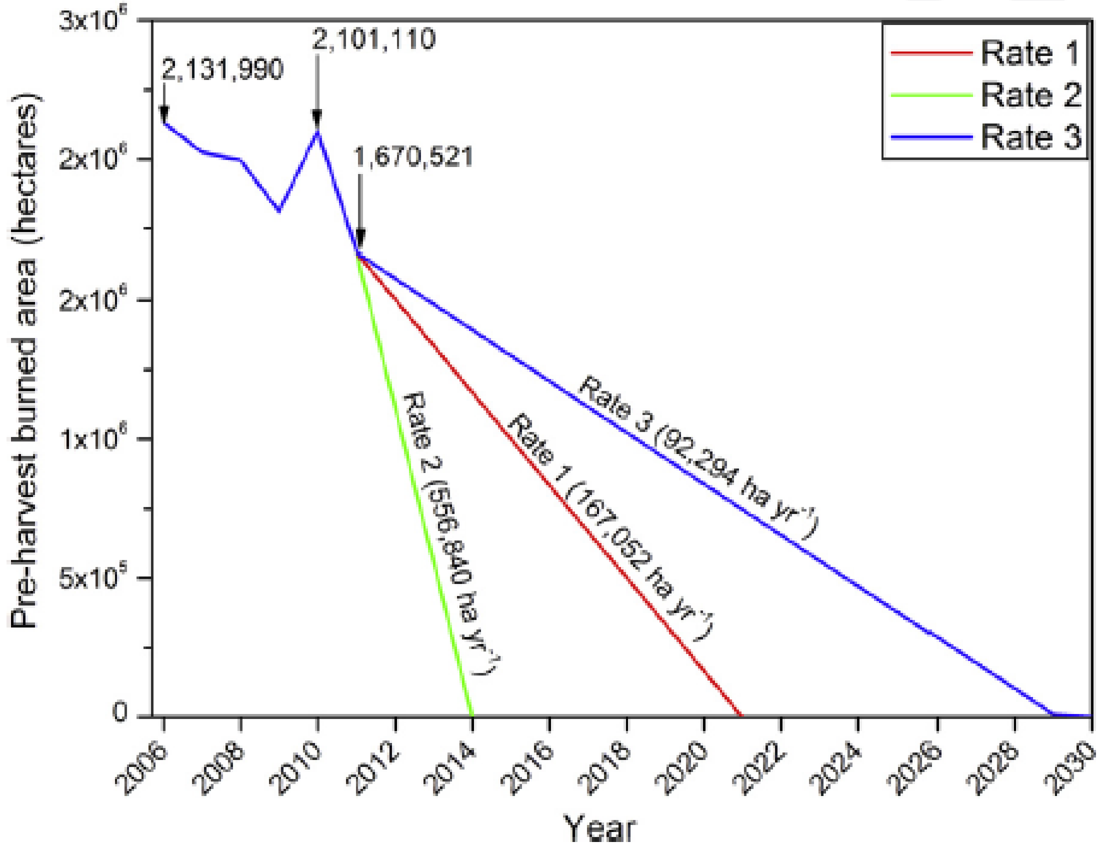


Fig. 2 – Harvest conversion rates proposed in this study according with State Law (rate 1 – red line, total conversion until 2021), Protocol (rate 2 – green line, total conversion until 2014) and real observed (rate 3 – blue line, total conversion until 2029) due to the conversion of remaining sugarcane areas harvested with burning (2011 harvest season – 1,670,521 ha) in São Paulo State, Brazil. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Bordonal et al. 2013

