ATLANTIC ZONE PROGRAMME

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Field Report No. 141

THE SAD STORY OF THE REJECTED BANANAS USED AS CATTLE FEED

A study in the Atlantic Zone of Costa Rica

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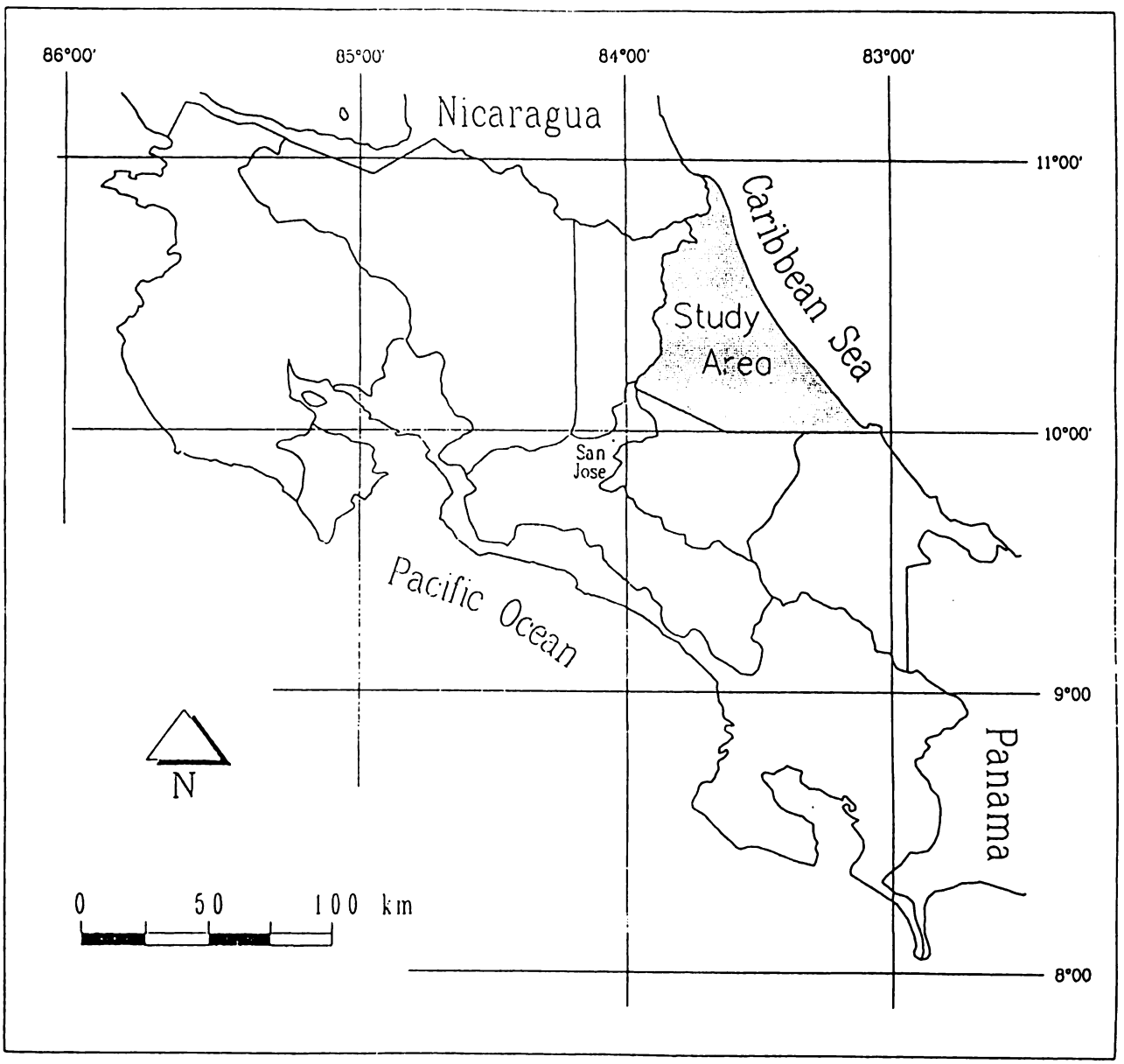
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The Atlantic Zone Programme (CATIE-AUW-MAG) is the result of an agreement for technical cooperation between the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), the Agricultural University Wageningen (AUW). The Netherlands and the Ministerio de Agricultura y Ganadería (MAG) of Costa Rica. The Programme, that was started in April 1986, has a long-term objective multidisciplinary research aimed at rational use of the natural resources in the Atlantic Zone of Costa Rica with emphasis on the small landowner.

PREFACE

General description of the research programme on sustainable Landuse.

The research programme is based on the document "elaboration of the VF research programme in Costa Rica" prepared by the Working Group Costa Rica (WCR) in 1990. The document can be summarized as follows:
To develop a methodology to analyze ecologicaly sustainable and economically feasible land use, three hierarchical levels of analysis can be distinguished.
1. The Land Use System (LUS) analyses the relations between soil type and crops as well as technology and yield.
2. The Farm System (FS) analyses the decisions made at the farm household regarding the generation of income and on farm activities.
3. The Regional System (RS) analyses the agroecological and socio-economic boundary conditions and the incentives presented by development oriented activities.

