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Maintaining production when trees dominate agroforestry systems at Vale do Ribeira, Brazil

Abstract

The Vale do Ribeira Successional Agroforestry System practiced in areas not covered by native vegetation in the dominion of the Atlantic Forest of Brazil, generates food security, agroecological processes and production, income, social justice and ecological restoration. There is a production bottleneck when the system reaches the tree dominated phase. Our objectives were to examine potential products and propose enhancing strategies. Species diversity and regulation constraints are challenges for production and commercialization. To be successful, one or a few products must be determined, product-specific strategies must be developed, together with building adequate regulations. The juçara palm (*Euterpe edulis*) is the species with the most interesting characteristics and should be the focal species for tree phase sustainable production.

Keywords: timber, ecological restoration, palm heart, Agrofloresta, Atlantic Forest

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Abbreviations: SAFVR, vale do ribeira successional agroforestry system; tree phase, tree dominated successional phase

Introduction

The Vale do Ribeira Successional Agroforestry System (Sistema Agroflorestal Sucessional do Vale do Ribeira, SAFVR), locally called ‘agrofloresta’, was first adopted in the 1990s in the Vale do Ribeira Region, on the border between Brazil’s São Paulo and Paraná States, and today covers thousands of hectares.[1] Its aims to generate income and food, and is the main source of livelihood for the hundreds of peasant families who practice it. Before adopting SAFVR practices, most of these peasants families have already abandoned the traditional swidden agriculture and are now practicing low income and environmentally degrading cattle raising, monoculture agriculture practices, or both.[2]

Like several other initiatives in agroforestry systems in Brazil, SAFVR are based on the traditional swidden agricultural practices of the indigenous people of tropical America,[3] with cyclical management of the landscape, alternating areas in fallow and areas under intervention.[4,5] The adoption of SAFVR practices typically begins on a small area of the family unit’s total area. This small area is one that is no longer covered by Atlantic Forest vegetation at the time of the intervention. The size of the installation unit is around 600 m2,[6,7] which receives a clear cut and the resulting plant material is chopped up and arranged in an orderly manner and with a defined arrangement in the soil, without the use of fire. Afterwards, a dense, diversified and planned planting is carried out for the future composition of the different vertical extracts.[8] Each year, one or two new installments of SAFVR are established in the family unit. Thus, the total area of SAFVR in the family unit constitutes the sum of SAFVR implemented over different years, creating a SAFVR mosaic of different ages and sizes, distributed heterogeneously in space.[6]

As the labor effort is concentrated on SAFVR plots, the family unit’s landscape transits from degraded to restored, as the once pasture and monoculture dominated landscape is covered by second growth forests. This also occurs because the peasants plan to set future SAFVR plots on naturally restored soils that come with secondary growth forests. Thus, even though ecological restoration is not its main objective, SAFVR is restorative, both in the implemented SAFVR plot[9,10] and at the landscape level.[11,12] It also generates social justice and food security, in addition to the sale of hundreds of tons of agroecological products in street markets and institutional sales.[13] For all its qualities, the optimization of SAFVR and its increase in area bring restoration, justice and income-generating landscapes. This should be the goal for social development and environmental conservation public policies.

The cultural background of the rural population of Vale do Ribeira, that are mainly caiçara (people with mixed African, European and Native ancestry), quilombola (mainly African descent) or indigenous traditional communities, facilitates their adherence to SAFVR, as it has the same paradigms related to natural tropical forest processes as their traditional swidden agriculture.[14] Thus, on the agroforestry plots, while the succession has not yet developed long enough for the system´s upper canopy to be dominated by trees. Those which are present are still lower than the crops, the management, products and processes are similar to those that the peasants have historically and culturally carried out through swidden agriculture: annual crops such as vegetables, beans and corn and, later on, cassava, bananas and fruits.

However, from around the seventh year of implementation trees form the upper canopy of the system. This is the start of the tree dominated successional phase (tree phase). Difficulties arise in maintaining the SAFVR[15] as there is a lack of production and, consequently, of income generation. Thus, the peasants opt for either a ‘redesign’ where the SAFVR receives clear cutting and a new SAFVR is implemented, or for ‘non-management’ in which products are extracted from the tree dominated plots, and peasants then apply their work in new agroforestry plots somewhere else in the family unit.