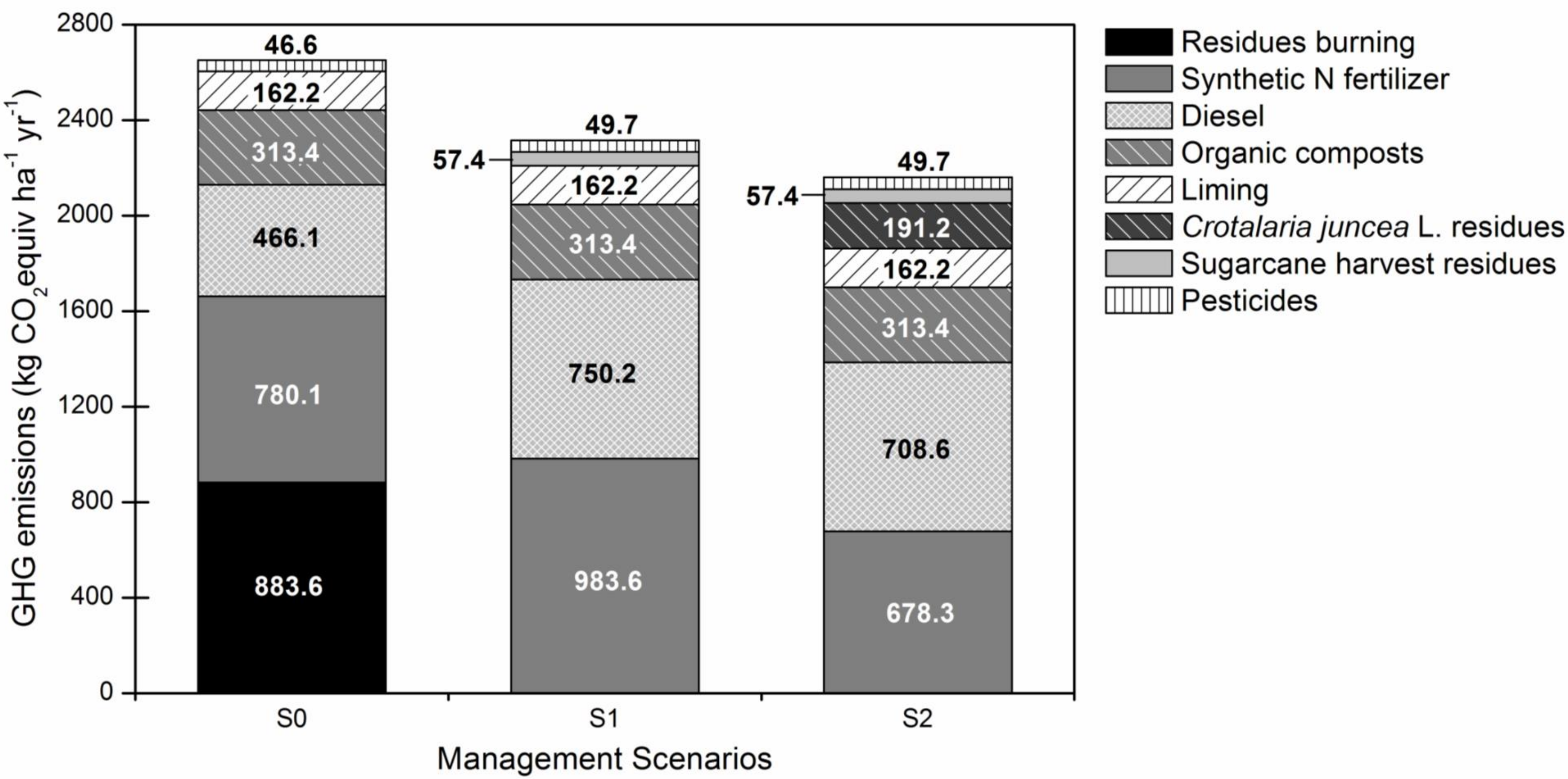


Fig. 3. Emissions of greenhouse gases (in kg CO_2eq ha^{-1} year^{-1}) due to sugarcane agricultural production in São Paulo State, considering a crop cycle of 6 years for management scenarios S0 (burning harvest that uses conventional soil tillage during sugarcane field renovation), S1 (green harvest that uses conventional soil tillage during sugarcane field renovation) and S2 (green harvest that uses reduced soil tillage plus crop rotation, during renovation, with *Crotalaria juncea* L.).

R. O. Bordonal et al. 2013

60%: Acúmulo C no solo

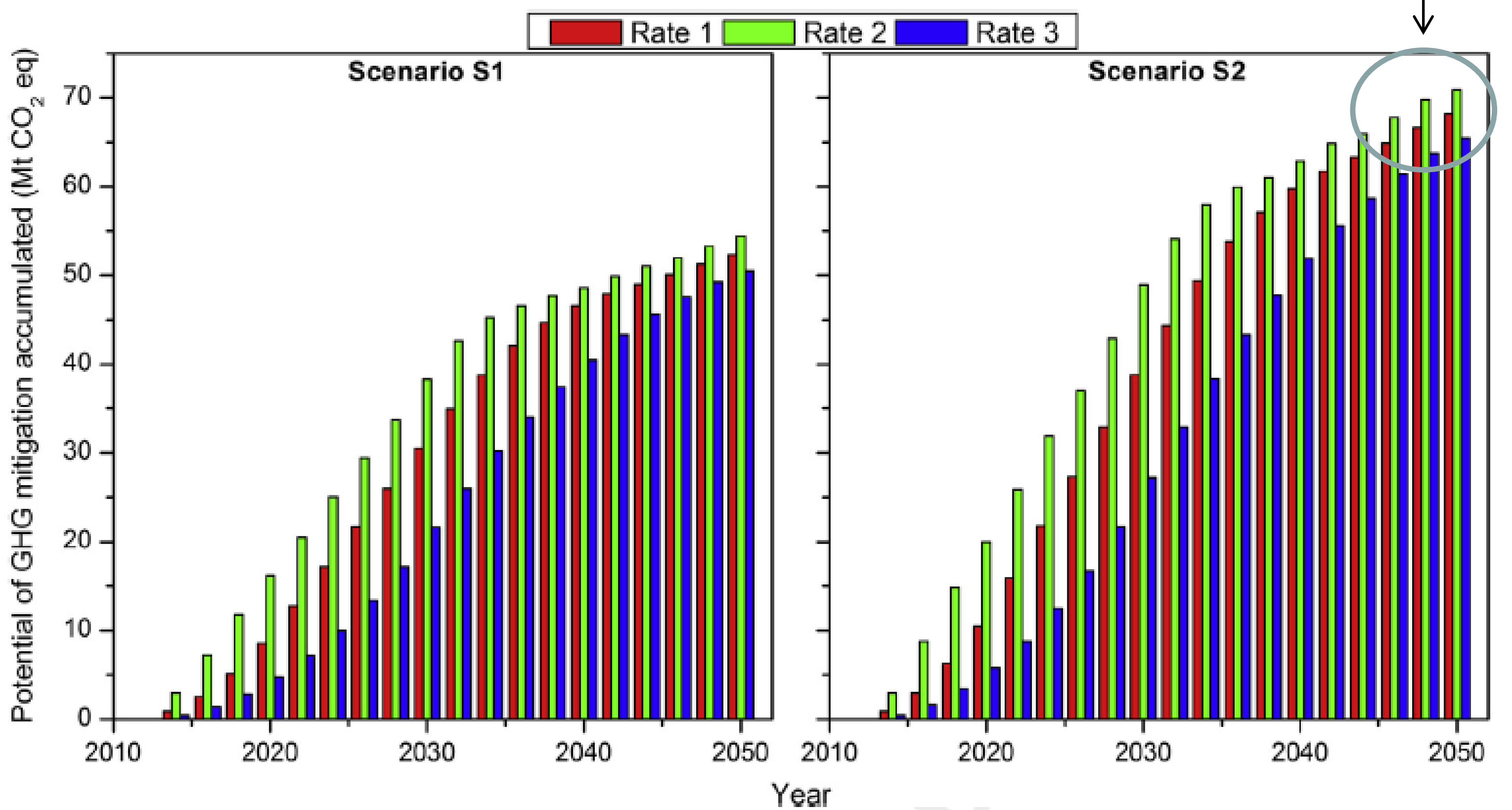


Fig. 5 – Avoided greenhouse gas emissions (in Mton CO_2equivalent) from 2012 to 2050 due to the conversion of remaining sugarcane areas harvested with burning (2011 harvest season – 1,670,521 ha) to green harvest scenarios in São Paulo State – Brazil, S1 (conventional soil tillage) or S2 (reduced soil tillage and crop rotation), based on three conversion rates (red bar based on State Law – rate 1; green bar based on Protocol – rate 2; and blue bar based on real data observed – rate 3). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Bordonal et al. 2013

