Traditional cocoa agroforestry systems in Waslala, Nicaragua: adoption of technology and adaptation to local environment and priorities

R. Lok[1] & D. Sandino[2]

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Introduction

The municipality of Waslala has about 40.000 inhabitants, 80% of which have been resettled in the area at the beginning of this decade. Most of the population lives in the rural areas under precarious circumstances; Cocoa (*Theobroma cacao*), maize (*Zea mays*), beans (*Phaseolus vulgaris*) and cattle being the main sources of income. The production of cocoa was severely affected with the introduction of *Moniliasis* in the area in the 80's. Programs to improve cocoa production have included the introduction of management practices to control the fungus. The main practices diffused in the area include the removal of infected fruit (once a week), pruning of the shade trees (twice a year), pruning of the cocoa trees (twice a year) and weed management (whenever needed). Extensionists do inform the farmers that they should open up the crowns to stimulate production, but no specific recommendations are given. Traditionally, most of the cocoa produced was sold at low prices to intermediaries: this hindered the management of the plots. As of 1996 though, some NGO's have established collection sites in the area and have been able to sell the cocoa at better prices. This not only helped increase the local farmer's income, but also stimulated a better management of the cocoa systems (Unión Europea 1994; Thienhaus 1992). Although the practices introduced to restrain *Moniliasis* have been widely accepted in the area, no single farmer has actually applied them to the letter: each seems to adapt the recomendations to his priorities and options which are in part determined by the bio- and geophysical circumstances of his plot. The main objective of this study was to analyze how this is done and why.

Methodology

Initially 60 cocoa producing farmers that had received training in improved cocoa management were selected in four communities in the area of Waslala. This was done with the help of an existing census. Basic social, economic and cocoa-management information was collected by means of a questionnaire. A second sample of 20 farmers was randomly selected from this first group for an in-depth study of the characteristics of their cocoa-plots. Furthermore, to get an insight into the relative importance of the cocoa-production, these 20 farmers were asked to draw maps of their farms and rate the different systems or resources according to their own criteria. Field data was collected from february to july 1998.

Descriptive and inferential statistical procedures were used to analyze the data. The relation between the incidence of *Moniliasis* and variables related to management and geo-physical characteristics (including distance between cocoa, height of first cocoa fork, percentage of shade, presence of water sources, area destined to cocoa, and total area) were analyzed through a stepwise regression (Freund and Littell 1986).

[1] Rossana Lok, Proyecto Agroforestal CATIE-GTZ, Area de Agroforestería, 7170 CATIE. E-mail: rlok@catie.ac.cr
[2] Dinorah Sandino, Pro Mundo Humano, carretera sur km 13, Managua, Nicaragua. E-mail: promundo@ibw.com.ni

Results and Discussion

The population under study has an average of six members per family. Education is relatively low, with 56% having completed some grades of primary school and 42% having no education at all. All depend on agricultural activities and 59 out of 60 families own their land. The average size of the farms is 21ha. However, 33 of the farms are under 20 ha, 20 farms are between 20 and 40 ha, and only seven farms are larger than 40 ha. All of the farms are diversified with a combination of production sub-systems, that can also include pastures and forest. The total amount of cultivated area (mainly cocoa, coffee and staples) on the farms is relatively small compared to the total amount of area of the individual farms.

The importance of cocoa production is expressed by the farmers in relationship to their other main agricultural products. In this way, the main opinions on the cocoa are that it yields better profits; it covers losses and requires less investment. For all three criteria the cocoa is compared with maize and beans, that are produced mainly for own consumption, while the cocoa harvest is destined almost entirely to the generation of cash income. Furthermore, the vulnerability of the production of staple food in the area was accentuated in 1998 by the enormous drought (caused by 'El Niño') and the subsequent fires. Farmers have incurred losses of their staple food production and some families have had nothing else to live on than the income generated by the cocoa harvests. Additionally, to obtain acceptable production, fertilizers and some chemicals have to be applied to maize and beans, while the cocoa plots produce with management inputs alone, consisting mainly of labor input. In this way, the cocoa production is turned into a relatively cheap system with the capacity of acting as a 'buffer' in time of need. It is in this light that the management and the characteristics of the cocoa plots has to be analyzed. The conscious combination of characteristics (species and bio- and geo-physical characteristics) enable the farmer to guarantee a sustainable production with little input year after year.

