Feasibility of Organic Production Systems in Talamanca, Costa Rica

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Abstract

Organic agriculture has been identified as a growing market niche, gaining importance at a time when globalisation and national macro-economic reform policies are hampering the economical profitability of production systems of small farmers in Latin America. IFAD is investigating the prospects for organic agriculture, as an alternative for small-scale producers, through the systematisation of some successful experiences. In this way, it is endeavouring to generate lessons for the design and implementation of poverty alleviation projects that aim to diversify the production of small farmers.

This report refers to one of the cases investigated and involves a rapid appraisal of the socio-economic and biophysical viability of producing organic banana and cocoa in Talamanca, Costa Rica.

The producers of this system are organized and commercialise their products through the Talamanca Small Farmers´ Association (APPTA). The investigated production system is characterised by a mixture of cocoa, banana, fruit and timber trees and root crops, on about 2 hectares per family. The commercialisation of organic banana and cocoa through APPTA, together with the production of fruits and timber wood, is found to be an economically feasible activity. Therefore, the commercialisation opportunities offered by APPTA are highly important for the local population and enable them to continue living in ways that fit in well with their traditional and cultural context, where respect for nature and environment play an essential role. The production of bananas sold for baby food offers reasonably good economic prospects, even though farmers' testimonies suggest that quotas for selling banana are rather limited. These limited commercialisation possibilities for banana underline the importance of cocoa, which is less profitable than banana, but offers a significant additional income for the household. Moreover the combination of these different crops permit the farmers to manage risk confronted by fluctuations in marked prices and opportunities of both crops.

Traditional management practices do not include the use of organic fertilizers, and so the extraction of nutrients as a result of production might affect the environment and eventually the economic sustainability of the system. A rapid appraisal of nutrient balances showed that the potassium extracted by sold banana could undermine the production systems in the long run. A pilot project in the area is experimenting with organic fertilizers that contain potassium and it was found that the use of this organic fertilizer would make it possible to restore the nutrient balances. Nevertheless, the use of these fertilizers has a negative impact on the system's economic performance, in the case of bananas sold for baby food, as income does not compensate for the extra costs. It is therefore suggested that economically feasible alternatives should be identified through participatory methods, in order to ensure the system's economic and environmental sustainability.

Introduction

The macro-reforms introduced by governments in recent decades, such as reduction of subsidies and barriers, have adversely affected the competitiveness of small farmers in Central America and projects and policies have made little progress in developing sustainable and viable alternatives for small farmers. What needs to be done, in order to develop viable alternatives for this group of producers, is to identify comparative production advantages in relation to new market opportunities.

One of these growing new market opportunities is organic agriculture. This expanding market is related to a growing awareness of the negative effects of agriculture based on the intensive use of external chemical inputs such as fertilizes, improved seeds and other types of agrochemicals. The concept of organic agriculture is based on an holistic view of production systems, seeking the optimal growth of plants and animals, not as individuals but as part of their larger ecosystems, where nutrients and other ecological services are recycled and used in mutually supportive ways (Altieri, 1995). This is achieved through cultural and biological practices, crop rotation and the application of animal and green manure to manage pest and nutrient balances.

The comparative advantage offered by small farmers within the context of organic agriculture is that their systems are generally more closely related to organic production systems than those of large-scale entrepreneurs, who base their production on large extensions of monocultures. The traditional production systems of small farmers in most parts of Central America are diverse and small-scale. They are based on local indigenous knowledge of the specific interactions of the natural environment and are mostly characterized by a relatively low use of external inputs.

In order to identify the potential of organic production systems as an alternative for small farmers, IFAD is executing a thematic study focusing on the prospects for organically grown agricultural products by small farmers in Latin American countries. The study's main hypothesis is that the production of organic crops and animal products may represent an important opportunity for small farmers in Latin American and Caribbean countries (IFAD, 2001). Through an analysis of some successful cases of organic production throughout the area, IFAD seeks to understand how these small farmers have been able to resolve problems (e.g. initial investment costs, negotiations with buyers, access to knowledge) and identify opportunities so that other farmers may shift to organic agriculture. The insights gained through this systematisation will throw new light on the need for institutional support for this group of producers.

One of the cases analysed in this study is organic banana and cocoa production in the indigenous villages of Talamanca, Costa Rica. In Costa Rica, organic production has increased substantially since the early 1990s, in the context of supportive government policies that have promoted the conservation of ecological diversity and have encouraged rural communities to carry out new environment-friendly activities, such as agro-tourism and organic agriculture. In addition, several NGOs have worked with rural communities to introduce these new activities and help them overcome related technical and marketing problems. In the case of banana and cocoa, about 1,500 small producers of Talamanca have received support from an NGO, the Talamanca Small Farmers Association (Asociación de Pequeños Productores de Talamanca, APPTA) (IFAD, 2001).

This case is documented through an analysis of the history of the association and the institutional setting on the one hand, and an analysis of the socio-economic viability of the production systems

on the other. This report focuses on the latter part of the study and describes the results of interviews, over a period of 2 days, with 7 organic farmers in the area.
It is important to note that the results shown in this document are based on a rapid appraisal of the production systems and should therefore be treated with caution and mainly be interpreted as indicative.