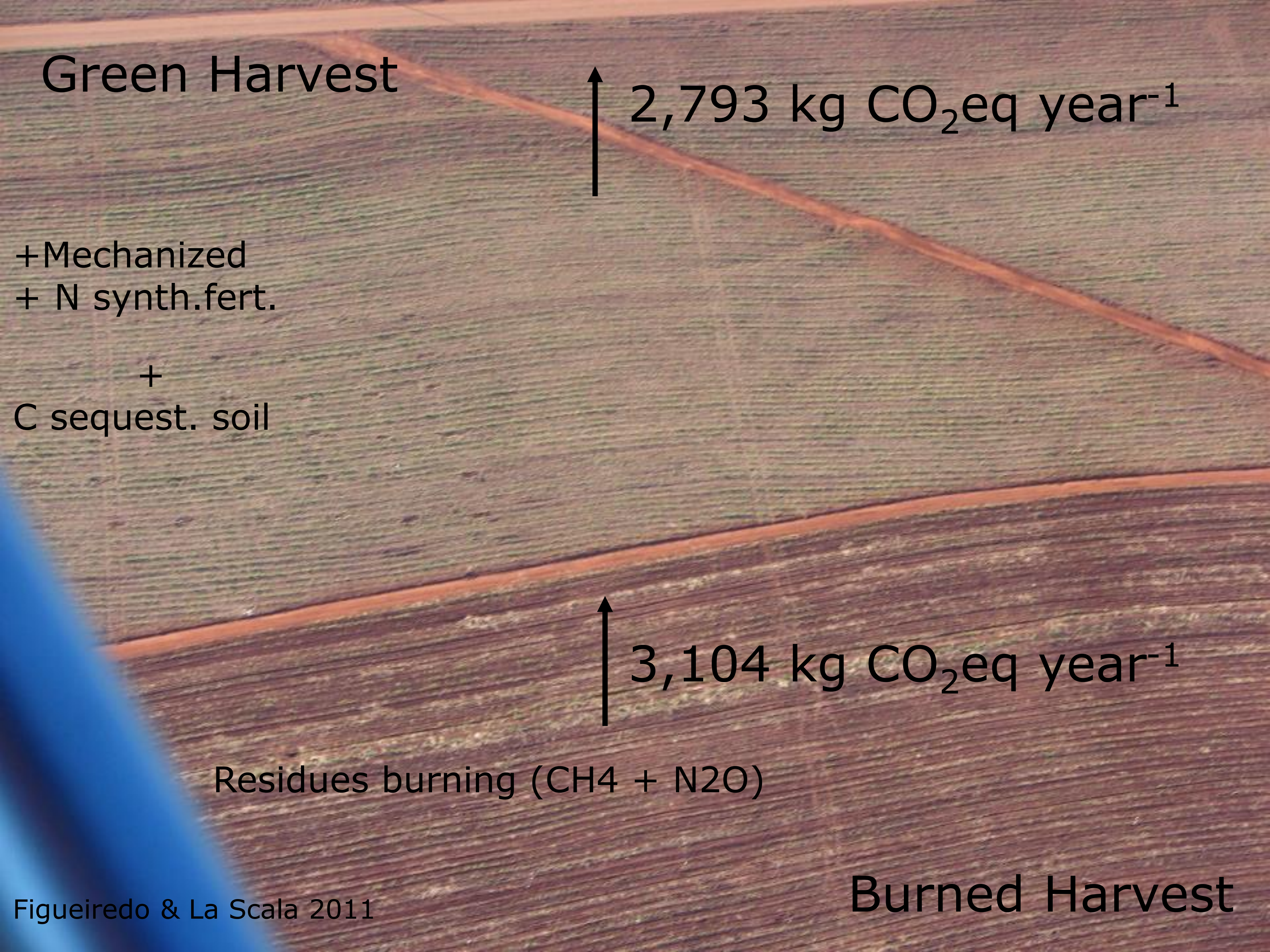
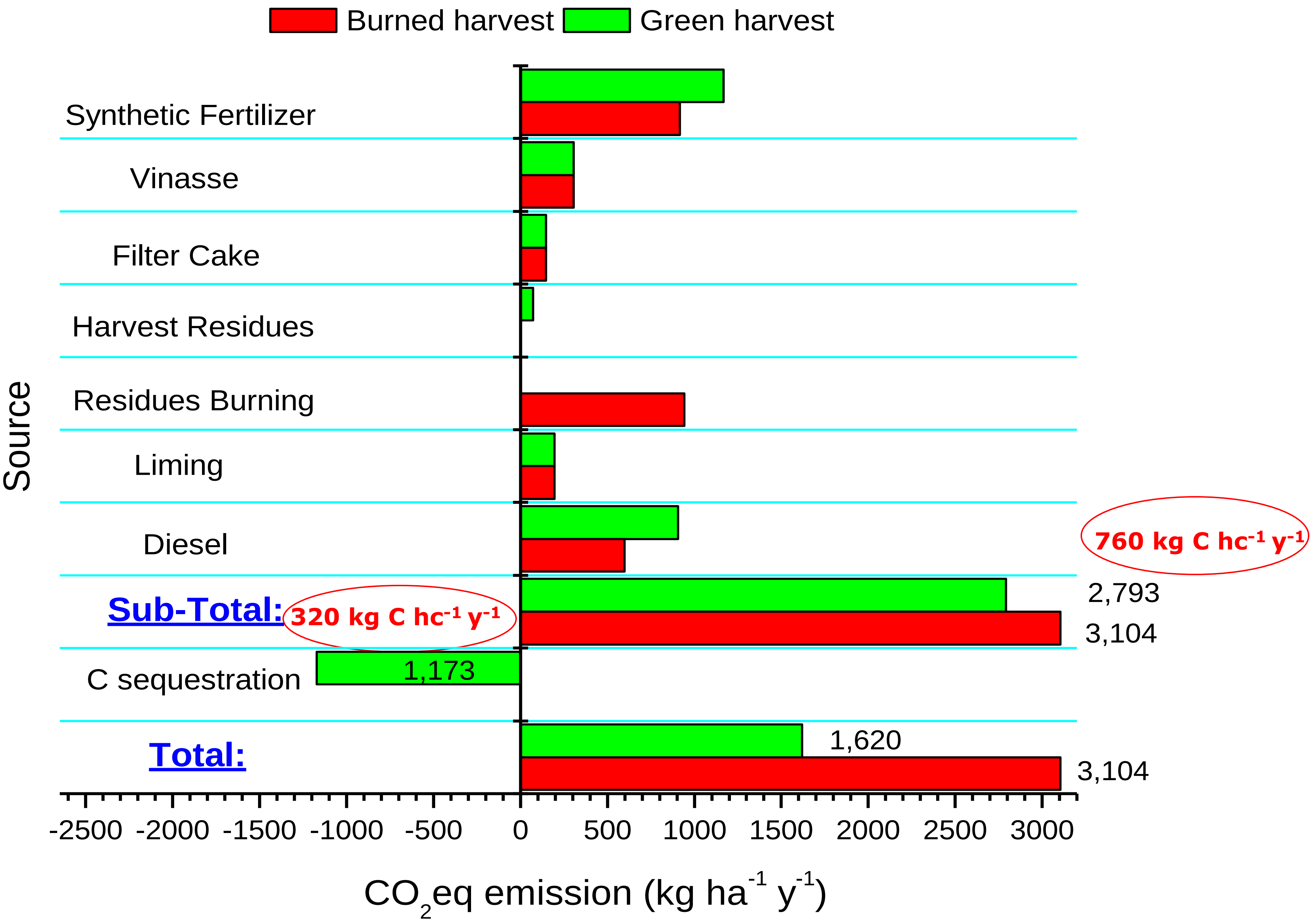

