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A proposal to enhance ecosystem services provision in rural landscapes – a study case in Brazil

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Introduction

The agroecosystem concept can be used to analyze food systems as wholes, including their complex sets and outputs, as well as the interconnections between their components, resulting in benefits for the whole system (Gliessman, 2006).

A term that has been widely used to indicate the many functions and benefits provided by agroecosystems is “multifunctional agriculture” (MFA).

The multifunctional capacity of agroecosystems is directly linked to the provision of ES, defined as the benefits people obtain from ecosystems. The Food and Agriculture Organization of the United Nations (FAO, 2011) stresses that healthy ecosystems provide a variety of vital goods and services that contribute directly or indirectly to human well-being, in economic, social and environmental spheres.

Although agroecosystems may have low ES values per unit area, when compared with other ecosystems, they offer the best chance of increasing global ES – given the proportion of land devoted to agriculture worldwide – by defining appropriate goals for agricultural and land use management regimes that favor the provision of these services (Porter *et al.*, 2009). In other words, it is possible and essential to improve ES provision from agriculture through agricultural management practices.

Hence, the objective of this work is to present an approach to evaluate soil functions in agroecosystems and their impact on environmental services (ES).

Materials and Methods

The case study is the Pito Aceso watershed, located in the mountainous region of Rio de Janeiro State – Brazil. This area is a typical landscape of this region, with a mosaic of land use types and steep relief.

A framework that established the link between agroecosystems and ES provision was developed, considering the criteria of management and agroecosystem establishment in the study area. A set of soil parameters that can be used as indicators to monitor the changes in the agroecosystems was also considered in this framework.

The criteria for the agroecosystem development were based on existing knowledge of the site associated with gathered information through interviews with farmers and further stakeholders, and small field studies on social, economic, environmental and agricultural aspects.

Results and Discussion

A matrix that evidences the relationship among the criteria for the establishment and management of the agroecosystems, in the study areas, and the environmental services (ES) types, soil functions, potential soil indicator, ES benefits, and policy relevance was created (Table 1).

Some results showed that ES types more affected by deployment and management of agroecosystems are supporting and provisioning services, what demonstrated the potential of agriculture management provide multiple services besides food, fiber and energy. "No fire use" and "agricultural consortium" were the criteria for deployment and management of agroecosystems with higher potential for increasing ES provision and biomass stock in soil and litter was the soil parameters to be used as indicator to monitor the impact (Turetta *et al.*, 2016).

Table 1. An example of the matrix – the whole matrix can be found in Turetta et al., (2016).

Criteria	ES type			Associated soil functions	Soil parameters or potential soil indicator	ES benefits
	provisioning	supporting	regulating			
No fire use	+++	+++	+++	Water infiltration/ Habitat	Soil porosity; bulk density; and others	Co2 mitigation; and others

Conclusions

1. Agroecosystems represent a way to practice multifunctional agriculture, as well as a source of environmental services (ES) provision; 2. An approach to assess soil functions in agroecosystems and their impacts on ES provision should consider as criteria the establishment and management of agroecosystems, taking into consideration the specificities of each area and a set of indicators to monitor changes.

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