In this case, current strategies, redesign and non-management, do not result in a strong alliance between income generation for the peasants and ecological restoration. The redesign constrains the potential environmental service brought by SAFVR, as it causes the tree phase to last only a short time in the landscape. This is precisely when the tree phase should be providing the greatest wealth of microclimates, ecological niches and biodiversity, in an environment similar to that of the tropical forest and to that of successful *strictu* *sensu* ecological restoration projects.[16–19] Non-management, with its low production, in low income generation is not attractive to new peasants, leading to a reduced adoption of SAFVR.

In contrast, the optimization of SAFVR as a production and restoration system creates more income for the peasant family and restores the ecosystem. This is more beneficial to the peasants as ultimately it generates restored and socially beneficial landscapes. Thus, there is the need to develop strategies that increase income and strengthen ecosystem services. In this sense, financially viable production systems must be built for the tree phase, maintaining this phase for a longer period at the landscape, so combining income generation with socially just ecological restoration.

The objectives of this work are to highlight the potential to produce new products with the greater potential for successful production and commercialization, and so to provide support for the strategies production planning of tree dominated succesional phase of the Vale do Ribeira Successional Agroforestry System – SAFVR.

Material and methods

The study was carried out in the Vale do Ribeira region, on the eastern part of the border between São Paulo and Paraná states, Brazil. The region has the best-preserved Atlantic Forest remnants still standing. The Atlantic Forest, considered one of the world´s most important 'biodiversity hotspots', is an endangered biome that has only about 7% of its original area remaining.[20] The predominant climate in the Vale do Ribeira is subtropical (Cfa).[21] We conducted our work among peasants belonging the Agroforestry Peasants Association of Barra do Turvo and Adrianópolis – Cooperafloresta, the first group of peasants from this region to adopt SAFVR in the 1990s and currently, among dozens of other peasants associations dealing with SAFVR, the one with most associates. Their headquarters is at the municipality of Barra do Turvo, São Paulo (Figure 1). The municipality is 158 meters above sea level on average and has an average temperature of 22.3°C and annual rainfall of 1,592 mm.

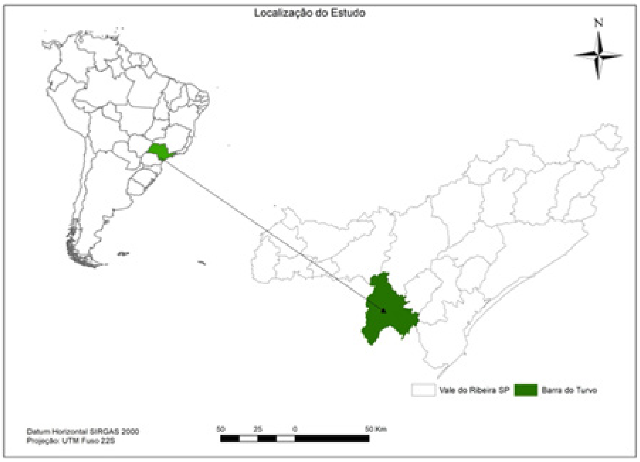

Figure 1 Barra do turvo municipality, regional center for agroforestry systems. Vale do Ribeira, Brazil.

We carried out more than 2500 days of field work over 17 years, from 2007 to 2023. During this period, the difficulties and opportunities of dealing with the tree phase were observed and systematically noted. In 2016, interviews were conducted with seven members of Cooperafloresta's board of directors. Responses were requested to contain an overview of Cooperafloresta's set of SAFVRs, not just the interviewees own plots. First, a semi-structured interview was conducted, following a ten-question guide. The responses were recorded and transcribed.

In the present work, the interviewees' answers to two of the ten questions generated quantitative data: 1- 'What are the current products on the SAFVR tree phase?' and 2- 'What are the potential products on the SAFVR tree phase?' All the products cited by the peasants were listed and classified as fruit, palm heart, leaf or timber.

