Cattle productivity and carbon stock in silvopastoral systems with Leucaena in the Colombian Dry Caribbean

José Edwin Mojica Rodríguez, Milton Rivera Rojas, Darwin Fabián Lombo Ortiz, Juan Ricardo Zambrano Ortiz, Jaime Andrés Arias Rojas, Sonia Daryuby Ospina Hernández.

Corporación colombiana de investigación agropecuaria - AGROSAVIA. RC.
Motilonia, Km 5 Road Becerril, Agustín Codazzi, Cesar, Colombia. jmojica@agrosavia.co orcid: 0000-0001-7751-8631

Introduction

Dual-purpose cattle systems in the Cesar Valley microregion are based on grazing for grasses and grasslands. In the region, the grass Colosuana (*Bothriochloa pertusa*) is the predominant grass that is usually associated with low milk yield in dual-purpose cows. The integration of shrubs and trees for different purposes in grazing areas is still occasionally adopted by farmers.

Methodology

The study was carried out at the AGROSAVIA (formerly CORPOICA – Corporación Colombiana de Investigación Agropecuaria) Research Center in Motilonia (10° 0′ 7″ N, 73° 14′ 51″ W, 106 m.a.s.l.) in the municipality of Agustín Codazzi, Cesar Department, Colombia. The zone has an average annual rainfall of 1585 mm, average annual temperature of 28.7 ºC and relative humidity of 70%. The soils of the experimental area have sandy loam texture with good drainage, pH (6.4 – 6.6) and organic matter (0.5 – 1.5%). The natural vegetation of the zone corresponds to transitional subhumid tropical forest (Holdridge, 2000). Milk yield and composition (total solids, fat and protein content) for cows Zebu x Swiss brown at the early (experiment 1) and mid lactation stage (experiment 2) were evaluated for silvopastoral systems that integrated *Eucalyptus camaldulensis* and *Leucaena leucocephala* with Brachiaria hybrid Mulato II (T1), *Brachiaria brizantha* cv. Toledo (T2), *Brachiaria brizantha* cv. Marandú (T3) and *Megathyrsus maximus* cv. Tanzania (T4) (Figure 1).

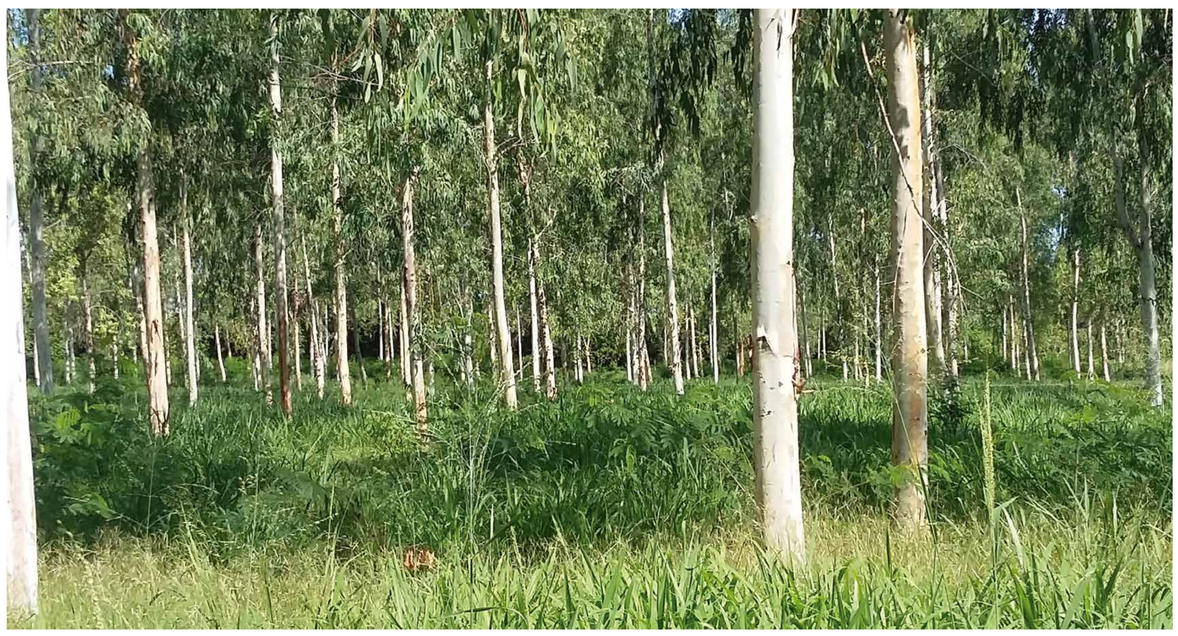

Figure 1. Silvopastoral system based on integration of Eucalyptus - Leucaena - Tanzania

The milk composition was determined using a milk ultrasonic analyser. Wood measurement variables for carbon stock of the Above-Ground Biomass in *E. camaldulensis* were calculated with allometric equations (AGB: $0.033(D^2H)^{0.959}$, Waraporn et al. 2016) multiplied by the carbon fraction 0.5 (IPCC, 2006). The crop or harvest period for Leucaena and grasses in the experiments 1 and 2 were 49 and 32 days, respectively. The initial establishment density of *E. camaldulensis* was 500 trees per hectare with harvest projection for fencing post at six years and final plot density of 300 trees per hectare. A simple crossover design was used to analyse the response variables of each experiment.