Objectives

Within the wider objective of the IFAD study- to identify the prospects for organic production in Latin America - this study focuses on an analysis of the organic banana and cocoa production systems of farmers affiliated to the Small Farmers Association of Talamanca (APPTA) in Costa Rica and aims to:

1. Provide a socio-economic evaluation of the organic banana and cocoa production system.
2. Offer a rapid appraisal of the environmental sustainability of the system
3. Present the farmers' views about their production system and the experience with APPTA.

Methodology

Over a two-day period, 7 open interviews (4 women, 3 men) on socio-economic data were conducted in the field with members of APPTA, in the villages Shiroles, Tsuiri and Amburi.

These interviews focused on production aspects such as: agricultural activities, management changes during the period affiliated to APTTA, available production resources, production of banana and cocoa (both sold production and production for home consumption), production of additional products (timber and fire wood, fruit, roots etc.), production methods, production scheme, main problems and opportunities. The data collected through these interviews provided the basis for assessing the economic performance of the production systems. The economic data summarized in Table 1 was calculated on the basis of each interview.

Table 1. Economic variables

Variable	Unit	Calculation method
Production	kg ha^{-1} yr^{-1}	Total production / production area
Gross income	USD	(Total value of sold and home production of all crops in the system[1]) * value production unit in farm
Direct costs	USD	Total costs of bought inputs + paid labour + paid services
Net income 1 (without family labour costs)	USD	Gross income – direct costs
Family labour income[2]	USD day^{-1}	Net income 1 / number of days of family labour
Total costs	USD	Direct costs + (number of days of family labour* daily labour costs in research area)
Net income 2 (including family labour costs)	USD	Gross income – total costs
Benefit/cost ratio	USD	Gross income / total costs
Productivity of land	%	Net income 2/ estimated land value[3]

[1] Gross income includes the value of sub products such as fruits and timber wood

[2] Family labour income is an indicator of the value of total production (both monetary and non-monetary) minus the direct cost paid in order to produce these products, divided by the number of family days worked to produce them.

The results of the individual case studies were summarized through descriptive statistics, which was the basis of the analysis in the next chapters.

Initially, the aim was to determine the cash flow from four years of production of both cocoa and banana, in order to take into account the establishment costs of these systems, since it was assumed that the systems were renovated every 5 to 10 years. However, since the cocoa trees belonging to the interviewed families were generally old (10-30 years) the data on nursery and establishment costs was less relevant. Generally, the cocoa trees that cannot be recovered through pruning are substituted with a new cocoa or banana plant. In the case of banana plantations, the same method is applied.

Context

Organic agriculture in Costa Rica

In Costa Rica organic agriculture has been growing steadily and today almost 7,000 hectares are under organic production (certified or in the process of certification), producing 30 different products. Overall, more than 4,000 people are involved in these production and agro-industrial activities (CEDECO, 1998). The main product is banana, but other important products are cocoa, coffee, fresh and dried fruits, grains, seeds and spices. In the mid-1990s, 550 hectares were planted with ecologically certified coffee, with an annual production of 250 to 300 tons.

Generally, farmers are members of associations or cooperatives. APPTA is one of the country´s largest farmers' association dedicated to organic agriculture and was founded in 1987. APPTA currently has 400 active members and markets the products of 1,500 producers, of whom 1,125 farmers with about 2 hectares of land each have been certified. According to data from APPTA, the area compromised by organic production is around 2,000 hectares (Centro de Comercio Internacional UNCTAD/OMC, 1999). In the year 2000, 210 tons of cocoa and 1,300 tons of banana were exported through APPTA.

Talamanca

Talamanca is situated in southeastern Costa Rica (see Map 1). It comprises the indigenous reserve, with an extension of approximately 64 000 hectares, and is part of Costa Rica's largest conservation area, "La Amistad". It has a diversity of landscapes and altitudes ranging from 40 to 1,500 meters above sea level. Talamanca is considered to be one of the areas in Costa Rica with the greatest biodiversity and habitats, and these have served as the basis for the development and the reproduction of the indigenous cultures of the Bribri and Cabécar. (Borge and Castillo, 1997)