More than 70 species of shade trees were identified in the plots of the 60 farmers of the sample. Of these, only 8 species were found in 15 (25%) or more plots. Guaba (*Inga* spp.), a woody legume, was found in 44 of the 60 (73%) of the plots with higher frequencies than any other tree species (2096 trees were reported). Laurel (*Cordia alliodora*) was identified in 43 plots, but at much lower frequencies than guaba (*Inga* spp.) (863 trees reported). The following were also important, but were all at even lower frecuencies: aguacate (*Persea americana*) in 31 plots; mango (*Mangifera indica*) in 27; majagua (*Thespesia populnea*) in 22; naranja (*Citrus sinensis*) in 20; and cedro (*Cedrela odorata*) and pejiballe (*Bactris gasipaes*) in 15 plots. Many of the species were identified as being of multiple use, the most common uses (besides shade) being firewood, fruit and timber (mainly for own consumption). Some species provide very specific services: majagua for instance, is used to provide fiber rope; laurel, muñeco (*Cordia* sp.) and guano (*Ochroma lagopus*) are used to make rooftiles and the trunk of the guarumo (*Cecropia insignis*) is used to pipe water, while the leaves are used as tamal-wrapping. Interestingly, madero negro (*Gliricidia sepium*) is recognized by some farmers as a species that contributes organic fertilizer, while guaba (*Inga* spp.), is only attributed use as shade and firewood. Not withstanding this, through time, farmers must have observed the positive effects of the association of cocoa with guaba (*Inga* spp.), which has led them to consciously select and manage this species in greater quantities than other species in their plots. For instance, farmer no. 22 whose expected yield is very high (Fig. 1), reported 100 guabas and 50 madero negro along with another nine tree species at much lower frequencies in his plot of 0.35 ha. Roskoski (1981), found high nitrogen fixing properties of *Inga jinicuil*, in association with coffee. The properties of the *Inga spp* in the plots in Waslala should be anayzed in future studies.

Yields vary greatly between plots, due to differences in bio and geophysical circumstances. On the other hand, unexpected differences were found between the yields per ha declared by the farmers and what was observed during the first production peak during the fieldwork. In more than 70% of the cases the differences between the declared and the observed yield were small or negative, implying that last year's yield over the whole year amounted to just a little bit more than this year's yield from one major harvest. The differences could be explained by the fact that the farmers are not giving correct information on their yields, in combination with the fact that 'El niño' may have affected the production cycle of some of the cocoa plots. Considering the insecure living circumstances in the area (kidnapping, murder and theft) and the possible debts incurred with NGO's that helped improve cocoa management, it is more than likely that many farmers are not willing to reveal their correct cocoa yields. To get an idea on the probable yield patterns during 1998, it was necessary to recur to data on the monthly collected cocoa by NGO's over 1997, and assume that the pattern of collection over one year would reflect the average local pattern of yield amongst those farmers that delivered their cocoa to the NGO (which includes the present sample). Through this pattern of collection, which clearly recorded two main peaks in 1997, a quotient (3.55) was estimated to calculate 1998 yield from the observed yield data of one harvest peak (Fig. 1). It is with this estimated yield per ha that further analyses were carried out.

Expected yields per ha per plot vary from 0 to 1700 kg, with 70% of the plots yielding 500 kg or less per ha per year, with a global average of 416 kg dry cocoa per ha per year (Fig. 1). This coincides with expected yields in cocoa plots with a minimum management as described by Alvim (1977), who indicates that yields can vary between 300 kg and 500 kg of dry cocoa per ha per year.

Considering the fact that dry cocoa is sold in Nicaragua at more or less one US $ per kg, and that the minimum wages in the area are of US$ 2,50 per day (which amounts to US$ 600,- per year, 20 working days per month), 40 % of the cocoa producers in the sample are covering one or more minimum wage with their total expected cocoa yield per year, while another 40% is covering less than half of the one minimum wage (Fig. 1).