Unstructured interviews were carried out with the interviewees and bibliographical research was carried out, both focusing on potentials and impediments of the production chains of the products mentioned. In parallel with the bibliographic research, the information obtained from the two quantified questions during the field work days, as well as the remainder of the semi-structured interview questions were used to discuss the difficulties in generating income in the tree phase together with the opportunities for action to overcome them.

Results

43 products from the tree phase were mentioned in the two quantified questions. 25 were current, 9 potential and 7 mentioned both as current and potential (Table 1). 36 are food (88%), three are timber (7%) and two are medicinal (5%) (Figure 2a). The food products mentioned were 31 fruits (76%), three palm hearts (7%) one leaf and one (2.5%) and one tuber (2.5%) (Figure 2b), with seven fruits being mentioned as both current and potential. Of the total species mentioned, 40% are indigenous to the region, 12% are originally from northern Brazil and the remaining 48% are exotic (Figure 3). The willingness of farmers to incorporate (agro)ecological tourism, bee products and payment for environmental services was also recognized in the answers to the quantified questions.

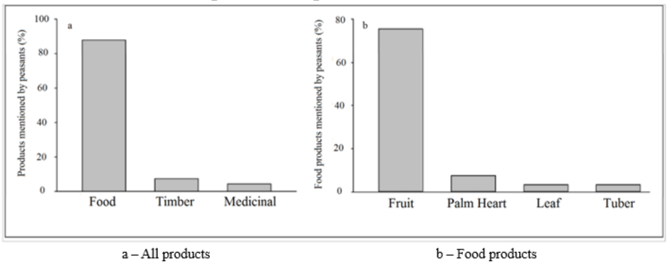

Figure 2 Products types from the tree dominated successional phase of the Vale do Ribeira Successional Agroforestry System, Brazil, mentioned by practitioners peasants in semi-structured interviews.

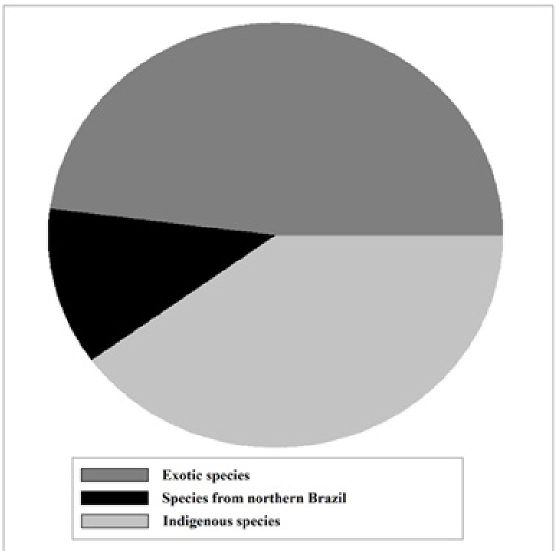

Figure 3 Origin of products from the tree dominated successional phase of the Vale do Ribeira Successional Agroforestry System, Brazil, mentioned by practitioners peasants in semi-structured interviews.

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Table 1 Products from the tree dominated successional phase of the Vale do Ribeira Successional Agroforestry System, Brazil, mentioned by practitioners peasants in semi-structured interviews

