Circular Agronomy in Brazil: Integrated Crop-Livestock Systems is the Key

Moreira, Silvino.G.[1*]; Hoogenboom, Gerrit[2]; Martin-Ryals, Ana D.[2] Sanchez, Pedro.A.[2] [1]Universidade Federal De Lavras – UFLA, Lavras, MG, silvinomoreira@ufl.edu. [2]University of Florida

INTRODUCTION

Due to the global challenges of climate change, it is unthinkable to increase agricultural land by cutting down forests. Thus, it is important to employ the environmental tools such as circular agriculture to improve crop production while decreasing inputs and environmental impact.

GOAL

The aim of this study was to demonstrate THAT IT IS POSSIBLE to increase the efficiency of an agricultural production system through use of the practices of Circular Agronomy.

MATERIAL AND METHODS

This study include two farms located in the State of Minas Gerais, Brazil:

- **3W Agronegócios farm (Farm 1)**: coordinates 21° 23' S and 44° 39' W, in the municipality of Itutinga, and;
- **Santa Helena farm (Farm 2)**: coordinates 21° 15′ 39″ S and 44° 31′ 04″ W, in the municipality of Nazareno;
- **Soil:** the main soils of the farms are classified as "Latossolo Vermelho-Amarelo" or Oxisol (Typic Hapludox);
- **Livestock:** 3,704 and 1,237 beef cattle animals were bought and confined during the two years (January to December 2020 and 2021) at Farm 1 and Farm 2, respectively.

Santa Helena Farm – 1116 ha

3W Agronegócio Farm – 1848 ha

Table 1- Growing time of different crops.

Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.
Millet				Common beans				Black Oats			
	Maize 1ª Season			C. beans 2ª Season				Black Oats			
	Soybeans					Wheat					
	C. beans1ª Season					Maize 2ª Season+brachiaria					
Sweet potato: only in Farm 2.											

- **Crops rotation: two crops per year**
- **The soil is covered through to year with crops:**
  - **First crop (September to March)**: soybean, maize and beans;
  - **Second crop (March to August)**: **wheat** after soybeans; **maize** after beans and **beans** after corn;
  - **Brachiaria intercropped with maize (March to August)**: *Brachiaria ruziziensis* planted in the same time as maize;
  - **January beans**: beans after millet (new areas from degraded pasture areas).

Crop rotation: crop diversity and organic matter (and straw) increase

1ª season: Soybeans after wheat

No nitrogen applied to soybeans, except small amounts together with MAP, used to supply P.

3W Agronegócio rotate the sweet potatoes in all grain areas every 4-5 years.

2ª season: Maize intercropped with *Brachiaria*

Brachiaria ruziziensis 30 days after maize harvest

Common beans after millet

2ª season: Wheat (in front) and common beans (different stages) in the background

Brachiaria ruziziensis roots

Wheat straw in roll (stored)

Wheat straw (after harvesting the grain), collected for use as animal forage

RESULTS AND DISCUSSION

- The average yields of soybeans, maize, common beans, and in spring/summer crops were 5.0, 12.4, and 2.5 tons ha^{-1}, respectively, that is, about 1.5, 2.0, 2.3, and times higher than the average Brazilian yields. In the second harvest they also showed yields equal to or above the national averages. In 2021, the average Brazilian yields of first crop beans, maize and soybeans were 1.17, 6.4 and 3.5 tons ha^{-1}, respectively. In the second crop, the average Brazilian yields of beans, maize and wheat were 0.9, 2.9, and 5.4 tons ha^{-1}, respectively.
- During three harvests, Farm 2 exported 1,298 tons of N in the grain, forage, and sweet potato and added 1,037 tons of total N. That is, they exported 235 kg/ha/year in grains and tubers and applied 197 kg/ha/year of N as fertilizer (Fig. 1 a and b).
- In the same period, Farm 2 applied in the three years 639.4 tons of total N and they exported 694.8 tons of N in the grain crops. They exported 225 kg/ha/year of grain and applied 210 kg/ha/year of N as fertilizer;
- During the two years of confinement, it was estimated that about 85% of the N consumed by the animals was excreted in feces and urine.

What do they do with leftover grain from cleaning silos and straw?

Leftovers that will be used in the compost

Small sweet potato to beef cattle confinement

Leftover grain silos, such as broken wheat, corn and soybeans are used to feed beef cattle.

Compost with Leftover from grain silos, animal confinement, and straw wheat.

Animals (beef cattle) in confinement

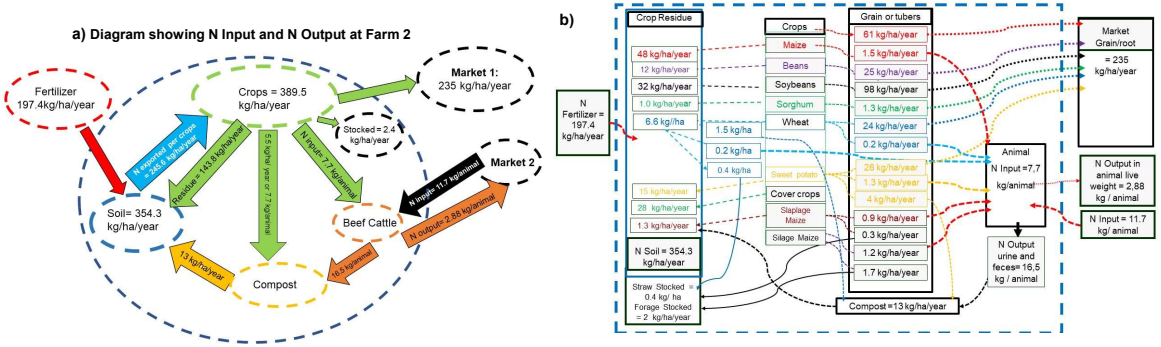

Figure 1. a) Diagram showing N Input and N Output at Farm 2. and b) Average inputs and outputs of nitrogen (kg/ha/year) in the production system of Farm 2, based on the 2018/19, 2019/20 and 2020/21 harvests and beef cattle production from 2020 to 2021.

RESULTS AND DISCUSSION

- In spring/summer crops, the Farm 1 occupied around 35% of its fields with soybean, 25% with beans, and 30% with maize and around 13% with sweet potatoes. The Farm 2 also maintained a proportion close to 70% or above of legumes and about 30% with maize.

CONCLUSION

- Using circular agronomy practices, the two farms applied 19 and 7% less chemical fertilizers than they exported of the crops, within a scenario of high crop yields;
- It was estimated that about 85% of the N consumed by the animals was excreted in feces and urine.

FINANCIAL SUPPORT

Capes-PrInt-UFLA Project
Food Production and Food Safety