Results

In experiment 1, the saleable milk yield was higher (P<0.05) with the integration of *Leucaena* - Mulato II (T1) (8.4 kg $cow^{-1}day^{-1}$), however the total solids (12.0%) and fat (3.3%) were lower (P<0.05) than for Leucaena – Tanzania (T4) (7.4 kg $cow^{-1}day^{-1}$), 12.8 and 3.9% for total solids and fat, respectively) (Table 1).

Table 1. Milk yield and composition of dual-purpose cows (early lactation stage) in silvopastoral systems that integrated *Eucalyptus camaldulensis* and *Leucaena leucocephala* with different tropical grasses. Agustin Codazzi, Cesar, Colombia.

Variable	Mulato II (T1)	Toledo (T2)	Marandú (T3)	Tanzania (T4)
Milk (kg $cow^{-1}day^{-1}$)				
Saleable	8.4^{a}	7.0^{b}	7.0^{b}	7.4^{b}
Total	9.5^{a}	8.3^{b}	8.3^{b}	8.4^{b}
Composition (%)				
Total solids	12.0^{b}	12.5^{ab}	12.9^{a}	12.8^{a}
Protein	3.1	3.2	3.2	3.2
Fat	3.3^{b}	3.5^{ab}	3.9^{ab}	3.9^{ab}

Means with different superscripts within same row are significantly different (P<0.05).

In experiment 2, the saleable milk yield per cow was higher (P<0.05) in the integrations with Tanzania (T4) (3.8 kg $cow^{-1}day^{-1}$) and with Mulato II (T1) (3.8 kg $cow^{-1}day^{-1}$) while the total solids were higher (P<0.05) in T4 (14%) (Table 2).

Table 2. Milk yield and composition of dual-purpose cows (mid lactation stage) in silvopastoral systems that integrated *Eucalyptus camaldulensis* and *Leucaena leucocephala* with different tropical grasses. Agustín Codazzi, Cesar, Colombia.

Variable	Mulato II (T1)	Toledo (T2)	Marandú (T3)	Tanzania (T4)
Milk (kg $cow^{-1}day^{-1}$)				
Saleable	3.8^{a}	3.6ab	3.5b	3.8^{a}
Total	5.0a	4.4b	4.3b	4.9^{a}
Composition (%)				
Total solids	13.2^{b}	13.7^{a}	13.7^{a}	14.0^{a}
Protein	3.2^{c}	3.6^{a}	3.6^{a}	3.4^{b}
Fat	4.0^{b}	4.7^{a}	4.7^{a}	4.4^{a}

Means with different superscripts within same row are significantly different (P<0.05).

The total and the commercial timber volume of *E. camaldulensis* was 59.2 and 31.2 m^3, respectively when considering 16.1 m as total height and 14.4 cm as diameter at breast height. According to commercial volume information it is expected that there will be a production of between 900 - 1200 wooden poles for fencing (2.1 m length) or different uses in farms. For carbon stock aerial biomass, the reserve was estimated as 12.6 tC ha^{-1} with fixation rates of 2.1 tC $ha^{-1}yr^{-1}$.

Conclusion

Tanzania - *Leucaena – E. camaldulensis* was identified as a silvopastoril system that increase the saleable yield and the total solids of milk compared with the predominant grass species (*Bothriochloa pertusa*) in the Colombian dry Caribbean region. This system exhibited a milk production of 4.4 and 3.9 kg $cow^{-1}day^{-1}$ and total solids of 12.2 and 12.9% at the early and mid-lactation stage for dual purpose cows, respectively. This therefore represents a real synergistic opportunity to contribute from adaptation to mitigation, from carbon fixation rates of 2.1 tC $ha^{-1}yr^{-1}$ at the cattle production system and farm level.

Keywords: Feeding cows, forages, silvopastoral systems, Leucaena, Colombian Caribbean Region.

References

Holdridge, L. 2000. Ecología, basada en zonas de vida. San José, C.R, IICA (Instituto Interamericano de Cooperación para la Agricultura). vol. 92-9039-131 6 p. 217.

Intergovernmental Panel on Climate Change (IPCC). 2006. Guidelines for National Greenhouse Gas Inventories. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. y Tanabe K. (eds). Published by: IGES, Japón

Waraporn O, Ladawan P, Sapit D. 2016. Development of general biomass allometric equations for *Tectona grandis* Linn.f. and *Eucalyptus camaldulensis* Dehnh. plantations in Thailand. Agriculture and Natural Resources. 50. 1. 48-53. doi.org/10.1016/j.anres.2015.08.001