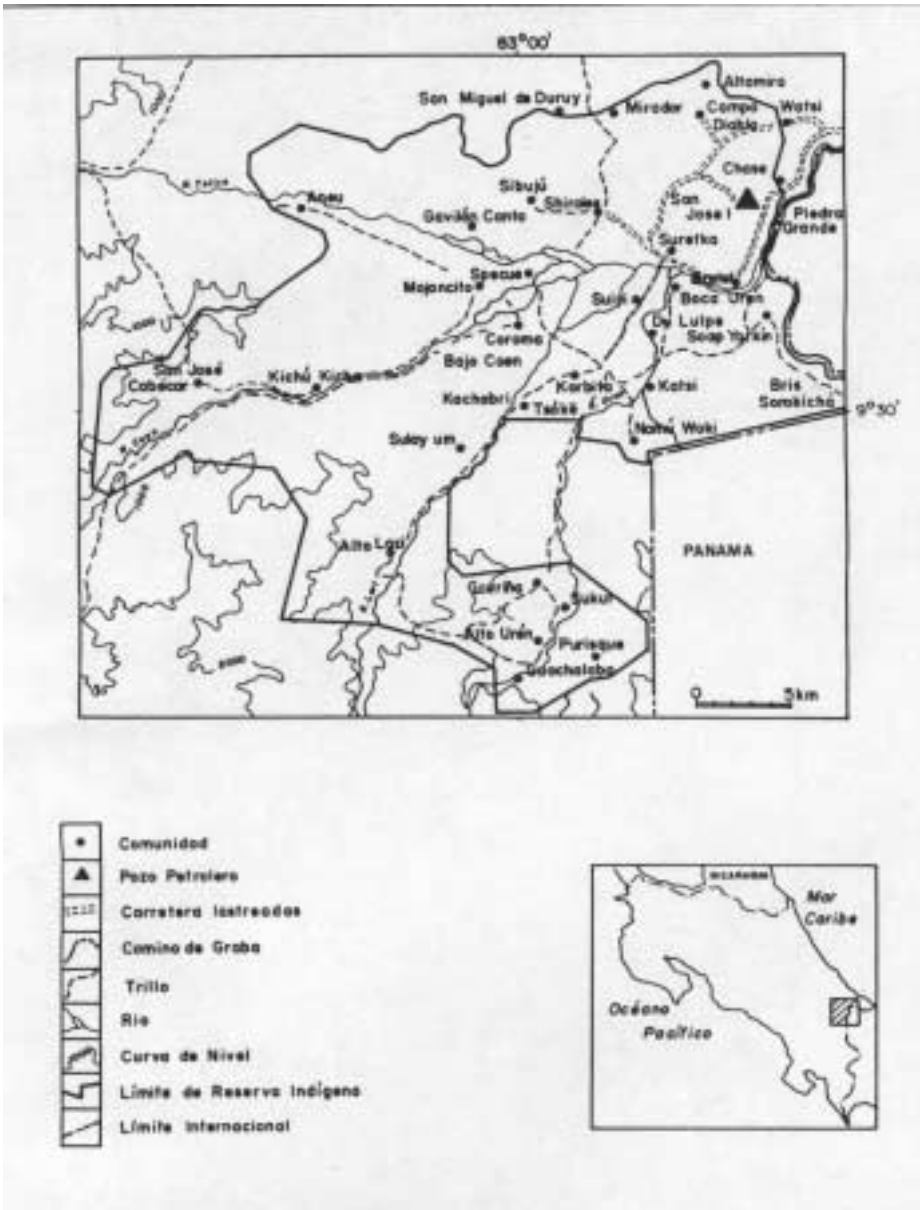
The average annual rainfall in the zone is about 4000 mm and average temperature ranges between 20.4 ^{o} C and 30.5 ^{o} C, according to the altitude.

As shown in Map 1, the largest concentration of population is found in the lower valley where approximately 80% of the indigenous population lives in about 12 % of the area. The infrastructure in this part of the Reserve consists of dirt roads, which facilitate marketing

[3] The value of the land is estimated at 900 USD, based on data obtained through personal contacts with farmers from the research area.

activities. The total population in the area is estimated around 10, 000 habitants, which means that the population pressure in the valley is around 67 persons/km^2.

Map 1. Talamanca zone in Costa Rica



Due to the high precipitation and the steep terrain of the area, the ecosystems are highly vulnerable. Nevertheless, the Bribri and Cabécar indigenous communities have adapted to the limitations imposed by this ecosystem and have managed to survive without causing major ecological damage to the area. To do so, they have developed an agroecosystem based on the cultivation of multiple crops, planted at the same time in the same space (perennial crops) or through rotation (annual crops). These crops are generally cultivated in areas of not more than one hectare. In the case of annual crops, a rotation period of 10 to 12 years is used. These agricultural activities are combined with fishing, hunting, gathering forest products and raising small animals. (Borge and Castillo, 1997).

Results

Description of production system
Cocoa was the most important commercial crop in Talamanca between 1940 and 1970. Banana plantations were restarted in the late 1970s and many of the lowland cocoa plantations were converted to banana plantations; most cocoa is now produced in hilly areas. There are farms in the region that have been abandoned due to disease. For example, in 1979 local farms were abandoned due to losses from the Monilia pod rot and production dropped to nearly zero. Many of these farms were never recovered due to declining markets. Cocoa production was promoted between 1982 and 1987 using new varieties of trees. Small farmers do not have the financial resources to purchase chemical inputs and their traditional production systems are characterized by a low use of external inputs. This, together with the emerging market opportunities for organic products, has led to a shift towards organic farming.

The cocoa plantations are generally mixed with bananas, fruits and timber wood, both for family consumption and for market production, particularly the production of organic bananas, which has been growing rapidly during past decade, thanks to new market opportunities for organic banana in baby food. Moreover, the most important advantage of banana over cocoa is that it provides a constant income throughout the year, whereas cocoa is harvested mainly during two annual harvest peaks.