Green Harvest
2,793 kg CO_2eq year^{-1}
+Mechanized
+ N synth.fert.
+
C sequest. soil
3,104 kg CO_2eq year^{-1}
Residues burning (CH4 + N2O)
Burned Harvest
Figueiredo & La Scala 2011

Table 2. Annual amount of agricultural supplies applied and fossil fuel consumption (Medium values for a five years crop cycle) for each harvest system in one hectare to burning harvest and green harvest.

Supplies	Burning harvest		Green harvest	
	Units	Amount	Units	Amount
Nitrogen synthetic fertilizer	$kg\ ha^{-1}\ y^{-1}$	88	$kg\ ha^{-1}\ y^{-1}$	112
Vinasse application	$kg\ N\ ha^{-1}\ y^{-1}$	44.2	$kg\ N\ ha^{-1}\ y^{-1}$	44.2
Filtercake application	$kg\ N\ ha^{-1}\ y^{-1}$	21	$kg\ N\ ha^{-1}\ y^{-1}$	21
Lime	$kg\ ha^{-1}\ y^{-1}$	400	$kg\ ha^{-1}\ y^{-1}$	400
Diesel oil	$L\ ha^{-1}\ y^{-1}$	147.68	$L\ ha^{-1}\ y^{-1}$	223.82

Figueiredo & La Scala 2011



Figueiredo & La Scala, 2011.

1. Bordonal, R. O. ; Figueiredo E. B. ; De Aguiar, D. A. ; Adami, M. ; Rudorff, B. F. T. ; La Scala, N . Greenhouse gas mitigation potential from green harvested sugarcane scenarios in São Paulo State, Brazil. Biomass & Bioenergy, v. OnLine, p. 195-207, 2013.

2. Bordonal, R. O. ; Figueiredo E. B. ; La Scala, N . Greenhouse gas balance due to the conversion of sugarcane areas from burned to green harvest, considering other conservationist management practices. Global Change Biology. Bioenergy, v. 4, p. 846-858, 2012.

SOIL CARBON LOSS THROUGH CO_2 EMISSION (SOIL RESPIRATION)

Typical mean emissions: 2.0 μmol CO_2 m^{-2} s^{-1}

1 month: 2,281 kg CO_2 $hectare^{-1}$ or 622 kg C-CO_2 $hectare^{-1}$

1 year: 27,372 kg CO_2 $hectare^{-1}$ or 7,465 kg C-CO_2 $hectare^{-1}$

An emission reduction 10% (from 2 to 1.8 μmol CO_2 m^{-2} s^{-1}) would result in a reduction of **746.5 kg C-CO_2 per year!**

Conceptual:

$$\frac{dC}{dt} = -kC \qquad \frac{dC}{dt} = -F_{C-CO2}$$

$$\downarrow$$

$$F_{C-CO2} = kC$$

$$C = Carbon\ Stock$$

$$k = k[temp(t), moisture(\vec{r},t), O_2(\vec{r},t), clay(\vec{r}), C/N(\vec{r},t)]$$

