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General view of a traditional *caíva* area (without pasture management), in the northern region of Santa Catarina State, southern Brazil, in remnants of araucaria forest. Photo: Ana Lúcia Hanisch

Improving an agroforestry system with livestock in southern Brazil

Ana Lúcia Hanisch

"Caívas are areas where the remnants of araucaria forest have been conserved for the purpose of animal herding and harvesting of yerba mate (Ilex paraguariensis)."

Agroforestry systems around the world have been valued for their environmental and cultural importance, but there is still a large gap (almost a taboo) in the economic valorization of these systems, especially in terms of increasing their productivity.

In southern Brazil, a type of agroforestry called *caíva* has existed for more than a century. This is a rural property where the remnants of *araucaria* forest have been conserved for the purpose of animal herding and harvesting of yerba mate (*Ilex paraguariensis*; Mello and Peroni 2015; Lacerda et al. 2020; Tomporoski et al. 2022). As an agroforestry initiative that involves native trees, cattle herds and pastures, it is classified as a silvopastoral system (see photo above).

Although *caívas* occupy more than 100,000 ha in the northern region of Santa Catarina State and a similar amount of land in Paraná State, factors

***Caíva* after adoption of Epagri technologies to improve pasture production, Canoinhas, Santa Catarina, southern Brazil. This includes planting of the shade-tolerant perennial pasture *Axonopus catharinensis* overseeded with ryegrass.**

such as legal insecurity, low economic yield and difficulties in management have led to the loss of thousands of hectares of this system, with enormous costs to biodiversity. One of the limitations in the maintenance of these systems is low animal productivity, which in turn is associated with, among other factors, the inadequate management of the native pasture vegetation.

Despite being productive systems, with the almost constant presence of cattle, *caívas* contribute to maintaining a significant forest cover in the region, maintaining rare tree species and even some species threatened with extinction. Surveys conducted in *caívas* have confirmed high levels of tree species richness (an average of 40 species), with a density ranging from 220 to 1,300 adult trees per hectare (Hanisch et al. 2010; Mello 2013; Pinotti et al. 2018), which confirms the importance of this traditional silvopastoral system to forest conservation.

In these systems, livestock usually graze on native pasture vegetation that forms the herbaceous stratum, without grazing control or soil fertilizing. Consequently, pasture yields are low and cease completely during the autumn and winter months, which results in a low stocking rate of 0.35 animal unit/ha (Hanisch et al. 2014). Such a situation is not economically attractive to smallholders, resulting in pressure on *caíva* landowners to replace this system with more profitable alternatives, such as reforestation with exotic species or annual commodity crops (Lacerda et al. 2020).

To address this situation, the Agricultural Research and Rural Extension Company of Santa Catarina State (Epagri), in partnership with several other entities, has been conducting research since 2006 on *caívas*. The results of the technologies that developed from this research have already shown that it is possible to increase animal production by up to 400% in this system, with maintenance of the tree stratum, active forest regeneration, and legal certainty over properties, all of which mean a significant increase in income for families (Hanisch et al. 2021). Environmental benefits occur because the first phase of adopting the technology is to set aside permanent preservation areas and prevent livestock from having access to them.

The technologies developed by Epagri are based on five activities:

1. selection of perennial pastures adapted to shaded areas, so as not to have to cut down native trees;
2. planting of improved pastures adapted to shaded areas (*Axonopus catharinensis*) without soil disturbance, in order to maintain the stock of organic matter and avoid the germination of the seed bank, with the use of herbicides only in the initial phase;
3. soil liming and annual fertilizing of the pasture with applications of organic and mineral sources (top dressing);

4. rotational grazing with pasture height control for animal entry and exit;
5. in the autumn/winter period, overseeding with ryegrass and clover — the areas thus remain productive for more than 300 days each year, with a capacity to support two animal units/ha and to conserve the tree stratum of the forest remnants.

A key step prior to the adoption of these technologies is the selection of a suitable area for *caiva*. In this regard, the main factor is shade provided by the trees. Only *caivas* that naturally have little shade are selected. It is important to realize that, as agroforestry systems in remnants, *caívas* have heterogeneous forest covers. They are classified according to the openness of the canopy: forest, closed *caívas*, open *caívas*, very open *caívas* and *potreiros*, or native pasture vegetation with a few native trees (Marques et al. 2019; see Figure 1).