The production of plantain (non-organic) has also become an increasingly important income source for farmers in the Talamanca valley, as it provides better market opportunities than banana and cocoa. The plantain is mainly found in the lower parts of the valley, where the soils are more fertile and better drained and are therefore more suited to the needs of this crop. In some villages, non-organic plantain is grown next to a mixed organic banana-cocoa production system. (Borge and Castillo, 1997).

Economic results
In order to gain insight in the economic performance of the system's different components, an economic analysis of the two main crops - banana and cocoa[4] - and of the system as a whole, was conducted separately. The system has numerous variations, but in general terms we can say that banana is produced in 'purer' stands than cocoa. This means that most of the farmers interviewed have about 1 hectare with cocoa as a main crop, mixed with fruit and timber trees plus some banana and about 1 hectare with more or less pure banana. In the case of plantain production, the stands are even more pure, and in most cases it is almost produced as monoculture.

The variability of the system has implications for the economic analysis in the sense that differences in plant density between one system and another determine the total output per hectare. However, the standard variations found in our data are relatively small, compared to their averages, for which reason we may assume that the averages can be considered as an accurate representation of the situation.

Banana
Average banana production in our sample is about 12 ton per hectare, which is low compared to the figures for large-scale banana production in Costa Rica, which produce up to 70 tons per

[4] In these separate calculations of banana and cocoa the value of the sub products such as other fruits, timber wood and roots is included and is equally divided according to area occupied by each crop.

hectare (Rosales et. al., 1998). However, this is a rather abstract comparison, since other products are also produced under this system - such as fruit and timber wood - in the same area. About 3 tons of banana is used for home consumption (human and animal) and the rest is sold for baby food to several buyers in the area such as APPTA, UCANEU (an other farmers´ association) and Trobanex, an agro-industrial company. APPTA is selling through Gerber and pays farmers USD 0.081 per kilo of banana. UCANEU pays the same price and Trobanex pays USD 0.097 per kilo.

The management of banana plantations is based on some manual activities such as weeding, clearing the soil around the plant and removing old leaves. In most farms, a selection process is applied through the removal of the numerous slips or shoots around the plant, leaving two strong and well distributed slips for the production of the next cycle. Most farmers put tapes around the stems in order to keep track of the maturation process and place sticks under the stems to prevent the plant from collapsing. Some farmers apply a bacterial composition EM[5]. Few farmers place plastic bags around the bunches to protect the fruit, as the main problem with this method is the height of the bunches in the most commonly used variety (Grand Michelle), which is about 7 meters tall. Input costs of EM, tapes and bags are included in the cost calculation.

In banana production for this market, no other organic inputs are normally used. Most production activities are done with family labour. Women, in particular, might hire labourers about 2 to 4 times a year to weed the farm, paying for this work either through the traditional "chichera"[6] system or in money.

Table 2 offers a summary of the economic data obtained through the interviews.

Table 2. Descriptive statistics of 1 hectare of banana production during 1 year. (N=6)

Economic variable	**Minimum**	**Maximum**	**Average**	**SD**
Production of banana (kg ha $^{-1}$)	7447	19496	**12623**	1868
Gross income banana and sub products[7] (USD ha $^{-1}$)	670	1658	**1100**	339
Net income 1 (USD/ha $^{-1}$) (Family labour costs not included)	505	1544	**984**	376
Number of days of family labour (days/ha)	49	82	**66**	15
Family labour income per day (USD/ha $^{-1}$)	6.5	23.5	**14.9**	5.9
Total costs (USD ha $^{-1}$) (Family labour costs included)	371	1039	**609**	241
Net income 2 (USD ha $^{-1}$) (Family labour costs included)	-62	945	**491**	372
Benefit/cost ratio	0.94	2.78	**1.81**	0.66
Productivity of land (%)	-7	105	**55**	41

[5] EM is an organic bacterial composition which aims to improve the general resistance of the plant. It has been developed and distributed by EARTH, the Regional Agricultural University for the Humid Tropics in Costa Rica, and has a value of 3.64 USD per liter. About 8 liters per hectare are used in one year. In general, farmers have given favourable reports of this product.

[6] Women prepare food and "chicha", a fermented corn beverage with alcohol, in exchange for work. A cultural and social activity traditionally practiced.

[7] In these calculations, both sold and home production of banana are valued: the sold production according to the prices paid by the different buyers and the home consumption is valued at the price of USD 0.081 per kg, as this is the most common price obtained locally for bananas. The sub products are valued according to local prices.

As we can see from the above table, the production system is economically viable and the average family labour income per day within the system is USD 14.9, twice the value of paid labour in the area, which is USD 7.27[8] per day. The net income of 1 hectare of banana, without considering family labour costs, is 984 USD ha $^{-1}$ year $^{-1}$ which should be regarded as the value of the income obtained by the family through this production activity, as the farmers themselves do not include family labour as a cost.

The average productivity of land calculated for banana is 55%.This percentage was compared with the average nominal interest on savings in colones, which is 15%. This means that the net income obtained through this production activity is 40% higher than what the family would have received if selling the land for the purpose of saving.