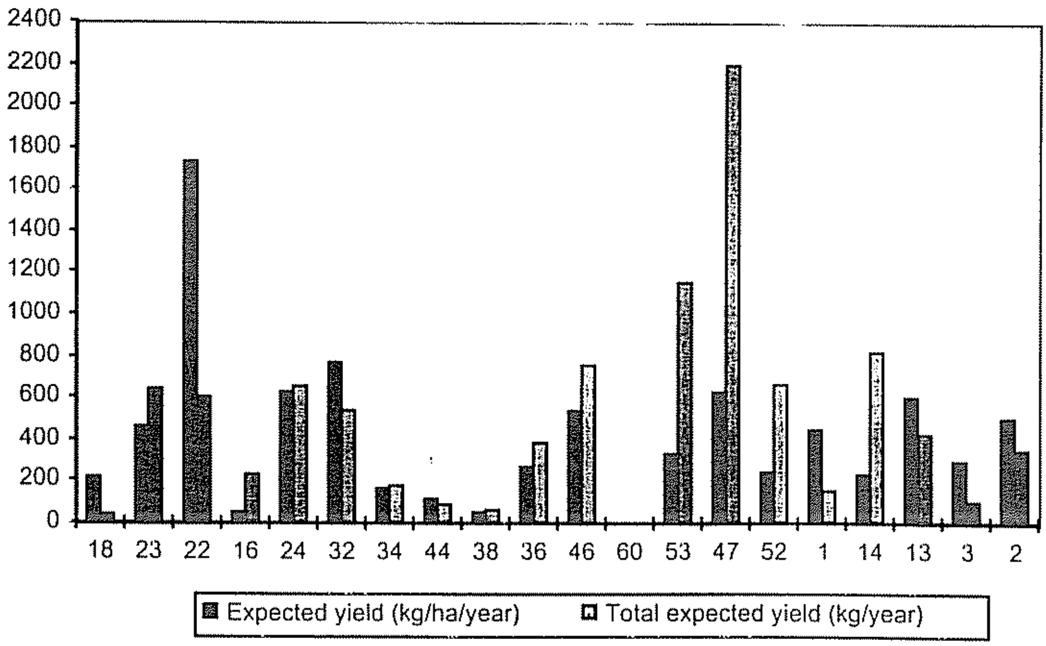

Figure 1. Expected cocoa yields (per ha and total) per plot over 1998 for the 20 farmers in the second sample, Waslala, Nicaragua.

The differences in yields per ha among the farms are related to the incidence of *Moniliasis* and bio and geophysical circumstances. There is no significant relationship between the incidence of *Moniliasis* and the management practices diffused in the area regarding the removal of infected fruit, the pruning of the cocoa tree and the pruning of the shade trees. Most farmers remove the infected fruit about once every two weeks. Only six of the 20 (three with a high incidence of *Moniliasis* and three with a low one) remove the infected fruit once a week (or more) as recommended. Pruning of the shade trees is also done less frecuently than recommended in both groups, but surprisingly, the pruning of the cocoa trees (excluding the crowns) is done much more frecuently than recommended in both groups.

Bio and geo-physical characteristics of the 20 cocoa plots of the farmers in the second sample were analyzed in relation to the incidence of *Moniliasis*, through a stepwise regression. The model identified the open state of the crown of the cocoa trees ($p<0.01$), the presence of water sources ($p<0.10$), the altitude (masl) of the plots ($p<0.01$) and total area of productive cocoa ($p<0.001$) as the variables that explain the incidence of the *Moniliasis*, producing a highly significant model: $p<0.001$ with a multiple regression coeficient of $R^2 = 0.74$.

The main characteristics of plots with a low incidence of *Moniliasis* include a tendancy to manage a closed cocoa crown, have no water sources running through or bordering the plots and of being relatively small plots on flat ground.

