Integrating crop pollination management, native beekeeping, and silvopastoral systems to improve the cattle sector's sustainability in Latin America.

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Introduction

» Intensification with monoculture pastures in Latin America: associated with biodiversity loss, (e.g., insect pollinators). Major concern for global food security and ecosystem functioning.

» Inclusion of forage legumes in cattle production systems: may increase plant diversity within a pasture, while providing floral resources for pollinators which in turn boost crop and wild-plant pollination.

» Sustainable intensification of cattle systems in Latin America: focus, e.g., on silvopastoral systems (SPS).

» Bottleneck for sustainable intensification: limited availability of legume seed threats to scaling efforts.

Objectives and Methodology

» To provide an overview of forage legumes and agroecosystem management tools, available to cattle systems for the conservation of insect pollinators, optimization of crop-pollination services, and tackling legume forage-seed bottlenecks.

» To discuss the opportunities and challenges of integrating principles of pollinator ecology and native beekeeping into SPS and artisanal and large-scale propagation of legume forage-seeds.

» To provide interested stakeholders, policy- and decision-makers with a perspective on how such agroecosystems may be designed as mosaics or scaled into multifunctional landscapes.

» Literature review and expert consultation.

Results and analysis

The forage legume seed bottleneck

» Adoption of forage legumes in tropical Latin America is very low.

» Seed scarcity limits wider use of forage legumes in cattle production systems, which hinders the implementation of more sustainable cattle production systems.

» Several projects, such as the Sustainable Colombian Cattle Project, support and promote the use of SPS. They have made significant advances (>35,500 hectares of SPS established in Colombia), but a widespread adoption of these systems may be limited by legume seed scarcity.

» There exists a strong private tropical forage seed sector in Brazil and Mexico, its focus is set on *gramineae* seed production, which leaves legume (*fabacea*) seeds largely neglected.

Benefits of bee pollination on legume seed production

» Most tropical forage legumes are self-pollinating but have an increased seed formation when their flowers (rich source of nectar and pollen) are visited by bees (Table 1).

» Cattle production systems that include legumes (e.g., forage banks or grass-legume systems) are intensively managed to minimize flowering of plants (i.e., no pollination service). The set-up of legume seed production sites allows, (i) the creation of gardens for wild and managed bees, and other pollinators throughout the year; and (ii) overcome differences in flowering times.

» Pollination gardens enhance the abundance, diversity and community composition of bees and other pollinators; visitation rates of bees to legume flowers, resulting in higher seed yields.

Table 1. Some examples of forage legume species with increased out-crossing when visited by different bee species.

Species	Plant growth habit	Pollinating bee species relevant for meliponiculture? [Yes/No]	Interaction type
Cajanus cajan	Herbaceous	Pollinating bee spp. unknown to the authors	Flower visitations with no reference to specific floral resource
Centrosema spp.	Herbaceous	*Centris (Centris) aenea, Centris (Hemisiella) trigonoides, Centris (Centris) flavifrons, Centris (Trachina) sp.;* [No]	
Chamaecrista rotundifolia	Herbaceous	*Xylocopa frontalis*; [No]	Foraging for pollen
Desmodium spp.	Herbaceous	*Centris (Hemisiella) tarsata, Thygater aethiops*; [No]	Flower visitations with no reference to specific floral resource
Gliricidia sepium	Tree	*Xylocopa frontalis*; [No]	Foraging for pollen
		Bombus pullatus; [No]	Flower visitations with no reference to specific floral resource
		Melipona favosa, Tetragonisca angustula; [Yes]	

Proposed interventions

<u>At the farm-level:</u>

» Smallholder on-farm legume seed production

» Integrated crop pollination

» Meliponiculture and other forms of traditional beekeeping

» Silvo-pastoral systems

<u>At the public and private sector level:</u>

» Landscape restoration approach

» Large scale legume seed production through private seed sector

Required enabling (macro) conditions

» Cattle sector policies and development plans: inclusion of pollinator services and forage legume seed production in the payment schemes for ecosystem services (for e.g., SPS), incentives or new value chains with differentiated products.

» Access to credit and productive inputs for sustainable intensification strategies, smallholder legume seed production, and meliponiculture: crucial for continuous seed supply and harnessing of ecosystem services.

» Access to/creation of knowledge: legume seed production, treatment and marketing, beekeeping, and honey production, or product differentiation.

» Research: evaluation of new genetic material key for identifying additional legumes for sustainable intensification scenarios, seed production and integrated meliponiculture.

Conclusions

» The development of pollinator friendly environments, based on forage-legumes and SPS and their introduction into cattle systems, brings several benefits.

» Legume seed production: creation of different revenues, e.g., from bee and seed sales.

» Interplay of pollinators and forage legumes: benefits can be further extended to the landscape level, affecting positively the yield of nearby pollinator-dependent crops.

» Enabling conditions, including policies, payment schemes for ecosystem services, incentives or new value chains, must be in place for this approach to work.

Further reading

Narjes M; Cardoso JA; Burkart S. (2021) Promoting forage legume–pollinator interactions: Integrating crop pollination management, native beekeeping and silvopastoral systems in tropical Latin America. Frontiers in Sustainable Food Systems 5:725981. https://doi.org/10.3389/fsufs.2021.725981

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