Ecological aspects of the analysis comprise comparison of the effects of different crops and production techniques on the soil as ecological resource. For this comparision the chemical and physical qualities of the soil are examined as well as the polution by agrochemicals. Evaluation of the groundwater condition is included in the ecological approach. Criterions for sustainability have a relative character. The question of what is in time a more sustainable land use will be answered on the three different levels for three major soil groups and nine important land use types.

Combinations of crops and soils

	Maiz	Yuca	Platano	Piña	Palmito	Pasto	Forestal I	Forestal II	Forestal III
Soil I	x	x	x		x	x		x	
Soil II						x		x	
Soil III	x			x	x	x		x	

As landuse is realized in the socio-economic context of the farm or region, feasibility criterions at corresponding levels are to be taken in consideration. MGP models on farm scale and regional scale are developed to evaluate the different ecological criterions in economical terms or visa-versa.

Different scenarios will be tested in close cooperation with the counter parts.

Summary

Costa Rica produces about a million tons of bananas for export. Changing from year to year, 20 to 30 percent is rejected for the export.These bananas could be used as a supplement for cattle feeding.
The purpose of this study was to quantify the input of bananas into farms with milk cows and to construct a macro-nutrient balance for these farms in the Atlantic Zone.
The use of bananas means for the macro-elements an extra input of about +15.45 g N, + 1.62 g P and +62.55 g K per cow per day.
The costs of using bananas depends on the transport facilities of the farmers. The rich farmers with own transport have less costs for using bananas than the farmers without own transport.

Figures

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1 Introduction

1.1 Bananas as cattle feed

Costa Rica produces about a million tons of bananas for export. Changing from year to year, 20 to 30 percent is rejected for the export. These bananas are dumped and left to rot if they are not removed by people, who can use them.

The fruits of banana plants are rich in energy and can be used in the natural form or in a processed form.
In the Atlantic Zone the bananas are grown on big plantations. The rejected bananas are for free for farmers, so they can use them for feeding with only the costs of transportation to the farm and extra labour on the farm. According to Preston and Leng (1987), these bananas could be used as a supplement for cattle feeding.

The purpose of this study was to quantify the input of bananas into farms with milk cows and to construct a macro-nutrient balance of some farms in the Atlantic Zone. In this study only the use and effect for cattle was investigated. This was done by interviews of dairy farmers. The questions were meant to quantify the macro-nutrients of the input and output of milk production.

The investigation only concerned the banana fruits although the foliage could also be used but the foliage of the banana plants remains at the field and this is very important for the organic matter content of the soils. It would not be economical to use the foliage as supplementary feeding because it has such a high volume. Although bananas could be used as the main feed ingredient of a diet for animals, they are usually used as a supplement or substitute to the normal diet.

Numerous experiments have been carried out to test the effects of banana feeding on animal production (meat, milk, eggs and skin/hair) (Denen and Colluci, 1992).

Reasons for the use of bananas as cattle feed in the Atlantic Zone are:
- pollution of the environment at the site where the bananas are dumped could be avoided.
- a possible rise in the milk production.
- a shortage of cattle feed could be diminished.

1.2 Atlantic Zone Programme

This report is the result of my practical period for my study soil science at the Agricultural University of Wageningen. The work presented in this report was carried out from February till June 1993 within the context of the Atlantic Zone Programme (A.Z.P). The Atlantic Zone Programme is situated in the Atlantic Zone (A.Z.) of Costa Rica. The office of the programme is situated at a village named Guápiles which is in the middle of the A.Z. (see figure 1)

Figure 1 The Atlantic Zone of Costa Rica.

Three institutes are involved in this programme:
— CATIE (Centro Agronómico tropical de investigación y Enseñanza), Costa Rica
— UAW (Universidad Agricola de Wageningen), Holland
— MAG (Ministerio de Agricultura y ganadería), Costa Rica

The Atlantic Zone Programme pretends to contribute, on a long term base, to a sustainable development of the Atlantic Zone through investigation and training. It's principal goal is methodology development for land use planning models.

The investigations are carried out on two levels. Some investigations will be integrated on the level of agricultural production systems. The others will contribute to improvement of the planning of land use on regional level.
The emphasis will be on the methodology of adaptation, simulation studies and models, later on to be able to extrapolate the results to other similar areas.

This investigation was meant to quantify the use of bananas In the A.Z. in relation with the nutrient balance of the dairy farms.

1.3 The Atlantic Zone of Costa Rica

1.3.1 Landscape

The Atlantic Zone of Costa Rica can be defined as the planification region Huertar Atlantica, consisting of the province Limón and the Horquétas district of the province Herédia (Stolzenbach, 1990).
It covers nearly 10.000 km^2, roughly divided into a coastal plain in the east and an extremely mountainous area in the west (figure 1). Soils are relatively fertile for tropical circumstances, on average becoming poorer towards the south (Romeyn, 1987).

The Atlantic Caribbean lowland has been a sedimentation area since early Tertiary. The coast line is made up by a narrow strip of succeeding beach ridges with parallel canals. Behind this, coastal swamps occur, gradually passing into a vast alluvial plain. At the foot of the mountain ranges the alluvium takes the form of alluvial fan deposits. Guápiles is situated at the beginning of the alluvial fan near the volcano Turrialba. At a few places, this flat landscape is interrupted by remnants of basaltic tertiary volcanoes. The soils all are of volcanic origin.

