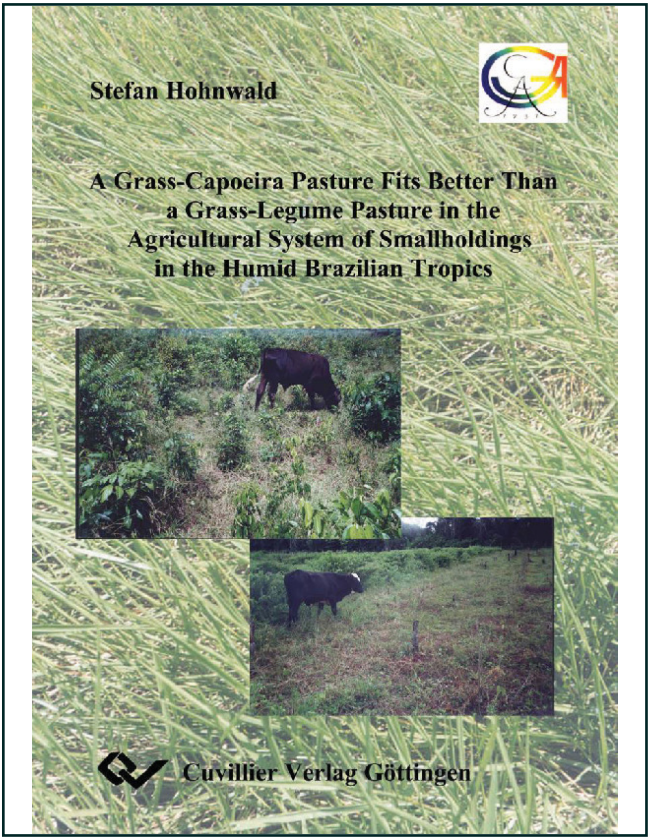
Stefan Hohnwald (Autor)

A Grass-Capoeira Pasture Fits Better Than a Grass-Legume Pasture in the Traditionale Agricultural System of Smallholdings in the Brazilian Humid Tropics



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1. INTRODUCTION

Since the UNCED Conference, held in Rio de Janeiro in 1992, the protection of tropical rainforest ecosystems has been accepted worldwide as an international task. According to the aims of the Agenda 21, the SHIFT[1]-program developed measures aimed at a conservationally and environmentally sound treatment and land use of tropical forest ecosystems, in order to maintain their biodiversity, their global climatic function, their economic and their non-use values (Lieberei & Salati, 1998). This program also contributed to the research program 'Man and Biosphere' of the UNESCO and the 'Pilot Program for the Conservation of the Brazilian Rainforest'. Nonetheless, destruction of Brazilian rainforest has continued due to logging for timber production, clearance for mining, exploitation for oil, and conversion into agricultural land (INPE, 2002). Thus, between 1978 and 1988 Brazil was the most forest destructive country in the world with a yearly reduction of 1.5 million ha of rainforest (Downing *et al.*, 1992; Skole & Tucker, 1993). Extensive cattle ranching (>50%), shifting agriculture (30-35%) and logging (10%) have been the most important land use systems replacing tropical forests (Fearnside, 1993; Serrão *et al.*, 1996). Because only 7.5% of the 20 million hectares of tropical pastures were related to subsidized ranching (Yokomizo, 1989), it became evident that most of the area had been cleared by smallholders (Faminow, 1998; Walker *et al.*, 2000). Conversion into pastures was particularly criticized because most humid tropical pastures are said to be unsustainable (Fearnside, 1993; Fairfax & Fensham, 2000) and often only planted for speculative purposes (Hecht, 1980; Parayil & Tong, 1998).

The Bragantina region in northeastern Pará (Brazil) is a region where agricultural systems have almost completely replaced the tropical rainforest (Denich, 1986). Smallholders with less than 100 ha farms settled 97% of the land (IBGE, 2002), and their traditional agriculture is based on the exploitation of the regenerative potential of the woody fallow vegetation. Recently, farmers have been forced to shorten the fallow period mainly due to increasing population pressure (Denich, 1989; Denich & Kanashiro, 1993). This is seen to be critical because the complete agricultural system is based on the re-growing natural fallow vegetation. The shortening of fallow periods leads to the well known downward spiral of land degradation and declining crop