$$Free-air\ porosity = Soil\ porosity - Moisture(vol.)$$

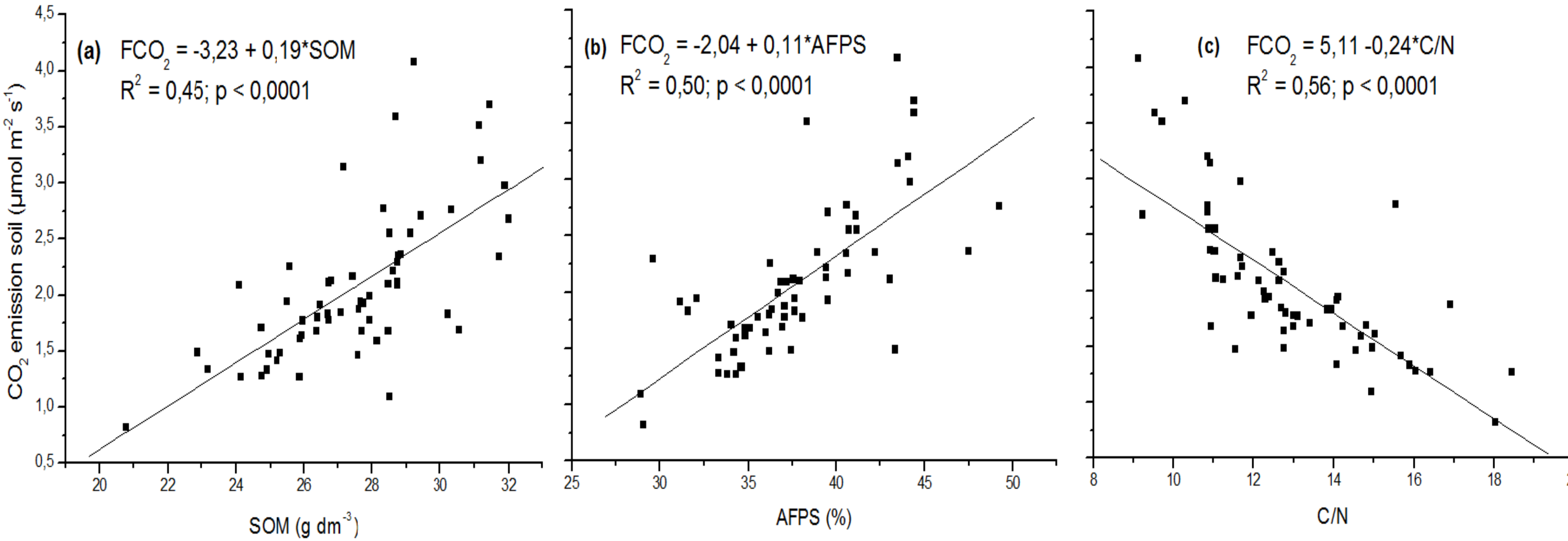
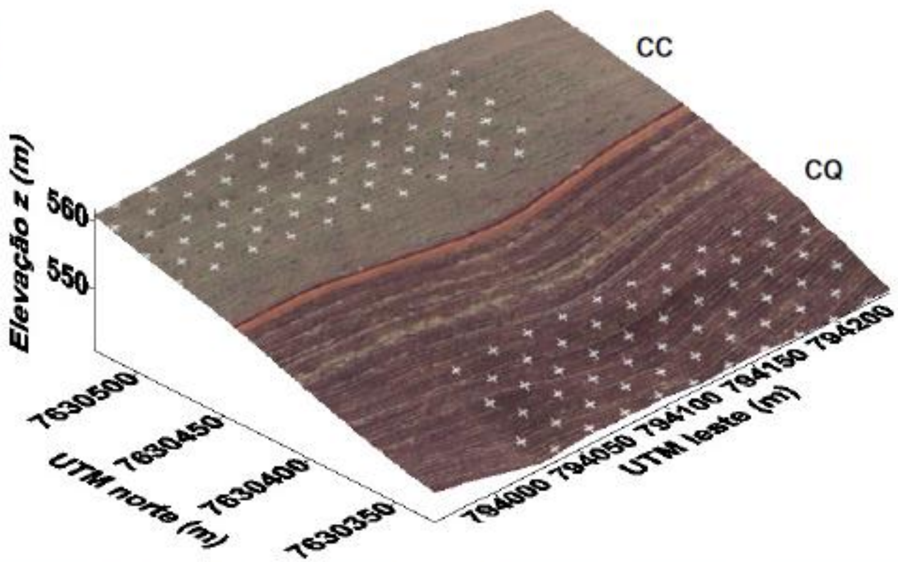


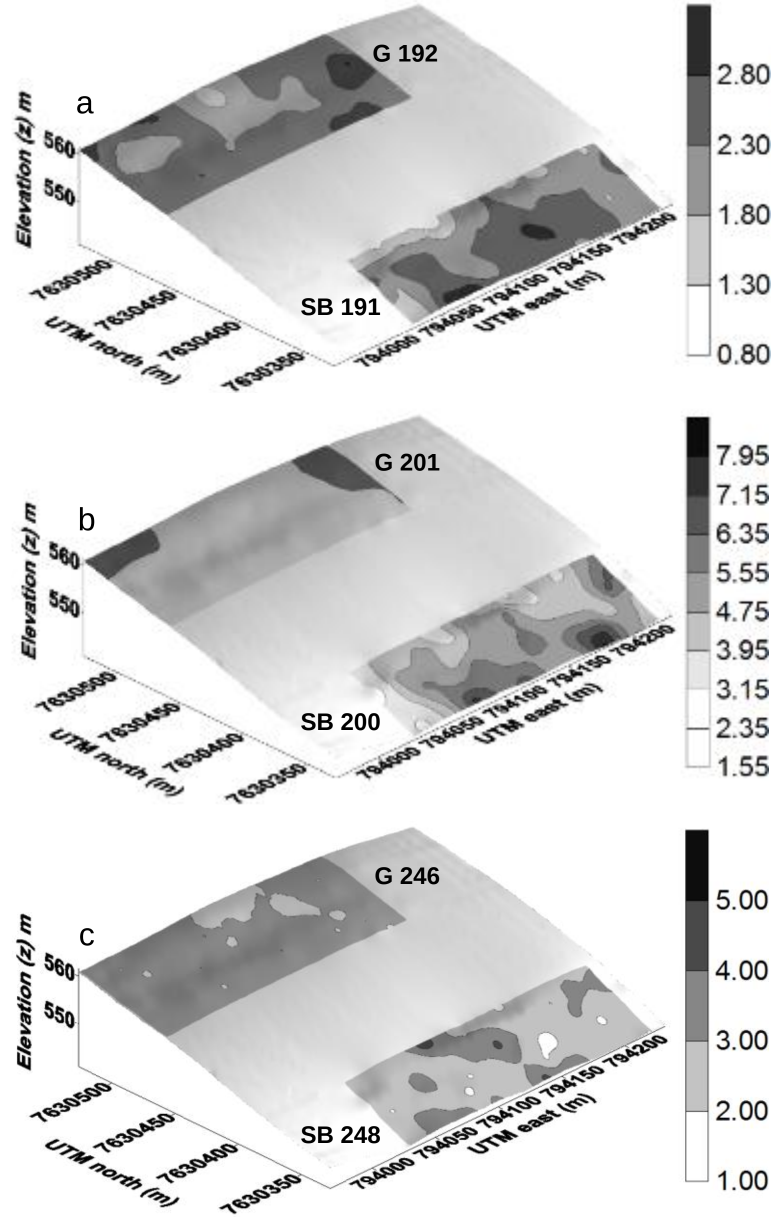
Figure 2. Linear regression analysis between CO_2 emission and soil organic matter content of the soil (a), air-filled pore space (b) and C/N ratio of the soil.