1.3.2 Climate

According to Nuhn's classification (1978), the Atlantic Zone is part of the "tropical humid zone". The climate in the Atlantic Zone is characterized by high temperatures and abundant rainfall during the whole year. The wettest period is in the summer months July and August and in the winter months November and December.
Annual variation of temperature is dominated by the monsoon with the highest temperatures before the onset of the summer rains (Portig, 1976). The temperature regime is given in table 1.

Table 1 The temperature regime (°C) measured at station 'El Carmen' over the period 1973-1985

Month	max	min	average
January	29.4	19.5	23.5
February	29.4	19.6	24.0
March	30.2	20.4	24.8
April	30.5	20.8	25.2
May	31.5	21.4	26.0
June	30.8	21.9	25.4
July	30.7	21.4	25.2
August	31.0	21.4	25.7
September	31.7	22.0	26.0
October	31.2	21.7	25.4
November	30.2	20.6	25.0
December	29.2	19.9	23.8

The mean annual radiation duration is 4.9 hours a day.
Rainfall varies from 2500 mm y^{-1} in the south-east to 5000 mm y^{-1} in the north-east and east of the zone. The mean annual temperatures vary from 18 to more than 24 degrees Celsius, depending mainly on altitude. The relative humidity is more than 80% during the whole year. Potential evapotranspiration in the Atlantic Zone varies between 3 mm day^{-1} in June and July to 4.2 mm day^{-1} in March and April (Rojas 1985). This means that there is an excess of rain of more than 1000 mm and crop growth is possible throughout the whole year. For more detailed information Rojas (1985) listed 10 meteorological stations in the Atlantic Zone.

1.3.3 Vegetation

The natural vegetation of the Atlantic Zone is tropical moist and wet forest and pre-montane wet forest. On the higher parts of the central and Talamancan mountain ranges lower mountain and mountain rain forest is the natural vegetation. Following van Sluys *et al.* (1987) regional and local differences in appearance and species composition are mainly the result of:

1 altitude, and in relation with this, mean temperature and temperature extremes, air humidity, precipitation and soils.

2 the total annual rainfall as an ecological gradient from northwest to southeast.

Large areas of the rain forest have been destroyed or are being destroyed as a result of wood extraction (Veldkamp *et al.*, 1992) and are conversed into silvo-pasture and crop land.

1.3.4 Land use

The land use in the Atlantic Zone is very variable. In the plain lowlands enormous banana plantations are found as well as small farmers who grow for example maize, pineapple and cassava. In the north especially, large areas are used for pasture and cattle.

The zone also has an area with (protected) forests. About 28% of the area is under forest. A larger area (33%) is used for pasture, 17% is used for permanent crops and 6% for annual crops.
Banana is by far the most important cultivated crop, generally found in big plantations (Van de Berg and Droog). See figure 2

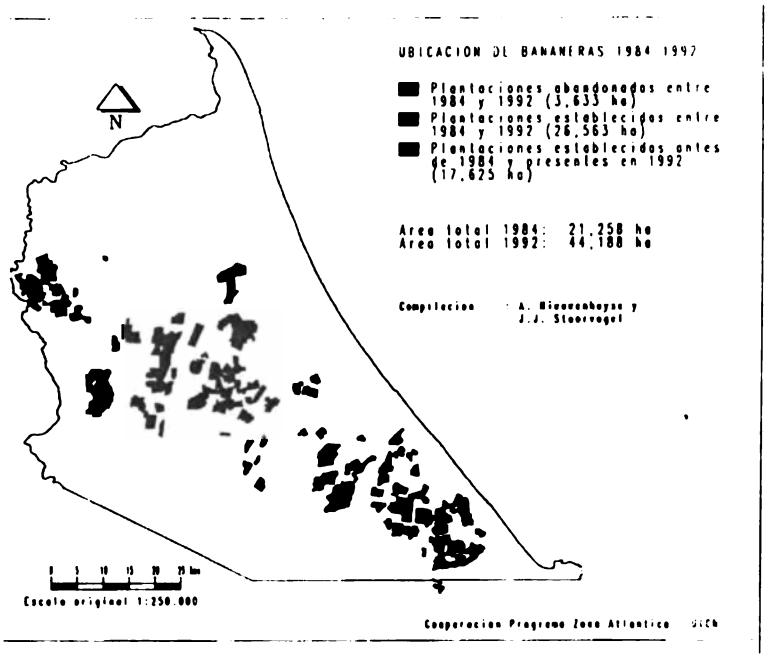

Figure 2 The plantations of bananas in the A.Z.

2 Methodology

The most important questions adressed in this study were:

'How many kilo's bananas are used in the A.Z. as cattle feed'?

'Is the use of bananas as cattle feed profitable'?

'Is there a relation between the user of bananas and the distance to the banana plantation'?

'Can a relation be found between farm type and use of bananas'?

To get an answer to these questions this study was conducted.
The study consisted of 4 parts:

1 General preparation and literature study.
The first month was used for literature study to get used to the terms of zootechnics used in Spanish or Pachuca (Costa-Rican dialect). This first period was also used for learning to speak but more to understand the Spanish of Costa-Rican farmers. The third aspect to learn was the social and cultural behaviour. I learned the hard way that it is not accepted to visit a farmer's woman for an interview, when she is alone at home.

