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Mini Review

The Polar Foundation Silvopastoril Program at DANAC Foundation, Yaracuy, Venezuela

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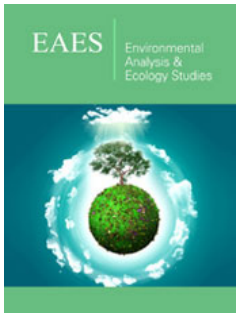
ISSN: 2578-0336



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Submission: December 11, 2021

Published: September 23, 2022

Volume 10 - Issue 2

How to cite this article: Eduardo E Escalante* and Hector Fabio Messa. HThe Polar Foundation Silvopastoril Program at DANAC Foundation, Yaracuy, Venezuela. Environ Anal Ecostud. 000731. 10(2). 2022. DOI: 10.31031/EAES.2022.10.000731

Introduction

At present, the development of sustainable and environmentally friendly livestock farming is becoming more and more necessary in the face of the problem of climate change. There are a couple of key elements or factors when establishing intelligent livestock systems, the first is the presence of the arboreal component, and the second, the integration and association of plant components (trees, semi-woody species and herbaceous plants) that meet diversity of functions in a stratified and diversified Silvopastoral system (Biodiverse), provide shade and protection for livestock, sequester carbon compensatory to greenhouse gases (Carbon Dioxide, Methane and Nitrous Oxide), forage and fruits for livestock and fix atmospheric nitrogen as in the case of leguminous plants.

The presence and use of the arboreal component in Venezuela has been an ancestral practice mainly in the plains of Venezuela, either as scattered trees, as is the case of the saman (Samanea saman) in extensive grazing areas [1,2], in living fences such as mataraton or black wood (Gliricidia sepium), or as forage and protein bank such as leucaena (Leucaena leucocephala) [3,4].

In 1997, The Sustainable Tropical Agriculture project, currently the National Training Center for Small Agricultural Producers (NTCSAP), emerged as a result of an alliance between the Polar Company Foundation, Danac Agricultural Research Foundation (Danac Foundation) and the Faculty of Agronomy of the Venezuela Central University (UCV), proposed as an initiative to have a permanent offer of technological innovations in sustainable agriculture and to contribute to the formation and training of talents (farmers, professionals and students) in the knowledge and application of the principles and practices of sustainable agriculture in Venezuela [4].

Several and different Silvopastoral Systems were developed in the Integral Farm of Sustainable Tropical Agriculture [4]:

A. Pastures in alleys of Mataratón (G. Sepium) and Leucaena (Leucaena leucocephala) 10.0ha. 2.- Enhanced pasture with high density scattered trees

B. Improved pasture (Panicum maximum (Guinea grass) with scattered trees 3.3ha.

C. Mixed forage bank: Mataratón (Gliricidia sepium), Nacedero (Trichantera gigantea) and Mora, (Morus alba) 1.1ha.

D. Silvopastoral Multi-strata System 4.4ha

E. Live fences

Pasture System in Alleys of Leucaena and Mataratón

The pasture system in alleys of L. leucocephala and G. sepium covers a total area of 10 ha. The paddocks were divided with electrified fences into 0.25ha modules for a total of 40 modules. G. sepium and L. leucocephala were established in double rows separated at 5m and with a distance between rows and between plants of 1m (1m x 1m x 5m) for an initial planting density of 3,333ha^{-1} plants. The predominant grasses are Star (Cynodon nlemfuensis) , Guinea (Panicum máximum), Brachiaria mutica and Caribbean (Eriochloa polystachia).

The herd is managed under rotational grazing, with an occupation time of 2 days and 74 days of rest, and average animal load of 2.2 to 2.5AUha-1 (1AU equals 450kg PV). However, in the dry season and due to the lower availability of fodder, the occupation time is reduced to one day and consequently the rest time decreases to 37 days. G. sepium and L. leucocephala are periodically pruned to maintain the height of browsing (1m) [4,5].

Enhanced Pasture with High Density Scattered Trees

The improved pasture with scattered covers a total area of 3.35ha and is divided into two pastures of 1.68ha each. The predominant grass is P. maximum and among the tree species, Samán (Albizia saman), Guacímo (Guazuma ulmifolia), Caro-Caro (Enterolobium cyclocarpum) and Pterocarpus officinallis; established by natural regeneration at a density of 120 trees ha^{-1}; [4]. This system is used for grazing growing animals, mainly replacement females, with an animal load of 1.0 to 1.5AU ha^{-1}.

Mixed Feed Bank

As of the year 2000, the establishment of a mixed forage bank began, by planting in the alleys of G. sepium, T. gigantea and Morus spp. The mixed bank It is a Multi-layer system, consisting of G. sepium in rows spaced 5 m x 0.6m between plants, with T. gigantea and Morus spp. established at 1m x 0.6m in the alleys.