M. R. Moitinho et al. 2014.

(A.R. Panosso, 2007-2011)

Guariba, SP   21º 24’ S, 48º 09’ O





Emissions: 2.06 (GH) x 2.87 (BH) μmol m^{-2} s^{-1}

Panosso et al. 2009

(M.M. Corradi, 2010-2011)

D100

D0

D50

Figure 15. Plots having different crop residues density on soil surface. October 2009.

(M.M. Corradi, 2010-2011)

Difference in total emission (D0-D100) = 386 kg of C-CO_2 in 50 days!

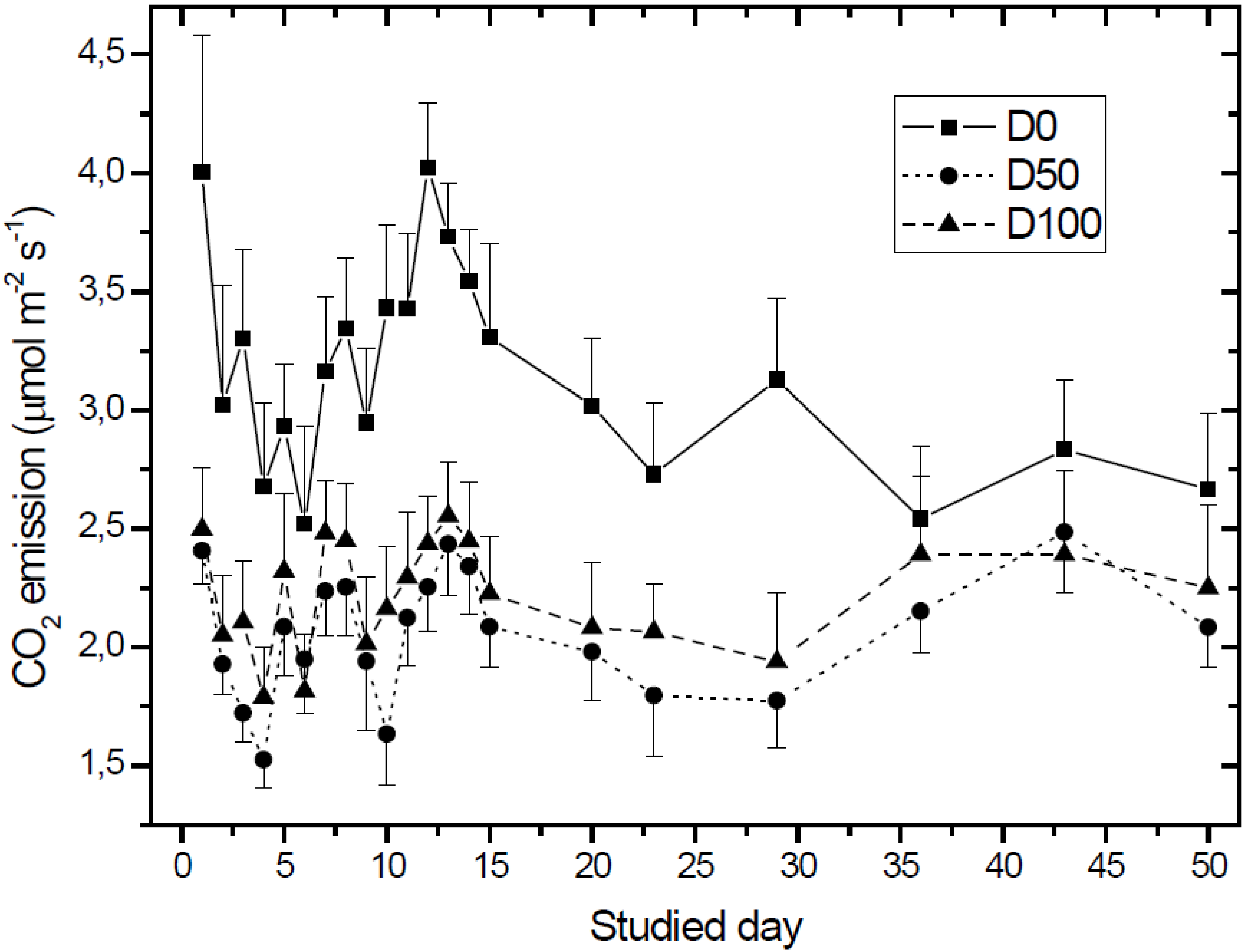


FIGURE 1. Mean (± half of standard error) of CO_2 emission in the studied days.