2 Selection of the study areas and writing of the working plan.
The hypothesis was that more bananas should be used by people who are working in more intensive forms of farming systems. Intensive dairy farming is only found in Río Frío, so this area was selected as study area.
The area is situated between the rivers *Río Puerto Viejo* and *Río Sucio*, north of the highway Braulio Carillo and south of the *Horquetas* village.
The problem of Río Frío is that dairy farmers here, work far more intensive than in other parts of the Atlantic Zone. So it cannot be compared with the rest of the Atlantic Zone. For this reason also the more representative area Río Jimenez was selected. This area is situated between the river Río Jimenez and the village Río Jimenez.
Farm types in this area and the choice for this areas will be discussed in chapter 4.

3 Field work and visiting institutes.
For about one month I have visited farmers and held 14 interviews in Río Frío and 6 in Río Jimenez. After visiting M.A.G. and I.D.A. (Instituto de Desarollo Agrario) in Río Frío I had also information from 26 other farmers in Río Frío about the fact if they were using bananas or not.

In the interviews (see annex I) 13 questions about fertilizing the soil, feeding the cattle and some economic aspects of using bananas.

4 Writing the report.

The last month was meant for writing the report and calculating the nutrient balances for the different farming types.

3 Bananas and their production

3.1 The production of bananas

Bananas *(Musa spp.)* are grown in practically all the tropical countries where production is possible all year round.
The banana plant needs heat, humid air, plenty of water and light. It dislikes wind. It likes soils rich in organic matter that drains quickly. Banana does not require annual planting. A banana plantation, with a good harvest, may last 7 to 10 years.

On a plantation, the following activities must be carried out: keeping the soil clean, applying fertilizers, pruning the plants, preventing the plants from falling, looking after the fruit and protecting the plants from diseases and insects. The yield of a plantation may vary between 30 and 50 tons. ha^{-1}. y^{-1}, depending upon the number of harvests (Henderson, 1977).

In the Atlantic Zone bananas are cultivated for export so the fruit has to be harvested green, when it is about three-quarters full and the ribs and angularities still show on the fruit. The further bananas have to be transported, the thinner and greener must be the fingers on the stem. Ripening of the crop takes normally four to seven days (Crowther, 1979).

The bananas are checked on spots or deviation in form. Most losses are related to poor harvesting, packing, transport and storage methods (FAO, 1984). The average loss of bananas is 20 to 30%.

3.2 The nutrient content of green bananas

Bananas are a good source of energy in the form of non-structural carbohydrates. The content of protein, fat and fibre is very low.
There are different varieties of bananas. These varieties contain different amounts of N, P and K. On average the green fruit contains 1% N, 0.13% P and 2.7% K on dry matter (Nijhoff,1987). These numbers will be used in the calculations in chapter 5 and 6.

4 Cattle farm types in the study area

4.1 The cattle farm types in Río Frío

Río Frío is a settlement area and a project area of the I.D.A. .
In 1977 the I.D.A. bought part of the area from *Standard Fruit Co.* and private owners. It distributed areas of ca. 10 ha to farmers from the area of San Carlos, the Central Valley and landless farmers. Now they are growing various crops or using the land for pasture.

The dairy farmers in Río Frío work quite intensive (they milk twice a day and use concentrated feed) and they produce above average compared to the rest of the Atlantic Zone. The reason for the higher production is that a part of the farmers came from the area of San Carlos. This area is one of the more suitable areas for dairy farming and so the people of this area have the knowledge about producing milk. The cattle farms in Río Frío can be divided in three different types:

— *Meat farms:*
big farms (30 to 80 ha) producing meat for the market. The management is extremely labour extensive. These farmers all had another job for extra income.

— *Milk farms:*
the dairy farms in this area are extremely homogeneous. They are all about 15 hectares in size and they work more or less the same way. The milk is mostly produced for the market (Companies Borden and Dos Pinos).

— *Dual purpose farms:*
within this type it is possible to classify big farms (30 to 80 ha) and small farms (about 15-20 ha). The big farms are working extensive and deliver meat and milk to the market (Borden and Dos Pinos,). The small farms about 15-20 ha) produce milk for own consumption and an irregular market and produce meat more or less for the market.

A few extra remarks on dairy and small dual purpose farms. In general a part of the menu is formed by concentrated feed and minerals and vitamins. In some cases they are using industrial or agricultural wastes like molasses from the sugar industry or bananas, the subject of this study. The other part of the menu is formed by a type of grass called Ratana (*Ischaemiun ciliare*). The farmers always thought that this was a good grass. Last years gradually they have changed their minds

and think about using some improved grass species like Kings grass (*Pennisetum spp.*). Kings grass contains more protein and energy. Some dairy farmers in the area are using this last species or *Brachaiaria ruziciensis* in combination with fertilization.

4.2 The cattle farm types in Río Jimenez

The same distribution in cattle farm types as in Río Frío can be made in Río Jimenez. The most clear differences between cattle farms in Río Jimenez and Río Frío are:

— The farms in Río Jimenez are more different in size.

— Dairy farmers in general don't use concentrated feed. Just at a few farms molasses or bananas are used. Fertilizers are not commonly used.