Common name	Scientific name	Product	Use	Origin
Abiu	*Pouteria caimito*	Fruit	Current	Indigenous
Guava	*Psidium guajava*	Fruit	Current	Indigenous
Grumixama	*Eugenia brasiliensis*	Fruit	Current	Indigenous
Cocoa	*Theobroma cacao*	Fruit	Current	North Brazil
Cupuassu	*Theobroma grandiflorum*	Fruit	Current	North Brazil
Custard Apple	*Annona squamosa*	Fruit	Current	Exotic
Banana	*Musa spp*	Fruit	Current	Exotic
Coffee	*Coffea canephora*	Fruit	Current	Exotic
Star Apple	*Chrysophyllum cainito*	Fruit	Current	Exotic
Golden Apple	*Spondias dulcis*	Fruit	Current	Exotic
Star Fruit	*Averrhoa carambola*	Fruit	Current	Exotic
Acerola	*Malpighia emarginata*	Fruit	Current/Potential	Indigenous
Cabeludinha	*Myrciaria glazioviana*	Fruit	Current/Potential	Indigenous
Yellow Mombin	*Spondias mombin*	Fruit	Current/Potential	Indigenous
Persimmon	*Diospyros kaki*	Fruit	Current/Potential	Exotic
Avocado	*Persea americana*	Fruit	Current/Potential	Exotic
Red Guava	*Psidium cattleyanum*	Fruit	Potential	Indigenous
Uvaia	*Eugenia pyriformis*	Fruit	Potential	Indigenous
Passion Fruit	*Passiflora edulis*	Fruit	Potential	Indigenous
Jabuticaba	*Myrciaria cauliflora*	Fruit	Potential	Indigenous
Jack Fruit	*Artocarpus heterophyllus*	Fruit	Current	Exotic
Lychee	*Litchi chinensis*	Fruit	Current	Exotic
Lemon	*Citrus × limon*	Fruit	Current	Exotic
Mangosteen	*Garcinia mangostana*	Fruit	Current	Exotic
Tangerine	*Citrus reticulata*	Fruit	Current	Exotic
Peach	*Prunus persica*	Fruit	Current/Potential	Exotic
Orange	*Citrus X sinensis*	Fruit	Current/Potential	Exotic
Canistel	*Pouteria campechiana*	Fruit	Potential	Exotic
Jussara	*Euterpe edulis*	Fruit, palm heart	Current	Indigenous
Peach Palm	*Bactris gasipae*	Palm heart	Current	North Brazil
Royal Palm	*A.cunninghamiana*	Palm heart	Current	Exotic
Yellow Laurel	*Nectandra lanceolata*	Wood	Current	Indigenous
Cedar	*Cedrela fissilis*	Wood	Current	Indigenous
Capororoca	*Myrsine coriacea*	Wood	Current	Indigenous
Guaco	*Mikania laevigata*	Leaf	Potential	Indigenous
Jaborandi	*Piper hispidum*	Leaf	Potential	Indigenous
Cocoyam	*Xanthosoma sagittifolium*	Leaf	Potential	Exotic
Yam	*Dioscorea sp.*	Tuber	Potential	Exotic

The interviews and field observations highlighted two main factors generating low production in the tree phase: Diversity in excess regarding the upper canopy, both in species composition and in spacing between individuals, and bureaucratic and legal obstacles to the indigenous product commercialization.

Discussion

There are many potentials and/or current products in the tree phase of the SAFVR. The predominance of food products is related to the peasant traditional subsistence system, swidden agriculture, shaping the current production and marketing channel. Currenty, only 19 of the mentioned 36 food products were actually commercialized from 2009 to 2011,[22] indicating that for many of them, such as coffee, there is current production but as yet no commercialization.

Medicinal plants and timber are considerable economic alternatives, and one of the two medicinal plants mentioned, jaborandi (*Piper hispidum*) is one of the most common components of SAFVRs.[17] But, among other improvements needed to accomplish commercialization success, such as defining these products as agroforestry tree products (AFTPs),[23] it would be necessary to create specific marketing channels, as these products cannot be sold through the current commercialization channels, that is, street market and institutional sells. According to brazilian regulations, a medicinal plant can only be legally commercialized through manipulation pharmacies and industries.[24]

There are dozens of timber species in the SAFVR but there is no commercial exploitation, only sporadic use in family units.[17,7] As there is not enough scale to supply industries, the most promising path is the manufacturing production of certified furniture. Successful timber production and commercialization on SAFVR can be accomplished and should have government incentives, as it faces many challenges. These are: restraint regulation, especially for native species, product removal from SAFVR without damaging other crops, specific training, planning and building adequate processing infrastructure and species diversity requiring specific techniques.

Overall, there is plenty of evidence that there is an underuse of the productive potential in the tree phase. This is caused mainly by excessive diversity in the upper canopy, both in species composition and in spacing between individuals, and bureaucratic and legal obstacles to the indigenous product commercialization. The excess diversity of species and spacing generates several difficulties, including: low numbers of individuals of each species resulting in low production of each product, unequal growth and sunlight access among individuals, heterogeneous product maturation time, harvesting logistic complexation, and a wide array of post-processing and commercialization needs due to a wide range of products.