Although no significant relationship was found beween the percentage of shade generated by the shade trees and the incidence of *Moniliasis*, there is a tendancy to encounter a more uniform amount of shade of between 20 and 35% in plots of eight years and older (Fig. 2). On the other hand there is also a tendancy towards finding more closed cocoa crowns in these same plots.

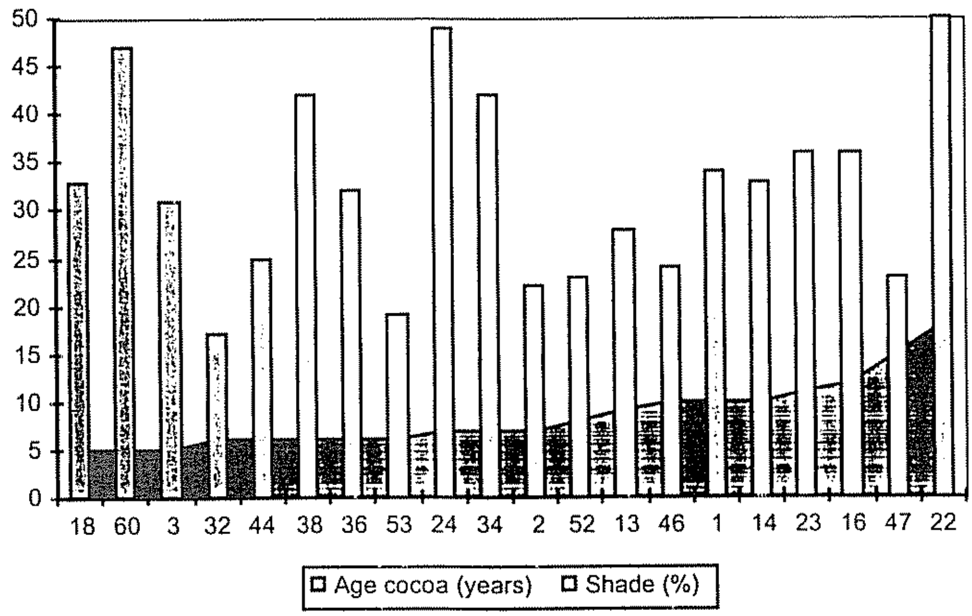

Figure 2. Percentage of shade in relation to age (in years) of the cocoa per plot for the 20 farmers in the second sample, Waslala, Nicaragua.

Farmers deliberately choose the sites where to establish their plots and manage the crown of their cocoa trees according to the presence of water sources (and thus the levels of humidity) in their plots. If they have water running through or bordering the plot they will tend to open the crown of the trees and let more light through. If this is not the case, they prefer to let crowns close, thus protecting the trees from dehydration and at the same time protecting the soil from erosion. Under these circumstances weeding is also less frequently needed As one farmer expressed himself clearly: "*I was told to establish my plot here on this piece of flat ground next to the river, because this was the best place according to the extensionist, but I regret having done so. Next time I will establish my plot far from the river on the slope. This will give me less work, while still producing an acceptable amount of cocoa.*"

On the other hand they are well aware that opening up the crown of the cocoa trees and thus letting in more light, will stimulate the production, but not many are willing to risk sustainability over time. A striking example of the extreme consequences of having opened up the crown of the trees to stimulate production is the case of farmer no. 60 (Fig.1) whose trees have come under so much stress through dehydration due to drought, that the trees have literally dried out, not yielding any fruits this year.

Conclusions

For the local farmers in Waslala, Nicaragua cocoa is an important production sub-system for the generation of cash and products for home consuption, such as firewood, fruit and timber and others. It is seen as complementary and a buffer to other agricultural crops on the farm, making it's sustainability over the years a necessity. This, in great part determines the way it is managed. Through a mixture of acquired, adapted and local knowledge, the farmers produce cocoa in a relatively cheap and sustainable way. Management strategies include a conscious selection of shade tree species, as well as the management of bio- and geo physical characteristics. The main shade trees selected are guaba (*Inga* spp) and laurel (*Cordia alliodora*), which are of multipurpose use, followed by several fruit species. Extension projects should take in to account farmer's criteria and views on the establishment and management of plots.

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