Corradi et al. 2013

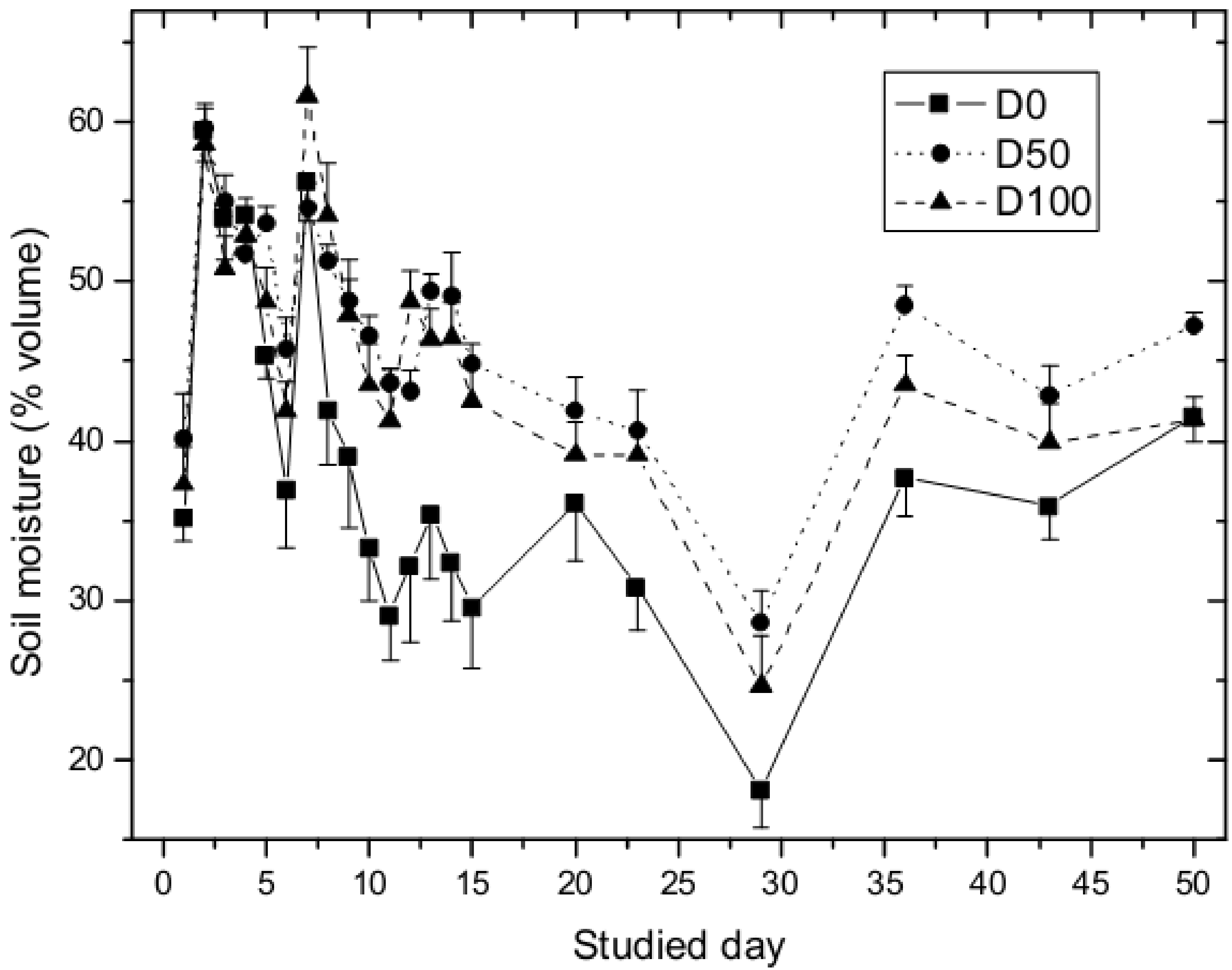


Figure 3. Mean (± half of standard error) of soil moisture in the studied days.