The plants of G. sepium were established with sexual seed collected in the area and the plants of T. gigantea and Morus spp., by vegetative seed. The system is managed under cutting and hauling, for the supplementation of cows in production and calves, through fresh consumption and silage The plants are pruned every 3 to 4 months, at an approximate height of 1.0-1.5m and the stems are distributed between the rows of the legume; providing soil coverage, barriers to erosion control and organic matter [4].

The Multilayer Silvopastoril System

The Multi-Layer Silvopastoral System (MLSPS) covers an area of 4.4ha and was jointly developed by the Danac Foundation and the CNCPPA since 2002 [3,5].

The system consists of three plant strata, whose components fulfill different functions and services:

a. **Tree stratum:** made up of leguminous species that produce fruits, wood and firewood, such as Saman (Albizia saman), Cují (Prosopis juliflora) and Cañafistola (Cassia moschata); and in addition Corozo palm (Acrocomia aculeata). In this stratum, timber species of high commercial value are also included such as Tectona grandis (teak), Cordia Thaisiana (Pardillo negro), Swietenia macrophylla (Caoba o Mahogany) and Tabebuia roseae (Apamate o Guayacan rosa), all of them, intended for wood production [4-6].

b. **Shrub layer:** Constituted by L. leucocephala, established at high density in quadruple strips and pruned at 1 m height to facilitate accessibility (browsing) of forage by cattle.

c. **Herbaceous stratum:** Conformed by P. maximum, provides fodder for animals, in addition to coverage and contribution of organic matter to the soil.

The MLSPS, was divided into modules or paddocks of 0.2ha, by electrified fences and managed under rotational grazing. The incorporation of cattle into the system began in 2007 with growing bovine females (mautas), with a low animal load (1AU ha^{-1}) to avoid damage to developing trees. As of 2008, adult bovine animals were introduced (Figure 1), and the animal load in the system was progressively increased [3,4,6].

Figure 1.

Three stratum Multilayer Silvopastoril System (MLSPS), made up of leguminous species, Saman (Albizia saman), Cují (Prosopis juliflora) and Cañafistola (Cassia moschata); and Corozo palm (Acrocomia aculeata)., and four Timber species: Tectona grandis (teak), Cordia Thaisiana (Pardillo negro), Swietenia macrophylla (Caoba o Mahogany) and Tabebuia roseae (Apamate o Guayacan rosa), all of them, intended for wood production on a P.maximun grass and L. leucaena fodder shrub. Foto: EEEscalante. 2011.

In the Silvopastoril systems,cows are managed under rotational grazing in silvopastoral systems, with an average animal load of 2.2 to 2.5AU ha^{-1}. Growing females (post-weaning) graze in an improved pasture with scattered trees with an average animal load of 1.5AU ha-1 [4].

Evaluations made in the tree component in multi-layer silvopastoral systems (MLSPS), determined that among the leguminous trees, A. saman was the species with the best growth and development, while in terms of timber trees, T. grandis, presented the largest Annual Average Increases for diameter at chest height, (DAP), Total Height (TH), and Fuste Height (AF), with values of 1.75cm year^{-1}, 1.09m year^{-1} and 0.51m year-1, respectively; followed by black Pardillo Cordia thaisiana [4].

Live Fences of Mataratón, Linear Plantation with Oil and Timber Palms and Biological Corridors

The integral farm has some segments of live fences, constituted mainly by G. sepium and have among their functions to provide shade and forages for the animals. Also, there are linear plantations of oil palms, such as Elais guineensis, Acrocomia aculeata and B. gasipaes. As an alternative for the use of space, the conservation of wildlife habitat and expand small-scale timber production on the farm, among others; since 2002, the species T. grandis, C. thaisiana, S. macrophylla and T. roseae, located 4m apart between trees, were established on the perimeter of the improved pasture with scattered trees.

Regarding the carbon storage, different land uses linked to the bovine subsystem of the integral farm and a fragment of primary forest (control) adjoining the production unit were evaluated. The total carbon in the system (organic soil carbon + total carbon above ground) in the primary forest was 3.2 times higher than the average value of the systems intervened (73.88Mg ha^{-1}). The systems with anthropic intervention presented total carbon storage values in a range of 63.79 to 100.69Mgha^{-1}, being the highest value the improved pasture with scattered trees [4].

From the environmental point of view, there is evidence that demonstrates that the stablishment and management of the different productive components of the integral farm have contributed to the conservation and improvement of the soils, to increase the vegetal cover, animal welfare, the protection of sources of water, carbon sequestration in the soil and in the biomass above the soil. They have also contributed to the compensation of greenhouse gas emissions, the increase in biodiversity associated with the production system (birds, mammals, reptiles, insects and plants), has favored connectivity between forested areas surrounding the unit of production; and also, it has contributed beauty and aesthetics to the landscape [4-7].

Conclusion

The silvopastoral program Fundacion Polar-Fundacion DANAC proved to be a useful tool for the transmission of knowledge and the relevance of silvopastoral systems in the development of an environmentally-smart sustainable livestock, allowing the training of producers, students and professionals of bovine animal prodcution in Venezuela.

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