[1] SHIFT – Studies on Human Impact on Forests and Floodplains in the Tropics. A German-Brazilian Research Program, BMBF, Germany

yields with smallholders threatening to destroy the resources they depend on (Loker, 1994). Since the second half of the 1960s farmers have enlarged the problem of scarce land resources by removing fallows to plant cash crops like black pepper, oil palms, and passion flower fruit (Silva *et al.*, 1998). Furthermore, since the 1980s smallholders separated more areas from the fallow cycle to start cattle husbandry (Veiga, 1993; Billot, 1995). Generally, unfertilized and extensively used pastures in the humid tropics were said to often reach an advanced state of degradation after 7 to 10 years due to decreasing soil fertility, insect pests and invading woody vegetation (Serrão & Nepstad, 1996). The stocking rate had to be gradually reduced until the costs of maintaining the pasture were no longer justified and were abandoned after 10 to 15 years of use. Eight years after abandonment, 'heavily-used' pastures still showed a retarded or disturbed regeneration of forest vegetation as indicated by a comparatively lower biomass, lower number of forest trees and higher depletion of soil nutrients than 'lightly-used' pastures (Buschbacher *et al.*, 1988; Uhl *et al.*, 1988). In contrast to large farms, smallholders could neither afford fertilizer nor mechanized weeding nor were they able to shift to free land resources. Thus, the smallholder pasture engagement ended with 'degraded areas' of unproductive pastures on which the regenerative capacity of the secondary vegetation had been severely weakened. These 'heavily-used areas' could not be turned back into agricultural use easily and were considered to develop rather into worthless scrublands (Uhl *et al.*, 1988). Thus, monocultural grass-only-pasture-systems did not seem to be a viable strategy in the humid tropics because smallholders lost their land resources and increased the pressure on their remaining fallow lands.

The objective of this study was to find ways to prevent ecological pasture degradation by integrating pastures into the traditional slash-and-burn cycle. An ecologically sound integration of cattle keeping would not only contribute to smallholders' income and fight poverty in the rural areas but also would mean an intensification of land use on already cleared land resources and a stabilization of the smallholders' situation. Furthermore, together with policies that slow down the opening of new frontier areas, this approach would give hope to prevent further deforestation of the Amazonian rainforests (Loker, 1994).

2. LITERATURE REVIEW

2.1. THE CAPOEIRA WITHIN THE SLASH-AND-BURN CYCLE

Slash-and-burn systems are typical for densely settled regions in the humid tropics with fixed abodes like in the Bragantina region. They consist of two main phases, that is the cropping and fallow phase which can be described as follows: after a 7 to 10 year fallow period, the secondary vegetation is cut at the beginning of the dry season (October-November). After a few weeks of drying off the slashed woody vegetation is burned (Denich, 1989; Baar, 1997; Denich & Kanashiro, 1998). Traditionally, nutrient enrichment of the soil after burning is explained by the input of major quantities of nutrients by the ash (Sanchez, 1982; Smyth & Bastos, 1984). But the decomposition of organic matter like fine roots also contributes to the nutrient supply (Sommer, 2000). After the burning, a one to two year crop period follows in which maize (*Zea mays* L., 6 months) or rice (*Oryza sativa* L., 4 months), beans (*Vigna unguiculata* (L.) Walp.) and cassava (*Manihot esculenta* Crantz, 16 months) are cultivated (Denich, 1989; Denich & Kanashiro, 1998). The re-sprouting of the secondary vegetation, begins immediately after the burning of the slashed dry matter. During the cropping period the re-growing vegetation has to be cut frequently. Three to five months before the cassava harvest the trees and bushes are no longer slashed so that the fallow period starts at this time. The secondary vegetation closes increasingly after the cassava harvest and a dense secondary forest develops after approximately four years. The agro-ecological cycle is closed when the secondary vegetation has accumulated enough biomass to allow the start of a new cropping phase (Denich, 1989; Baar, 1997). Thus, the complete slash-and-burn cycle is based on the recuperative abilities of the fallow vegetation (Denich, 1989; Loker, 1994; Juo & Manu, 1996).