The excess of diversity and spacing is caused in part by a plurality of objectives, concepts and paradigms under which the SAFVRs are planned, executed and evaluated as successful or not: production, soil restoration, social justice, cultural rescue and analogy with the original biome, among many others (Steenbock et al. 2013c). This plurality of objectives and paradigms results in a very diverse spatial design of individuals and species composition. This is especially evident in the tree phase, which is intended to be the most lasting and the purpose of agroforestry. It is here that agroforestry and natural forest are most similar in terms of their wide range of paradigms and success factors.

The excess of diversity and spacing also arises from the relatively short time since the adoption of SAFVR. In the successional phases prior to the tree phase there is a history of hundreds of years of development of swidden agriculture technologies,[25] but the tree phase is not part of the peasants experience and traditional culture. Hence it is often conducted through trial-and-error methods.[15]

Non-existent, contrary or excessively bureaucratic regulations and public policies affect the commercialization of products from planted indigenous species, especially timber.[26,27] This stands out as causing difficulties in income generation on SAFVR, and on agroforestry systems in Brazil[28,29] and around the world.[30–35] On the other hand, adequate public policies may support the integration of indigenous species production in agroforestry systems for multiple social, economic and environmental benefits.[36,37]

Besides the detrimental effect on peasant's livelihoods, this issue generates uncertainty regarding the assured legal commercialization of their production. This is a disincentive, both to peasants and to research, limiting action on the development and construction of the new technologies needed throughout the tree phase from planning, planting, management, processing, commercialization, to evaluation, etc. Juçara Palm (*Euterpe edulis* Martius) for palm hearts and indigenous timber species are the SAFVR tree phase components most harmed by this lack of technologies caused by current regulations and public policy.

In this context, the construction of both product-specific strategies and stimulative regulations for planting and commercializing native species is imperative for the productive and commercial success of the tree phase of SAFVR. Outcomes and strategies that adhere to the multiple objectives and paradigms of SAFVR must be found. These would involve planning, implementing and managing SAFVRs to meet the demands of multiple objectives, including their production chains.[38,39] These objectives might include the restoration of landscape, the generation of income through payment for environmental services and/or the stimulation of rural tourism initiatives.

Juçara palm was mentioned by all interviewees. More than any other species it meets the objectives and paradigms established by SAFVR practioners. It has the most complete set of interesting characteristics for ecosystem services production, while also being an indigenous species that is vulnerable to extinction.[40] It is considered a keystone species, as its fruits feed numerous animal species, including some endangered by extinction, such as The Black-fronted Piping Guan (*Aburria jacutinga*) and the red tailed amazon (Amazona brasiliensis), both of which occur in the Vale do Ribeira. Jucara palm has an established sustainable management[41] and its harvest brings no significant negative physical impacts on other crops of the SAFVR tree phase. It has two main products: palm heart, a traditional and renowned product of Brazilian cuisine with a well established market,[41] and pulp, similar in taste, texture and colour to açaí (*Euterpe oleracea*) pulp. Its functional properties are rapidly gaining market appeal.[42] Both products are processed and commercialized through facilities and routes that already exist in Cooperafloresta and other peasants associations of the region.

Work alongside public agencies and stakeholders is needed to construct and implement the regulations and public policies needed to encourage the production and commercialization of planted native species and to boost the market for certified forest biodiversity products and to encourage the development of optimization technologies. Recently, some Brazilian states have made such innovatations in their regulations and public policies. For example, the State of São Paulo issued Resolution SMA 189/2018,[43] which brings significant advances in opening paths for the planting, registration, management and commercialization of planted native species. Another example is Rio Grande do Sul State, which has invested in the interpretation and application of the already broad existing legal framework and it has created the Ecologically Based Agroforestry Certification procedure in 2013.[29]

Conclusion

There are dozens of species with current or potential importance that are found in the tree phase of the SAFVR. For productive and commercial success, there is a need to create both product-specific strategies and the regulations needed to enhance the management of them as planted and domesticated native crop species. The juçara palm (*Euterpe edulis*) is the species that has the greatest potential as the first priority focal species.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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