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Silvopastoral systems as an sustainable alternative in small farms in Misiones, Argentina

Maria Belén Rossner†, José Luís Houriet and Luís Colcombet

INTA Cerro Azul, Argentina

Introduction

The northeast region of Argentine has high concentrations of smallholders with 50% of the population living in agrarian sectors. In the Center region of Misiones, 86% of the farms are smaller than 50 Ha. The prevalent production systems are forestry, annual (maize and bean) and perennial crops (*Ilex paraguariensis* and *Camelia cinensis*) and livestock. The farming systems are extensive, with low inputs of technology and the main objective of the farmers is to sustain their family demands. In this context the silvopastoral systems emerge as an alternative for sustainable production. The aim of this work was to evaluate the socio-economic impact of the introduction of a silvopastoral system on a smallholder's farm in Misiones Province.

Materials and Methods

The study took place in a smallholder farm located in the center region of Misiones Province, Argentina. The farm had 24 Ha and diversified production including crops, livestock, forestry and silvopastoral systems. The owner and his family are the manpower and the production is for the maintenance of their needs. The production indexes and gross margins per activity and those of global systems were calculated from measurements of livestock production per ha, carrying capacity of each pasture, wood production and incomes and outcomes for each activity. Wood production with a total cycle of 24 years was calculated using a forest simulation program (INTA-UNaM-Private companies NEA). The incomes and outcomes were measured through a poll made directly to the farmer. The measures were made at the beginning of the study in 1998 and then in 2005 and 2008.

Results

The silvopastoral system increased the production indexes (Table 1) and gross margins through increases in the forage, cattle and tree productivity (Table 2). It also allowed capitalization through infrastructures related to cattle management and those of the forestry component.

Table 1 *Evolution of Carrying capacity in EV year ha^{-1} and Annual meat production in kg year ha^{-1} in the farm before and after silvopastoral system's implementation (1998 and 2005-2008 respectively).*

	1998	2005	2008
Carrying Capacity (EV year ha^{-1})	0.65	1.22	1.41
Annual meat production (kg year ha^{-1})	62.4	128.2	166.6

Table 2 *Gross Margins (GM expressed in U$S per year ha^{-1}) from activities grouping as follow: cropping (agriculture, maize, bean, perennial crops), forest (Pinus elliotti), livestock (meat production) and global result, before and after silvopastoral system's implementation (1998 and 2005–2008 respectively).*

Activity	GM 1998	GM 2005	GM 2008
Crops (Agriculture)	5390	1865	1799
Forest*	0	−111	−126
Livestock	33.8	82.2	125.2
Global	5424	1837	1798

*This results were obtained considering outcomes from the forest plantation, costs of each year and without incomes from wood production (annualized wood incomes, see text).

The total annualized income of wood production with a total cycle of 24 years was 181 US$ per year ha^{-1}, which represents an increase in the global gross margin of the farm of 15% in 2008.

† E-mail: brossner@cerro.inta.gov.ar

Conclusion

The positive effects of this system combined with more efficient utilization of family labor and its flexibility to meet different socio-economic and productive realities, makes the silvopastoral system a feasible and sustainable alternative for the smallholders of Misiones, Argentina.

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Comparing energy use efficiency and green house gas emissions for livestock products

Jonathan Vayssieres†, Alexandre Thevenot, Mathieu Vigne, Emmanuel Tillard and Philippe Lecomte

CIRAD Livestock Systems Research Unit, 7 ch. de l'IRAT, 97410, St Pierre, La Réunion

Introduction

Livestock production contributes significantly to global warming (Steinfeld *et al.*, 2006), society and policy makers need information to better evaluate whether choosing more environment-friendly livestock products in human diets can mitigate global warning. Livestock products LCA studies available in the literature lack comparability because available assessments are conducted on different territories or with different methods (de Vries and de Boer, 2010).

Method

Taking the study case of the tropical island of La Réunion, 165 livestock farms were studied including major animal production: dairy milk, beef, pork, chicken, and rabbit. La Réunion farming systems are high input systems comparable to European ones. Based on the PLANETE tool (Risoud, 2002), a partial "cradle to farm-gate" LCA was conducted. Farm data on input consumption (including fertilisers & fossil fuels) and output production (eg meat, manure) were collected from the records of the 165 farms. The inventory of direct greenhouse gas (GHG) emissions, mainly CH_4 from enteric fermentation, and CH_4 and N_20 from excreta stored or laid out on pastures were based on the IPCC methodology. The inventory of indirect energy consumptions and GHG emissions (mainly CO_2) were based on specific consumption data from La Réunion for water, fuel, electricity and gas. For industrial processes, European life cycle inventories were re-used (mostly from the EcoInvent database) and extra energy costs and CO_2 emissions were added to take into account the energy consumed for transport from Europe. As the primary function of livestock products is to satisfy the human body's need for nutrition two indicators were calculated: i) the quantity of crude energy produced per kg of fossil energy consumed (= energy use efficiency) and the quantity of GHG emitted per kg of protein produced. These indicators are useful in comparing products with variable water content such as milk and meat.

Results

This study yielded a consistent series of results for energy use efficiencies and GHG emissions between products (see Table 1). Production of 1 kg of beef protein has the highest impact on climate change, followed by milk and rabbit, whereas chicken and pork protein have the lowest impacts. Whatever the production, the rationing is the main source of fossil energy consumption (>30%). System performances for pork and chicken are more homogeneous because of their standardisation (see coefficients of variation). Differences in environmental impact can be explained mainly by three factors: difference in feed conversion efficiency, difference in reproduction and mortality rates and difference in enteric CH_4 emissions.

Table 1 *Technico-environmental performances for different livestock productions in La Réunion (2007)*

	Feed conversion efficiency (kg concentrate/kg product)	Energy use efficiency (kg crude energy/kg fossil energy)	Part of fossil energy consumptions linked to animal rationing (%)	GHG emissions (kg CO_2-eq./kg protein)	Coefficient of variation (%)	Part of enteric CH_4 in total GHG emissions (%)
Milk (dairy)	0.79	0.37	55.3	87.3	24.5	26.2
Beef (suckling)	4.00	0.19	31.9	239.7	66.5	65.5
Beef (fattening)	5.48	0.42	53.3	104.7	27.3	40.1
Pork	3.23	0.62	77.0	35.9	18.7	6.1
Chicken	2.19	0.36	75.3	25.9	15.6	1.8
Rabbit	3.99	0.15	58.8	83.2	28.8	2.3

† E-mail: jonathan.vayssieres@cirad.fr