5 Results

5.1 Actual use of bananas

In the area of Río Frío 20 farmers were interviewed. The results of 14 interviews are given in table 2. At these 14 farms bananas are still used at the moment of interviewing; at the other 6 farms the use of bananas stopped or was irregular; results of those farms are not listed in the table.

A problem with some interviews was that -some farmers didn't want to give the answers, or couldn't give the answer because they changed every year.

In Río Frío was found that 20 out of a total of 46 of the dairy and dual purpose farmers use bananas (M.A.G. Pers comm).

The amounts of nutrients are calculated with the values from chapter 3.2 and the nutrients N, P and K are considered as eaten with the bananas but not changing the metabolism of the cows. Only the energy of the bananas is considered as be used.

In Río Frío a relation between the use of bananas and the distance of the dairy farm to the banana plantation was not found. The users of bananas were divided random over the area. The price of the bananas varied a little with the distance but didn't influence the decision of using bananas.
The decision for using bananas or molasse or other residues was often made by personal feelings. One farmer illustrated this by the remark: 'I know that molasse is to expensive for my cattle but they like it'.

The 4 bigger farms in Río Frío had a truck or tractor and they could get the bananas cheaper than the farmer without own transport.
This is true under the assumption that the truck or tractor is already paid off, so only gasoline is a cost.
Also in Río Jimenez the most important factor appeared to be cheap transportation. The farmers with a truck or tractor used bananas. The farmers without didn't use bananas but they said, they would if they owned a truck. In this case not many conclusions can be drawn because only 6 interviews were made.

The most farms were meant to produce very extensively meat. The owners of these farms all had an other form of income.

Table 2 Data on the use of bananas and the fertilization effect of bananas on farms in $kg.ha^{-1}.y^{-1}$ in Río Frío.

Farmer	Farm (ha)	cows	bananas kg $cow^{-1}d^{-1}$	N	P	K	bananas tonnes y^{-1}
1	15	15	12	8.3	1.1	23.6	65.7
2	10	16	10	11.0	1.5	31.5	58.4
3	50	22	20	6.1	0.8	17.3	160.6
4	8	4	10	3.4	0.5	9.9	14.6
5	71	70	6	4.1	0.5	11.6	153.3
6	12	15	12	10.3	1.4	29.5	65.7
7	12	15	12	2.9	0.4	8.2	36.5
8	30	30	15	10.3	1.4	29.6	164.3
9	10	18	10	12.4	1.7	35.5	65.7
10	31	25	8	4.4	0.6	12.7	73
11	10	19	16	21	2.9	60	110.9
12	15	23	16	16.9	2.3	48.4	134.3
13	10	18	10	12.4	1.7	35.4	65.7
14	20	15	10	5.2	0.7	14.8	54.8

Table 3 Data on the use of bananas and the fertilization effect of bananas in $kg.ha^{-1}.y^{-1}$ in Río Jimenez.

Farmer	Farm (ha)	cows	bananas kg $cow^{-1}d^{-1}$	N	P	K	bananas tonnes.y^{-1}
1	100	80	10	5.5	0.8	15.8	292
2	65	49	15	9.1	1.2	25.7	268.2
3	63	25	0	-	-	-	-
4	40	21	0	-	-	-	-
5	35	15	0	-	-	-	-
6	60	50	12	6.7	0.9	19.7	219

5.2 Potential use of bananas

The optimum of using bananas as supplementary feeding is said to be 12 kg per day per cow for an average farm in Río Frío (pers. comm. MAG). Details about the method of calculation were not given.

This means that 65.000 kg bananas per farm per year can be used on an average farm (10 ha and 15 cows) in Río Frío. In the area of Río Frío originally about 150 farms were set up by the IDA. The amount of rejected bananas in Costa Rica was 250.000 tonnes. The fraction rejected bananas that potentially can be used in Río Frío is negligible compared to the 250.000 tonnes that are available:
(150 farms * 65 tonnes)/250000 tonnes) * 100% = 4%.

With the average banana use of the 14 farmers in Río Frío (90 tonnes) this would be (150*90)/250000) * 100% = 5.4%.

In other areas with more intensive farming systems (pigs or dairy near San Jose) also a lot of bananas are used but for this no estimation was made.

5.3 Effects of using bananas

The milk composition (fat- and protein content) is not significantly affected by the level of supplement of bananas as found by Cerdas Ramirez (1981). This study was conducted in the last month of lactation. Other studies found a rise of production of 20% or about 1.5 kg of milk (ASBANA, 1981). This study was also done in the last part of lactation.
The major part of the farmers, even the farmers who do not use bananas estimate that the rise of production of milk caused by the use of bananas is 1 or 2 litre per cow per day.

The rise in production is depending on the other part of the menu. The rise was bigger when the use of Ratana (low in energy content) was higher. Another positive factor is the use of extra nitrogen in the diet because this nutrient is neither abundantly available in bananas nor in ratana. According to this Preston and Leng (1987) found that the use of urea as supplement with bananas in the diet for the cows works positive.

The combination of 12 kg bananas.cow^{-1}. day^{-1}, concentrated feed and ratana as the diet for cattle in the Atlantic Zone is the economical optimum (M.A.G. 1993). Details about the method of calculation were not given.
The farmer who had the highest production per cow in this area, told that he had worked with bananas and gave several weak points and also some strong points of bananas.