The economic performance of the traditionally managed system is therefore rather positive. However, the production system analysed in these cases did not include any methods aimed at maintaining or improving the sustainability of production levels, such as the use and production of organic fertilizers.

In order to maintain and improve the production levels, certain types of organic fertilizers can be applied, but given the current prices and production levels, this would reduce the economic performance of the system, as labour and input cost of these practices would be higher than the extra income obtained. This can be demonstrated through the example of a case study, which is part of a pilot "Post Harvest" project executed by the University of Costa Rica (UCR), in collaboration with APPTA.

The low prices paid for bananas by the food market have prompted APPTA to search for better market opportunities. An interesting opportunity in the international market is the commercialisation of organically certified fresh bananas. The major challenges in this marketing process are the quantity and the high quality standards required for fresh bananas to be accepted in the international market. The objective of this " Post Harvest" project of the UCR and APPTA is to design and implement a viable post harvest system that will facilitate the commercialisation of organic banana as fresh fruit. The main focus of the project is to prevent diseases that affect fruit quality, maintain a stable production, prevent early maturation and prevent damage to fruit during the harvest and post harvest process (Umaña, 2001).

To guarantee the stability and sustainability in the banana production, two fertilizers were introduced, which are permitted in the context of organic agriculture, since they are made from meteoroids: Phosphoric rock and K-Mag, composed of potassium and magnesium.

Table 3 shows data from a case study of a farmer included in the post harvest project, who is applying the two fertilizers. Although the farmer did not have to pay for these fertilizers during the experiment, their cost was taken into account in order to evaluate the economic viability of the system.

It is assumed that the farmer will eventually sell his production as fresh fruit and will obtain better prices. However, at the time of the study, this particular farmer was selling his bananas to

[8] The value of paid labour is estimated at 7.27 USD daily, which is paid in the research area for agricultural work in these mixed systems and is about 30% lower than the minimum wage in Costa Rica, such as that paid by the international banana companies in same area.

the baby food market. As we can see in Table 3, the economic performance of the system, in the context of the baby food market was considerably lower than that observed in Table 2. This is mainly because the additional labour and input costs of the fertilizer application are not compensated by extra income obtained through these fertilizers. The family labour income dropped to half of its value compared to that of the traditional system reflected in Table 2.

The example demonstrates that the use of organic fertilizers, in the context of the baby food market, will probably have a negative impact on the economic performance of the system. This was confirmed by the UCR researchers, who emphasised that the use of these fertilizers, in the context of this traditional market, should be carefully reviewed and validated before it is promoted on a larger scale. At present, these fertilizers are applied only by the 30 farmers that are intending to sell to the fresh fruit market by the end of the year.

Table 3 Economic performance of banana in pilot farm using organic fertilizers

Gross product (USD)	**977.12**
Banana/plantain (USD)	825.60
Sub products (USD)	151.52
Direct costs (USD)	**471.78**
Value of inputs (USD)	441.48
Paid labour (USD)	30.30
Net income 1 (USD)	**505.34**
Family labour (days)	78
Value family labour (USD)	6.48
Total costs (USD)	1038.84
Net income 2 (USD)	**-61.72**
Relation benefit/costs	0.94
Opportunity costs	-0.07

Cocoa

One of the main obstacles to the recovery of the cocoa plantations after the Monilia crisis has been the low price of cocoa on the international market. APPTA managed to sell cocoa through a firm in the Unites States of America, which sells the product to the manufacturers of Newman products as certified organic cocoa. The price of cocoa on the national market is USD 0.30 per kg, whereas APPTA pays farmers USD 0.91 per kg cocoa.

Table 4 shows the economic performance of cocoa. As we can see, the economic performance of cocoa is slightly negative if family labour costs are included. Family labour income earned from cocoa is lower than the market value of labour in the area (USD 5.68 versus USD 7.27) and the productivity of land is negative. Cocoa is rather labour intensive, as it is necessary to check the plantation for Monilia every week or two, maintain appropriate levels of shade and weed and prune regularly. These are all management practices that help to prevent Monilia infection.

Although the economic performance of the system is slightly negative if family labour costs are taken into account, it is important to realize that the farmers themselves do not consider family labour as a cost. The net income - without considering family labour costs - is USD 264 ha^{-1}

year $^{-1}$ and should be regarded as an important supplement to the family income, especially for households whose members do not have access to other job opportunities.

Table 4. Economic performance of 1 hectare of Cocoa. Descriptive Statistics (N=6)

	Minimum	Maximum	Average	SD
Production (kg ha $^{-1}$)	133	200	**172**	26
Gross income of cocoa and sub products (USD ha $^{-1}$)	187	406	**270**	88
Net income 1 (USD ha $^{-1}$) (Family labour costs not included)	110	406	**250**	106
Number of days of family labour	11	82	**44**	24
Value of labour day (USD ha $^{-1}$)	3.4	19.7	**5.7**	6.8
Total costs (USD ha $^{-1}$)	102	610	**344**	171
Net income 2 (USD ha $^{-1}$) (Family labour costs included)	-258	173	**-74**	183
Benefit/cost ratio	0.48	2.37	**0.78**	.80
Productivity of land (%)	-29	19	**-8**	20

The economic performance of the mixed system

A separate evaluation of the banana and cocoa components within this system has been useful to understand the economic performance of both crops and, based on this, a farmer's decision on the management of the system. Farmers tend to be more motivated to invest in banana; inputs such as bacterial composition, tapes, and plastic bags are used for banana, whereas for cocoa generally no inputs are used. Moreover, farmers tend to replace a dead cocoa tree with banana and not with cocoa, as bananas offer better economic prospects than cocoa.