The secondary vegetation of the fallow has its origin in the potential natural vegetation. In the northeast of Pará this is the evergreen tropical rainforest, which switched into a semi-evergreen rainforest further east (Ducke & Black, 1953; Kuhlmann, 1977). When settlement started at the beginning of the last century the natural forest was cleared and destroyed (Egler, 1961). Tree species that did not endure the frequent slash and burning vanished. Woody species from the genera *Casearea*, *Davilla*, *Lacistema*, *Myrcia*, *Miconia* and *Vismia* that were able to survive mechanical and fire damages, remained in the region and became more important (Baar, 1997). When slash and burn activities were carried out more frequently a fallow vegetation with a distinctive species composition was formed. In northern Brazil this fallow vegetation is called

'Capoeira' which originates from the Tupi language and means 'forest that once was' (Clausing, 1994). The Capoeira is an extremely dense secondary forest (Figure 1) that consists of about 122,500 individuals ha^{-1} (Schuster, 2001) of young trees, bushes, woody and herbaceous lianas, herbs and grasses (Denich, 1989; Baar, 1997). It shows a remarkably fast re-growth because it also consists of many pioneer species. Capoeira species regenerate mainly vegetatively (58% of species), while 25% of the species show generative and 17% indifferent regeneration (Clausing, 1994). The vegetation either re-sprouts from subterranean rootstocks, from epicormic buds of stumps or from horizontal and tap-roots (Vockel & Denich, 1998). Within the Capoeira 85% of the species are clumped and 8% are dispersed coincidentally. Most Capoeira species have negative segregation to other plant species, and 20% of the Capoeira plants have an independent growth behaviour. There are no signs that species are positively related to each other (Schuster 2001).

The Capoeira is highly phytodiverse with, on average 60-80 species/ 100 m², but samples of more than 120 species have been reported (Baar, 1997; Schuster 2001). The most frequent plant families in 3-4 year old Capoeiras are *Fabaceae*, *Poaceae*, *Myrtaceae*, *Bignoniaceae*,

Figure 1: Typical example of a 3-4 year old Capoeira in northern Pará, Brazil. The photo shows the extreme dense growth of the secondary vegetation, which restores extraordinarily fast

Asteraceae, *Smilacaceae*, *Euphorbiaceae,* and *Rubiaceae*. Importance-values of Capoeira species were calculated by taking into account the frequency, number of examined plots, abundance, biomass, and leaf index. In Table 1 the most frequent species according to Baar (1997) and most important Capoeira species according to Denich (1989) are listed.

Table 1: The most frequent and important Capoeira species (Denich, 1989; Baar, 1997)

Species name	Family	frequent	important
Vismia guianensis (Aubl.) Choisy	*Clusiaceae*	X	X
Myrciaria floribunda (H. West ex Willd.) O. Berg	*Myrtaceae*	X	X
Myrcia deflexa (Poir.) DC.	*Myrtaceae*	X	X
Myrcia bracteata (Rich.) DC.	*Myrtaceae*	X	X
Banara guianensis Aubl.	*Connaraceae*	X	X
Lacistema pubescens Mart.	*Lacistemataceae*	X	X
Rollinia exsucca (DC. ex Dunal) A. DC.	*Annonaceae*	X	X
Rourea ligulata Baker	*Connaraceae*	X	X
Myrcia cuprea (O. Berg) Kiaersk.	*Myrtaceae*	X	X
Abarema cochleata (Willd.) Barneby & J.W. Grimes	*Mimosoideae*	X	X
Inga heterophylla Willd.	*Mimosoideae*	X	X
Memora flavida (DC.) Bureau & K. Schum.	*Bignoniaceae*	X	X
Myrcia sylvatica (G. Mey.) DC.	*Myrtaceae*	X	
Davilla rugosa Poir.	*Dilleniaceae*	X	
Casearia grandiflora Cambess.	*Flacourtiaceae*	X	
Annona montana Macfad.	*Annonaceae*	X	
Serjania paucidentata DC.	*Sapindaceae*	X	
Neea oppositifolia Ruiz & Pav.	*Nyctaginaceae*	X	
Bernardinia fluminensis (Gardner) Planch.	*Connaraceae*		X
Senna chrysocarpa (Desv.) H.S. Irwin & Barneby	*Caesalpinioid.*		X
Davilla kunthii A. St.-Hil.	*Dilleniaceae*		X
Phenakospermum guyannense (Rich.) Endl.	*Strelitziaceae*		X
Memora allamandiflora Bureau ex K. Schum.	*Bignoniaceae*		X
Machaerium quinata (Aubl.) Sandwith	*Papilionoideae*		X
Terminalia amazonia (J.F. Gmel.) Exell	*Combretaceae*		X
Doliocarpus brevipedicellatus Garcke	*Dilleniaceae*		X