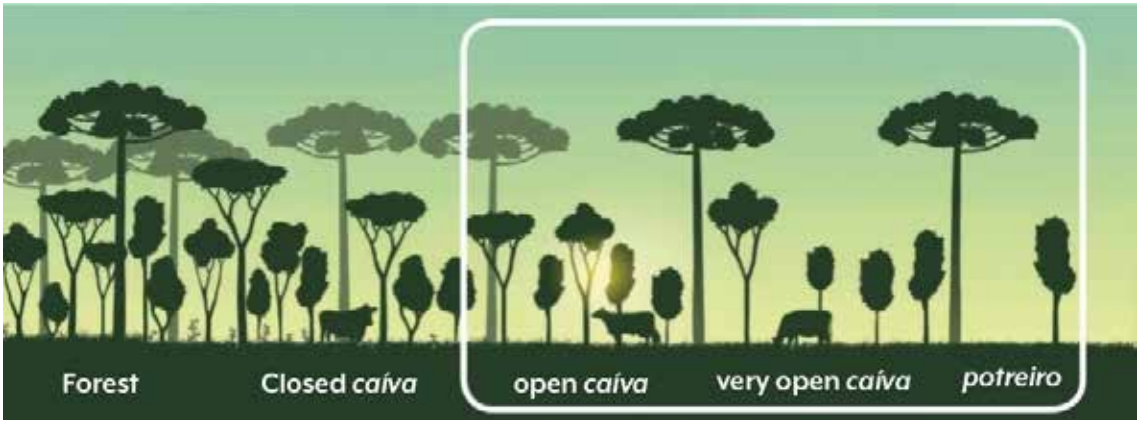

Figure 1. Gradient of shading in *caivas* with different forest covers, from a forest area (with many trees) to an open pasture area with few trees (*potreiros*)

Adopting the strategies of pasture improvement, soil liming and annual fertilization with rotational grazing can occur only in the open and very open *caívas*. This will bring significant results in increasing pasture production and, consequently, in animal production (Hanisch et al. 2022). In other types of *caívas*, it is suggested that they be used for the preservation and provision of ecosystem services.

Research on *caivas* improvement is helping to show that it is possible to conserve forests and generate income with increased productivity. A question that is always asked when the results of increased animal production are presented is: But don't animals eat forest seedlings, compromising forest conservation? First, it is important to remember that the animal has been part of the system for dozens of years, and its presence is important to keep the areas clean of weeds. This facilitates the harvesting of the yerba mate that grows in these systems. And second, with the increase in forage availability that results from the adoption of Epagri's technologies, it is possible to increase the animal load without compromising forest regeneration (which is very active in the fallow areas). This is because animals do not consume tree shoots when there is pasture available (Pinotti et al. 2020; Hanisch et al. 2021).

Epagri is completing 17 years of continuous research, with increasingly encouraging results and with its practices already adopted by dozens of families. Its work has been published in national and international journals and has received several awards and recognitions. Research will continue to face many challenges, but also have many achievements.

Research is based on the premise that the country's research and development sector needs to develop technologies for the farming families who have conserved the forest remnants through utilization. Much has been done and researched on how to recover degraded areas, but very little is invested in agroforestry systems with conservation potential. These now need to be adapted to the purposes of increased production in order to generate income for families.

Research on complex systems such as agroforestry requires medium- and long-term financial resources, as well as multidisciplinary teams, with a focus on productivity and environmental conservation. There is a great demand for the generation and diffusion of technologies for farmers who conserve their forests through using them as agroforestry systems. It is hoped that this technology for pasture improvement in *caívas*

will be an important aid in the process of valorization of these systems, and that it will contribute to the generation of income, better working conditions and environmental conservation in rural properties in southern Brazil.

Finally, it is essential to ensure that the valorization of the *caívas* as areas of environmental use and conservation through strategies for their productive improvement does not contradict the need to maintain permanent preservation areas and to create areas for the exclusive purpose of conservation of the mixed *ombrophilous* forest landscapes.

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