Weak points:

— Variable nutrient content and quality.
— Starch and tannin content of bananas which influence the digestibility and taste.
— The better producing races like Holstein don't like bananas.

Strong points:

— The high energy content.
— The high water content, which can affect the production in case of a lack of grass.
— The low price depending of the transport.

This farmer was selected by the M.A.G. for experiments with improved grass species and was relatively well informed about this matter.

6 Ecological and economical analysis

6.1 Nutrient balances

6.1.1 Nutrient balances of dairy farms

The effect of feeding bananas to cows on the nutrient balance of a farm is difficult to predict. The nutrient- and energy content of bananas is known but the interactions of the nutrients and energy coming from bananas with the nutrients of the normal diet are not exactly known. It could be possible that the extra input of nutrients and especially energy from bananas cause a higher production of milk in combination with a better conversion of the normal diet. This could mean that the nutrient balance changes in a negative fashion because the input is a little higher but the rise of output of milk is relatively higher. On the other side it could be possible that the nutrient balance changes positive because the rise of input with bananas is bigger than the change in the rise of output of milk.

To simplify the situation the following assumptions were made:

— The nutrient content of green bananas has been taken the same for bananas of different plantations and different cultivars.
— The bananas are used by the cattle as an extra energy source.
— The use of macro nutrients coming from other food is not changed positively or negatively. Thus the bananas are an extra input of nutrients with a certain 'recovery' caused by losses with the digestion and the release from faeces. Interactions of macro nutrients from bananas and other food are neglected.

The nutrient contents of bananas, concentrated feed and milk are given in table 4.

Table 4 The amounts of N, P and K in $g.kg^{-1}$ in bananas, concentrated feed and milk

	N	P	K
Bananas (dm)	10	1.3	27
Conc. feed (dm)	22	6	n.a.
Milk	5.7	1	1.5

(Walstra P., 1984)

The input of N, P, and K caused by the use of bananas can be calculated under the given assumptions as mentioned above. The production of milk is increasing with 1.5 litre per cow per day if the cows are eating 12 kg fresh bananas with a dry matter content of 20%. This means that a N-flow caused by bananas is positive:

12 kg/5 * 10 g N = 24 g N from bananas per cow per day
1.5 l * 5.7 g N/l = 8.55 g N in the milk per cow per day

\- + 15.45 g N/cow/day

The P-flow:
12kg/5 * 1.3 g P = 3.12 g P from bananas per cow per day
1.5 l * 1 g P/l = 1.5 g P in the milk per cow per day

\- + 1.62 g P/cow/day

The K-flow:
12kg/5 * 27 g K = 64.8 g K from bananas per cow per day
1.5 l * 1.5 g K/l = 2.25 g K in the milk per cow per day

\- + 62.55 g K/cow/day

The balance per farm is given in tables 5-7 (Río Frío) and 8-10 (Río Jimenez).

Table 5 The Nitrogen balance in $kg.ha^{-1}.y^{-1}$ for the farms in Río Frío

Farm	N in bananas	N in conc feed	N in fertilizer	N in milk	N total
1	8.3	0.0	0.0	20.8	-12.5
2	11	4.4	0.0	23.3	-7.9
3	6.1	0.0	0.0	9.2	-3.1
4	3.4	0.0	75	9.4	+69.0
5	4.1	0.0	0.0	6.2	-2.1
6	10.3	3.7	0.0	20.8	-6.8
7	2.9	4.1	0.0	17.3	-10.3
8	10.3	10.3	0.0	20.8	-0.2
9	12.4	26.5	0.0	33.7	+5.2
10	4.4	8.5	0.0	21.8	-8.9
11	21	4.4	75	31.6	+68.8
12	16.9	17.7	75	44.7	+64.9
13	12.4	17.7	0.0	37.9	-7.8
14	5.2	4.4	75	12.5	+72.1

The N-balance in Río Frío is for 5 of the 14 farms positive. Only farm 9 of these positive farms doesn't use fertilizer. Compared to the other farms, farm 9 uses more concentrated feed per hectare. For the other 4 farms the positive balance is due to the use of fertilizers. The input of N by bananas compared to the output in milk ranges from 4% (farm 6) to 66% (farm 3 and 11).

Table 6 The Phosphate balance in $kg.ha^{-1}.y^{-1}$ for the farms in Río Frío

Farm	P in bananas	P in conc feed	P in fertilizer	P in milk	P total
1	1.1	0.0	0.0	3.7	-2.6
2	1.5	1.3	0.0	4.1	-1.3
3	0.8	0.0	0.0	1.6	-0.8
4	0.5	0.0	0.0	1.6	-1.1
5	0.5	0.0	150	1.1	+149.4
6	1.4	1.1	0.0	3.7	-0.8
7	0.4	1.2	0.0	3.0	-1.4
8	1.4	3.1	0.0	3.7	+0.8
9	1.7	7.9	0.0	5.9	+3.7
10	0.6	2.6	0.0	3.8	-0.6
11	2.9	1.3	150	5.5	+148.7
12	2.3	5.3	150	7.8	+149.8
13	1.7	5.3	0.0	6.6	+0.4
14	0.7	1.3	150	2.2	+149.8

The P-balance in Río Frío is for 7 of the 14 farms positive. The P input caused by bananas can be compared with the N input caused by bananas, the influence of fertilizers for the input is for both the most important. The input of P by bananas is compared to the output in milk about 13% to 52% (farm 11).