Nevertheless, to get a realistic idea about the economic performance of the system as a whole, the mixed system was evaluated and the results are summarized in Table 5.

Table 5. Descriptive statistics of 1 hectare of mixed cropping system (N =6)

Economic variable	Minimum	Maximum	Average	SD
Total gross income (USD ha $^{-1}$)	353	777	**595**	164
Gross income obtained through additional products [9](USD ha $^{-1}$)	42	207	**84**	61
Net income 1 (USD ha $^{-1}$) (Family labour costs not included)	338	762	**568**	154
Number of days of family labour	29	82	**49**	19
Value of labour day (USD ha $^{-1}$)	4.1	19.0	**11.6**	5.2
Total costs (USD ha $^{-1}$)	255	611	**430**	120
Net income (USD ha $^{-1}$) (Family labour costs included)	-258	342	**165**	230
Benefit/cost ratio	.58	2.34	**1.4**	0.59
Productivity costs of land	-29	38	**18**	26

As can be seen in Table 5, the mixed system's economic performance is rather satisfactory. Net income is positive, also if family labour costs are included, and family labour income is USD 4.33 higher than the labour income paid in the area for similar work. Productivity of land is

[9] The gross income obtained through additional products is included in the total gross income

3 % higher than the average nominal interest on savings in colones, which means that the net income obtained through this production activity is higher than what the family would have received if selling the land for the purpose of saving. The net income obtained through this production activity, available for the farm household is 548 USD ha $^{-1}$ year $^{-1}$.

It is important to emphasise the role of the other products in this system (mainly pejibaye, citrus fruit, avocado and timber wood), which comprise about 14% of the value of production in the mixed cropping system, and are an important addition to the family diet. In this assessment, these sub-products are given an extremely low value as the farmers claim that there is no market for these crops and their local value is much lower than their national market value. APPTA is also in the process of opening an organic market for these other products, which would increase the economic performance of this system.

An alternative use for these sub-products is to transform them into more valuable products such as pigs. This possibility is explored in the next section.

Raising pigs.
About 40% of the families interviewed families have pigs. On average, they raise 2 pigs, twice a year. Some families buy the pigs when they are 2 months old, at USD 15 each, and sell them some 5 months later for about USD 55 each, receiving a gross income of USD 160 for 4 pigs.

The pigs are fed with products grown on the farm, such as pejibaye, plantain, banana and maize, at a total estimated cost (at village prices) of USD 71 during the whole year for four pigs. This implies that the net income obtained through the production of pigs is about USD 89 , which provides extra income for the family household, especially for the women who normally care for these animals. This income can partly be considered as extra indirect income from the mixed cropping system. We can conclude that transforming products that are difficult to sell into pigs offers a viable alternative to increase family incomes.

Observations on sustainability of the system

In general, the production systems of Talamanca are considered to be ecologically balanced, due to the low production levels and thus the low subtraction levels of nutrients, the integration of different types of crops and the existence of the natural vegetation within the system. These elements together reinforce the recycling of nutrients and ensure mutual support between the different elements of the system. Due to the thick ground cover, the degree of erosion and leaching are assumed to be minimal compared to the large-scale production systems. An important advantage of the system is that all product residues of the crops used for home consumption and the residues of the cocoa are reintegrated into the system.

However, there may be a high loss of nutrients, especially in the case of bananas, where a relatively high loss of biomass occurs, particularly when the whole bunch is exported from the farm. It is therefore important to evaluate how current production levels and management practices affect the sustainability of the system.

Table 5 shows the nutrient composition of bananas (pulp and residuals). Considering the production levels of about 12 ton ha $^{-1}$ yr $^{-1}$ calculated for this study, this implies a loss of 21.6 kg of nitrogen, 2.5 kg of phosphorus and 68.4 kg of potassium ha $^{-1}$ yr $^{-1}$.

Nevertheless, most of the potassium is found in the crop residues[10] and we can assume that crop residues of bananas for home consumption (about 3 tons per year) return to the farm. By taking into account this aspect, the loss of potassium can be reduced to 55,2 kg ha $^{-1}$ yr $^{-1}$. The amount of nutrients lost through Mg and Ca and micronutrients is very low and can be ignored.