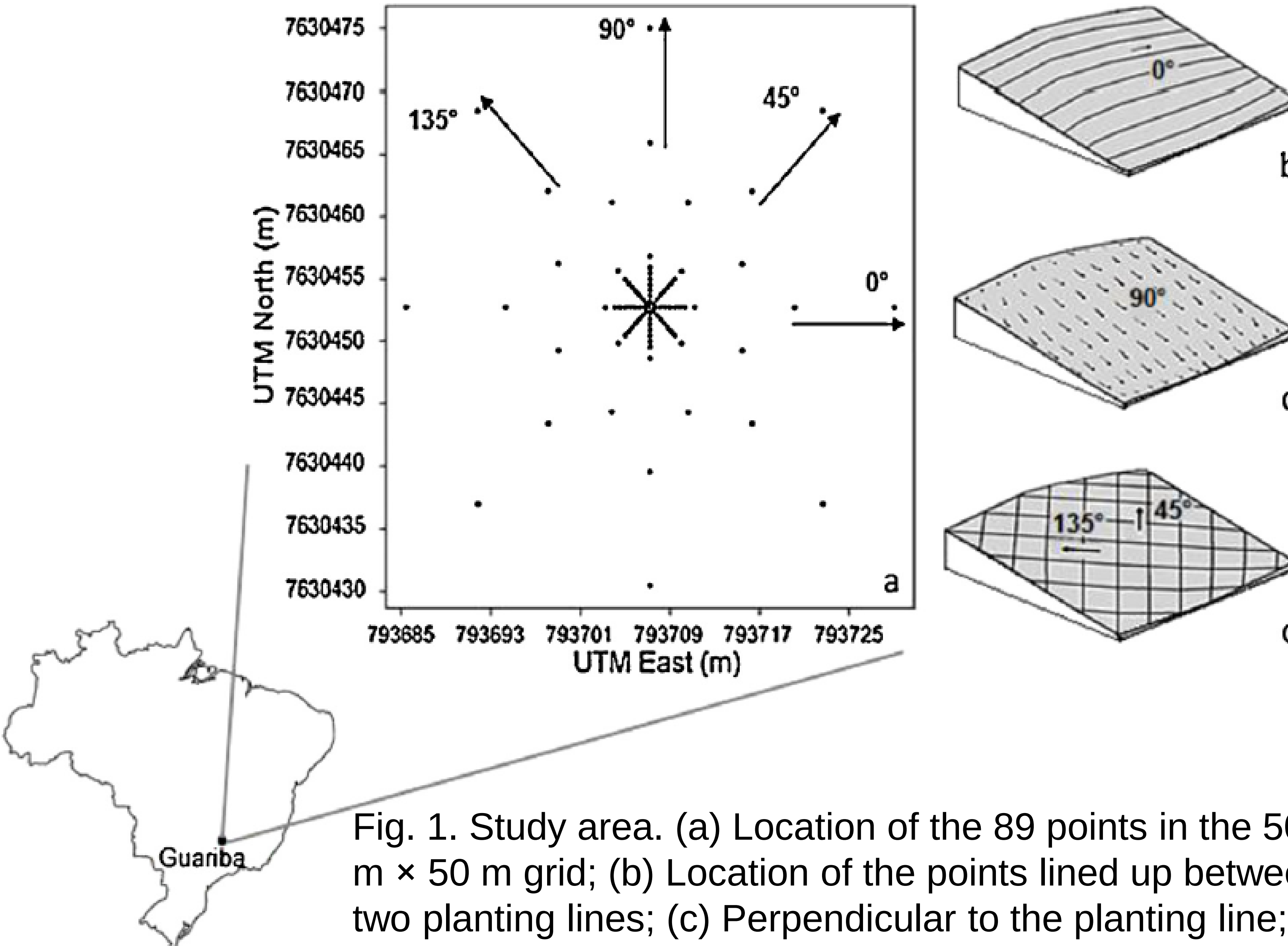


Fig. 1. Study area. (a) Location of the 89 points in the 50 m × 50 m grid; (b) Location of the points lined up between two planting lines; (c) Perpendicular to the planting line;(d) 45◦and 135◦were the directions of tillage used for 6 years to eliminate ratoon crops.

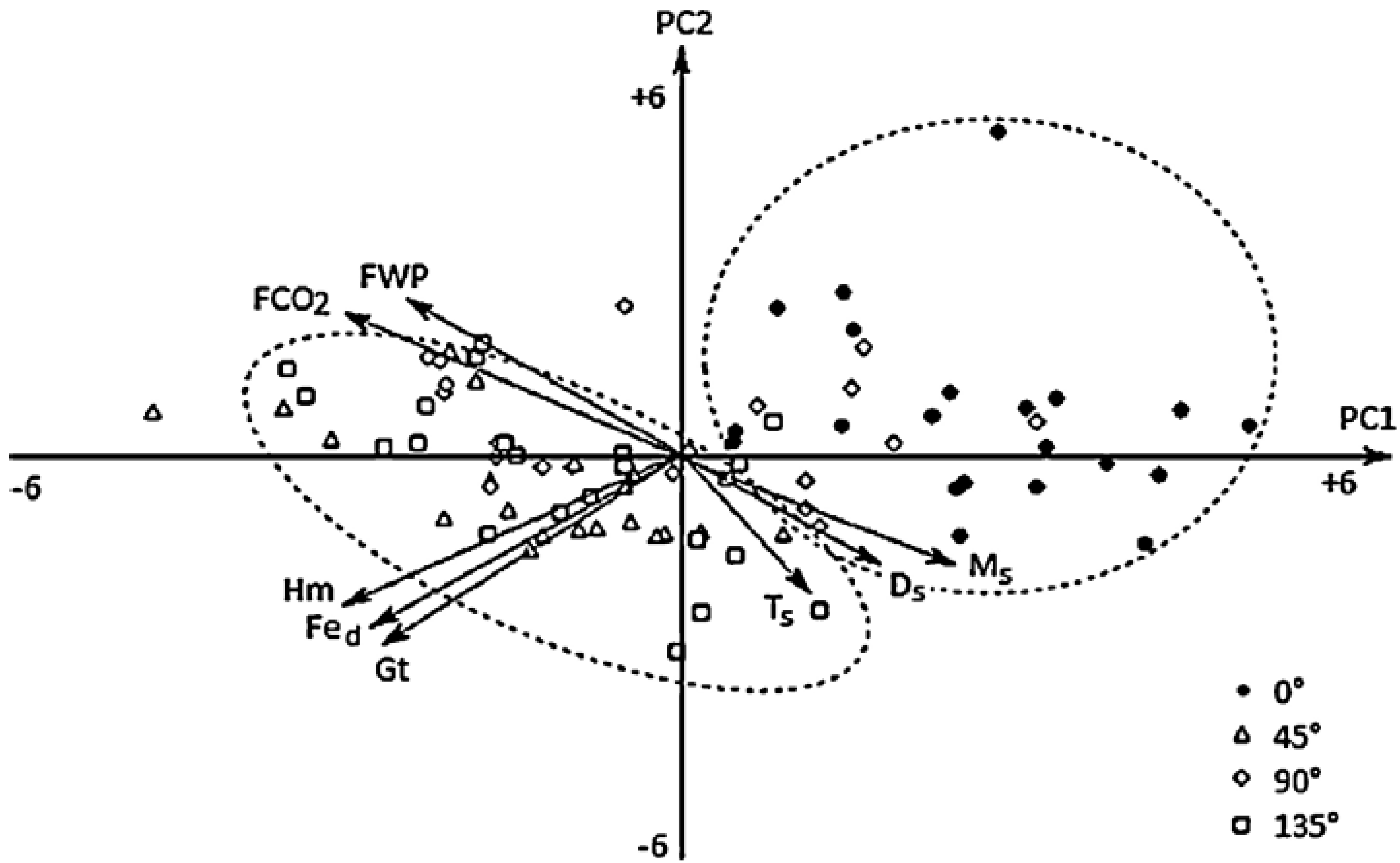


Fig. 4. Two-dimensional plot of the first two principal components (biplot). FCO2= soil CO2emission; FWP = free water porosity; Ts= soil temperature; Ds= soil density;Ms= soil moisture; Fed= iron oxides extracted by dithionite-citrate-bicarbonate; Hm = hematite; Gt = goethite.

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3. Bahia, A. S. R. S. ; Marques Júnior, José ; Panosso, Alan Rodrigo ; Camargo LA ; Siqueira D.S. ; LA SCALA, N . Iron oxides as proxies for characterizing anisotropy in soil CO2 emission in sugarcane areas under green harvest. Agriculture, Ecosystems & Environment (Print), 2014.

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We suggest reduction of tillage intensity and frequency as well as the maintainance of crop residues on soil surface in order to increase soil C stocks in long term, as a result of reduced emission

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Grad. + P.Grad students.

Thank You!