Table 7 The Potassium balance in $kg.ha^{-1}.y^{-1}$ for the farms in Río Frío

Farm	K in bananas feed	K in conc	K in fertilizer	K in milk	K total
1	23.6	-	-	5.5	+18.1
2	31.5	-	-	6.1	+25.4
3	17.3	-	-	2.4	+14.9
4	9.9	-	-	2.5	+7.4
5	11.6	-	-	1.6	+10.0
6	29.5	-	-	5.5	+24.0
7	8.2	-	-	4.6	+3.6
8	29.6	-	-	5.5	+24.1
9	35.5	-	-	8.9	+26.6
10	12.7	-	-	5.7	+7.0
11	60	-	-	8.3	+51.7
12	48.4	-	-	11.8	+46.6
13	35.4	-	-	9.9	+25.5
14	14.8	-	-	3.3	+11.5

The potassium balance is for all the farms positive. This is caused by the high content of potassium in bananas. The amount of K in concentrated feed is not known.

Table 8 The Nitrogen balance of the farms in $kg.ha^{-1}.y^{-1}$ in Río Jimenez.

Farm	N in bananas	N in conc	fertilizer	N in milk	N total
1	5.5	-	-	6.7	-1.2
2	9.1	-	-	9.1	0
3	-	-	-	4.1	-4.1
4	-	-	-	4.3	-4.3
5	-	-	-	3.6	-3.6
6	6.7	-	-	6.9	-0.2

The N-balances all are negative except for farm 2. In Río Jimenez the input and the output are lower than in Río Frío. The loss of N at farmlevel here also is the biggest.

Table 9 The Phosphate balance of the farms in $kg.ha^{-1}.y^{-1}$ in Río Jimenez

Farm	P in bananas	P in conc	P in fertilizer	P in milk	P total
1	0.7	-	-	1.2	-0.4
2	1.2	-	-	1.6	-0.4
3	-	-	-	0.7	-0.7
4	-	-	-	0.8	-0.8
5	-	-	-	0.6	-0.6
6	0.9	-	-	1.2	-0.3

The P-balances all are negative.

Table 10 The Potassium balance of the farms in $kg.ha^{-1}.y^{-1}$ in Río Jimenez

Farm	K in bananas	K in conc	K in fertilizer	K in milk	K total
1	15.8	-	-	1.8	+14.0
2	25.7	-	-	2.4	+23.3
3	-	-	-	1.1	-1.1
4	-	-	-	1.1	-1.1
5	-	-	-	0.9	-0.9
6	19.7	-	-	1.8	+16.9

The Potassium balances are positive in case of using bananas. The K-content of concentrated feed is not known but probably the K-balance will be positive also without using bananas because of the content of K in the soil and the dry deposition.
The missing parameters are the input through grass, leguminosa wet and dry deposition, and the output through leaching and volatization and meat. Without these parameters in both study areas the Nitrogen and Phosphate balances are negative. The Potassium balances are in both study areas (with bananas) positive because the Potassium content of bananas is so high.

6.1.2 Nutrient balance of the banana plantations

To reach a production of one ton of bananas according to Marchal and Malessard (1976) there is a variable amount of nutrients necessary for the different cultivars. (see table 11).

Table 11 The amounts of N, P and K (kg) necessary to produce one ton of bananas (fruit) (Marchal and Mallessard, 1979 from Soto, 1985).

banana cultivar	N	P	K
Americani	3.9	0.51	17.1
Grande Naine	4.3	0.43	15.1
Amou	4.7	0.56	28.1

The cultivar Grande Naine is mostly used in the Atlantic Zone.
The average production of bananas in the Atlantic Zone is 40 tonnes fruit. This means that about 172 kg N, 17.2 kg P and 640 kg K is removed with the harvest. The nutrients used by the plant, for producing the leaves are to be neglected in this calculation, because they remain at the field
The Standard Fruit Co. and Del Monte Corp. use for the fertilization of bananas 432 kg $N.ha^{-1}.y^{-1}$, 633 kg $K_2O.ha^{-1}.y^{-1}$ and 72 kg $P_2O_5.ha^{-1}.y^{-1}$ in 6 periods (Soto, 1985). This means that a positive balance between input and output for N and P, and a slightly negative balance for balance for K. Not included are losses by leaching (all nutrients), and gaseous losses (N).

6.2 Cost/benefit analysis

For calculating the benefit of using bananas the following assumptions were made:

- The time necessary for feeding the bananas (12 kg green bananas per cow per day) was estimated 1 or 2 minutes per cow.
- The farmers invest a salary of 150 colon (1.10 US dollar) per hour.
- The price of the bananas is depending of the transport. In case of own transport facilities the costs are negligible. In case of transport by others the price is about 3000 till 4000 colon for one week; for the calculations 3500 was used.
- The milk price is considered constant and guaranteed at 45 colon per litre milk.
- The extra yield per cow per day is 1.5 litre of milk.
- The physiological optimum amount of bananas per cow per day is 12 kg.