Table 5. Extraction of macronutrients through the production of banana (kg/ton)[11]

Nitrogen	1.8	Magnesium	0.15
Phosphate	0.21	Calcium	0.29
Potassium	5.7	Iron	0.02

In agroforestry production systems, trees play an essential role in the recycling of nutrients from lower soil layers. In the production systems of Talamanca a considerable number of trees and shrubs are used, especially Laurel (*Cordia alliodora),* fruit trees and some nitrogen fixing species. The number of trees and shrubs is estimated at about 400 ha $^{-1}$ (which implies a distance of 5 meters between trees or shrubs). These trees and shrubs are pruned in order to ensure adequate shade levels. The pruned material, together with the litter falling from the trees, decomposes in the soils, supplying it with nutrients. Taking into account the types of trees and consulting several sources of literature on similar ecological zones (Young 1997, Henriksen 1999, Deugd, 2000) it was estimated that the input of macro nutrients by 400 trees and shrubs was about 20 kg of nitrogen, 0.08 kg of phosphorus, 8 kg of potassium and 0.1 kg of magnesium.

Comparing nutrient output through crop harvest and nutrient input through pruned material from trees (see Table 6) it can be concluded that the nitrogen, phosphorus and magnesium extraction is probably compensated, or at least leaves no considerable losses, whereas the potassium balance is negative with a loss of about 47 kg yr^{-1}.

In order to assess whether these levels of potassium loss threaten the sustainability of the system it is important to take into account the level of potassium available in the soils in the area. According to soil data from the research area (Umaña, 2001), the average level of potassium is 0.23 cmol (+)/L which is considered to be rather low (just within the normal range) and thus a susceptible element in the system. Therefore we can conclude that these annual potassium losses will have a negative effect on the sustainability of the system in the long run.

Table 6. Nutrient fluxes within the traditional banana production system (kg ha^{-1} yr^{-1})

Nutrient flux	**N**	**P**	**K**	**Mg**
Output through harvest	21.6	2.5	55.2	1.8
Input through recycled nutrients	20.0	0.08	8	0.1
Balance	**-1.6**	**-1.7**	**-47.2**	**-1.7**

The rather low levels of potassium in the soils is one of the reasons why the “Post Harvest” pilot project of the UCR and APPTA (see economic results of banana for more details) decided to include the K-Mag fertilizer in their experiment. According to the soil data collected for that “Post Harvest” pilot project the levels of phosphorus in the soils are very low and in order to correct this deficiency Phosphate rock is applied. Table 7 demonstrates the effect on the nutrient balance when these two fertilizes are applied according to the recommended levels.

[10] Pulp contains only 1.3 kg of potassium per ton (Deugd, 1994).

[11] Source: Rosales et. al., 1998

Table 7. Nutrient fluxes in the banana production system: organic fertilizers applied (kg ha^{-1} yr^{-1})

Nutrient flux	**N**	**P**	**K**	**Mg**
Output through harvest	21.6	2.5	55.2	1.8
Input through recycled nutrients	20.0	0.08	8	0.1
Input through fertilizer[12]	0	16.5	77	63
Balance	**-1.6**	**14.1**	**29.8**	**61.3**

After the application of these organic fertilizes only the nitrogen balance remains slightly negative, but this should not be considered as significant.

It is important to note that in calculating this balance, important nutrient fluxes such as erosion, leaching, gaseous loss, nitrogen fixing of ground cover and wet and dry deposition have not been taken into account, since no data on these nutrient fluxes were available. Nevertheless, this rapid and rather rough estimate of these three nutrient fluxes serves as an indication of the sustainability of the systems and demonstrate the susceptibility of the traditionally managed banana.

Perception of the farmers

In general the farmers were very positive about the marketing experience through APPTA. In the case of cocoa in particular, they felt that no other viable marketing opportunity would have been possible. The participatory character of APPTA's organisation seems to have a positive affect on local organisation levels. Farmers are organised in committees, which are responsible for exercising an internal control to ensure that products are 100% organic. Moreover, in the committees the two-weekly quotas are distributed among the members of the organisation. Another interesting aspect of the organisation is the active participation of the women. For this research, 4 women were interviewed and all showed a very positive and active attitude towards improving their situations.

The main obstacles mentioned by the farmers are low market prices for banana, limited quotas for the commercialisation of banana and a lack of market opportunities for other products produced in the farms such as pejibaye, citrus and avocados. In this light, the "Post Harvest" project and APPTA's efforts to open up market opportunities for the sub products are highly relevant for its members.

Another problem often mentioned was the lack of financial resources available to buy inputs, both organic materials for cocoa and banana and non-organic materials for the production of plantain. Given the relatively good organisation levels of the farmers working with APPTA, it was suggested that establishing community banks might be an interesting way of responding to this demand.

Technical problems related to the management of the mixed cropping system were not mentioned when farmers were asked about general problems in production. However, with regard to the production of annual crops, population pressure appears to pose a major problem, since farmers frequently mentioned that the production of annual crops was impossible as no land was available. This may be caused by the relatively high concentration of people in the valley and the slash and burn production system used to cultivate annual crops.