All these values are used in table 13

The average of these calculations is a benefit of 3500 colon (26 US $) per week on a farm with 15 cows if there is no transport of their own. In case of own transport the bananas

Table 12 Results of calculations for the benefit of using bananas in Río Frío and Río Jimenez.

Farmer Río Frío	cows	Benefit Colon	farmer Río Jimenez	cows	Benefit Colon/week
1	15	3500	1	80	30.000
2	16	4000	2	49	14.000
3	22	10000	3	-	-
4	4	-1600	4	-	-
5	70	33000	5	-	-
6	15	3500	6	50	14.000
7	20	6000			
8	30	6400			
9	18	5000			
10	25	8300			
11	19	5400			
12	23	7300			
13	18	5000			
14	15	3500			

will give a rise of income of 7000 colon.
In practice this value is not true because the assumption that the milk price is constant is not true. In fact the big foreign companies which buy the milk, are making the decision to buy the milk on two main criteria:

— the price of the milk.
— the quality of the milk.

For smaller producers of milk both criteria are hard to satisfy. (Relative more costs for, for example, cooling tanks) When a farmer succeeds in producing milk of good quality and the price is low enough still the selling of the milk is not guaranteed. The companies Dos Pinos and Borden hardly work with contracts. In a tropical area like the A.Z. cows are very susceptable for diseases. These diseases cause a variation in quality of the milk. To avoid or to cure the diseases investments are necessary. At the moment (1993) not all the farmers want to take the risk of investments. The bigger farmers with more cows, more hectares, money and transportation possibilities can invest with a smaller risk and more benefit.

The salaries in the neighbouring countries are lower and so the milk can there be produced cheaper. The companies change easily from suppliers in different countries.
This situation causes partly that the smaller farmers are not willing to make more costs for a possible but very insure rise of income.

7 Conclusions and recommendations

The use of bananas means for the macro-elements an extra input of about +15.45 g N, P + 1.62 g P, and K +62.55 g K per cow per day.

The nutrient input caused by bananas at the dairy farms is the biggest for Potassium.

The nutrient balance for Nitrogen at the dairy farms is the most negative one.

The input of N by bananas is compared to the output in milk about 4% till 66% in Río Frío.

The input of P by bananas is compared to the output in milk about 13% till 52% in Río Frío.

The input of K by using bananas is compared to the output in milk positive in Río Frío and in Río Jimenez.

The use of bananas as supplementary cattle feed can be profitable.

The costs of using bananas depends mostly on the transport facilities of the farmers.

The bigger farmers with more cows, more hectares, money and transport possibilities can invest with a smaller risk and more benefit, so the richer people get richer and the poor people relatively poorer, this is the sad story of the rejected bananas used as animal feed in Costa Rica.

Recommendations for the farmers in the Atlantic Zone

- The quality of the milk has to get more attention.
- Cooperations are needed to make the farmers independent of foreign companies.
- Leguminosa like Arachis Pintoi should be used, for increasing the N-input

8 Personal experience

My time in Costa Rica started in a period of my life that I will remember as horrible but essential for my development. Everything in my life had changed completely and when I went to Costa Rica again everything changed but this time in the end positive. Many things in my live had gone wrong in Holland but I learned to think positive in Guápiles. This village and her people I will never forget.

During the Practical period I found out that I underestimated the importance of knowledge about interviewing techniques. It should be better to oblige a course about interviewing techniques combined with a course of Spanish especially for Costa Rica.
Another thing is the fact that we Dutch think that we know everything better and have to improve the system, people are using for years.
The people in Costa Rica often choose for a certain way of working instead of what we are thinking: "that they don't know how to work at a better way."

Further was my lack of knowledge about Zootechnics a problem. I often felt helpless when the farmers told about their farming system and I thought: Do I understand the Spanish wrong or what is happening, this can't be right.
It should be arranged that always it is possible to have a Tico for working together in the field.

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Annex I: The interview

1	Como es el nombre de la finca o de el finquero y que es su direcion?	1	Name of the farmer and address?
2	Usted usa bananos o platanos regalar, Quantos?	2	Do you regularly use bananas/plantains, how many?
3	Quantas vacas de leche quien comen bananos tiene Usted y otro vacas?	3	How many cows, who are eating bananas do you have, and other cows?
4	Tiene Usted Leguminosas en el pasto?	4	Do you have leguminosas in the field?
5	Los bananos vienen de finca y distancia?	5	Of which plantation the bananas are coming ?
6	Quantos kilos bananos por hectarios por dia	6	How many kilos of bananas, for how many hectares for how many days?
7	Que comen las vacas por el alimentacion con bananos? solo yerba o ?	7	What are the cows eating with the bananas only grass?
8	Quantos kilos de leche usted venda por dia ?	8	How many kilo's of milk you sell per day?
9	Usted usa otro alimentation?	9	Other Alimentation for the cattle?
10	Qualqier yerbas. y este yerba es de finca suyo?	10	Which grass species do you use?
11	Usted usa fertilisante artificial o alimentacion otro?	11	Do you use fertilizer,how many and which
12	Los bananos son picando para comer?	12	Are you cutting the bananas before feeding?
13	Quanto questan los bananos para Usted?	13	What is the price of the bananas for you?
14	Tiene usted transport p.e. un camion pequena ?	14	Do you have a truck ?