[12] Source: Umaña 2001

Conclusion

APPTA is providing important marketing opportunities to a significant group of small farmers, enabling them to sell organic products, which would otherwise have been difficult to sell. It was found that the family income obtained through the management of the mixed system is higher than the wages paid for similar work in the area, and that the productivity of land is higher than average nominal interest on saving deposits. Through these marketing opportunities, many farming families in the Talamanca valley are able to manage their production systems in an economically viable way and are able to maintain their traditional lifestyle, as the organic approach to production fits in well with the population's cultural context. These opportunities prevent farmers from being forced to migrate and looking for other job opportunities outside the Reserve. Moreover, biodiversity is maintained and pollution of the environment and population is prevented, at least within the context of the evaluated banana-cocoa system.

Through a separate economic analysis of banana and cocoa it was shown that the economic performance of banana is better than that of cocoa. Nevertheless, even though farmers argue that banana production has grown rapidly during the last decade, cocoa has not been replaced by banana. This might be caused by the restricted quotas for the commercialisation of banana, which farmers mentioned as one of their major problems, and is also due to the cultural importance of cocoa for the local population. This underlines the importance of the possibilities offered by APPTA to market cocoa.

APPTA's attempts to commercialise organically certified sub-products, especially fruits, are very important, given that farmers consider that the market opportunities for these products are very limited. Selling these products may considerably improve the system's economic performance, if we take into account the estimated amounts of sub-products produced in these systems.

It is also important to consider that the system's organic character is partly related to the current demand for organic products. At present, non-organic plantain is an important cash crop in the valley of Talamanca. If APPTA had not existed, some of the mixed systems might have been transformed into plantain. This is especially true of the lower areas where the most suitable soils for plantain are found. The above has implications for policies aimed at promoting organic agriculture, since it shows that such policies must consider the importance of guaranteeing market opportunities for organic products and facilitate the certification of organic products.

In literature about Talamanca, generally positive statements are made about the balance between production systems, the traditional population and their natural environment. It is also noted that the population and its activities can be seen as part of the natural environment. It is certainly true that the indigenous communities manage their environment in a much more balanced way than people outside the Reserve do. Nevertheless, it is important to evaluate the effect on the sustainability of these systems when crops are produced for commercial purposes. This is especially important in the case of organic production, which is supposed to have a positive effect on the sustainability of production systems. In the course of this report it was demonstrated, though a rough estimation of nutrient fluxes, that assumptions regarding the sustainability of the traditional system should be critically reviewed, since the negative potassium balance might adversely affect the system in the long run. A pilot project in the area proposed the use of organic fertilizers K-Mag and Phosphate rock, which seems to be an interesting solution to restore nutrient balances. However, according to the data, extra inputs and labour costs are not compensated by extra incomes, in the context of current market opportunities. The suggestion is

therefore to implement participatory experimentation on farms to facilitate the development of cheap and flexible solutions to ensure the system's environmental and economical sustainability.

References

Altieri M. (1995) Agroecology: *The Science of Sustainable Agriculture*. Boulder CO: Westview Press.

Borge C. and R. Castillo (1997) *Cultura y Conservación en la Talamanca Indígena.* 1 ed. San José *Costa* Rica. EUNED.

CEDECO (1998) *Estado Actual de la Agricultura orgánica en Costa Rica*. San José. Costa Rica.

Centro de Comercio Internacional UNCTAD/OMC (1999*) Alimentos y bebidas ecológicos: oferta mundial y principales mercados europeos*. Ginebra: CCI, 1999. xiii, 367 pp.

Ellis F. (1993) *Peasant Economics, Farm households and agrarian development.* Second edition. Cambridge University Press, UK.

IFAD (2001) *Searching for new options for the rural poor in Latin America. Adopting Organic production among small farmers: opportunities and challenges*. Approach paper. Thematic Study. International Fund for Agricultural Development.

Deugd M. (2000) *No Quemar, sostenible y rentable? Estudio de impacto del sistema Agroforestal Quesungual*. Informe final II Proyecto Lempira Sur FAO. GCP/HON/021/NET. Honduras.

Deugd M. (1994) *Estimation of nutrient fluxes in the Bukoban agroecosystem*. Method evaluation for data collections to assess sustainability on field level in Tanzania. MSc thesis. Department of Agronomy Agricultural University Wageningen The Netherlands.

Henriksen I. (1999*) Interspecific competition and nutrient cycling in alley cropping systems with common bean in humid premontane climate in Turrialba, Costa Rica*. MSc thesis. Department of Plant ecology. Institute of Botany University of Copenhagen. Denmark.

Rosales F.E., S.C. Tripon and J Cerna, EDT (1998) *Producción de banano orgánico y,o, ambientalmente amigable*. Memorias del taller internacional realizado en la EARTH Guacimo, Costa Rica, 27-29 de julio 1998.

Umaña G. (2001) *Practicas agrícolas en campo y después de la cosecha y uso de extractos naturales para el mejoramiento de la calidad y disminución del desarrollo de pudriciones poscosecha de banano orgánico*. Universidad de Costa Rica. Centro de Investigaciones Agronómicas. Convenio Bilateral para el Desarrollo Sostenible Costa Rica- Holanda.

Young A. (1997) *Agroforestry for soil management*. Second Edition. CAB international in association with the International Centre for Research in Agroforestry.