Evaluation report

Contamination potential of coffee processing 2006/2007

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May 2007
Matagalpa, Nicaragua

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1. Introduction

1.1 Background

Since 2001 FondeAgro is active in the departments of Matagalpa and Jinotega to improve the living and working conditions of small and medium-size farmers. In the department Jinotega one of the most important agricultural activities is the production of coffee. Coffee offers farmers the opportunity to earn the necessary means to improve their living conditions. FondeAgro is supporting coffee producers with, among other things, technical assistance in growing and processing coffee, access to credit, assistance in diversifying their production and the commercialization of the coffee.

Although the production of coffee is a way to improve the farm income and a highly valued product by its consumers the production of coffee also has a less positive side. During the processing of the coffee cherry to a washed green coffee bean two by-products, coffee pulp and wastewater, are produced. These by-products, if not managed well, have a high contamination potential. Regularly these by-products enter rivers and creeks. The pulp and wastewater eliminate a large part of natural life in river systems. Moreover the organic material provides an excellent medium for bacteria. This causes health risks because of the intensive usage of the rivers by the rural population for washing and, in some cases, even for the drinking water supply. For this reason from several sides pressure is put on coffee producers. The government has instated strict wastewater laws and the contamination potential of coffee processing is an important aspect in coffee certifications. A high contamination potential of Nicaraguan coffee processing and an inability to comply with laws, norms and regulations can negatively affect the commercialization possibilities and competitive position of Nicaraguan coffee.

The motivations for FondeAgro to attend to the contamination potential of coffee processing are multiple. As explained above the efforts are motivated from a public health, environmental, economic and competitiveness point of view. These efforts are also stimulated in government policy “Estrategia para la reconversión y la diversificación competitiva de la caficultura en Nicaragua”. The mission of this policy, among others, is an environmentally sustainable use of natural resources.

1.2 Project objective

The objective of this project can be divided into two levels. In the first place the project has the objective to develop suitable means to reduce the contamination potential of coffee processing at coffee plantations from FondeAgro beneficiaries and secondly, make this knowledge available to coffee producers and other organizations working in the production of coffee.

1.3 Method and project activities

The setup of the first part of the project is to assist a number of coffee producers in lowering their contamination potential and in this way validate various options. In the first coffee season 2006/2007, which is evaluated in this report, a number of pilot activities have been set up at small fincas and a central beneficio used by a large number of small producers. The various activities are evaluated in this report on technical, economical and social aspects.

1.4 Structure of report

In this report all the different activities in the environmental assistance project are documented and evaluated. The objective of the report itself is the transfer of knowledge about different wastewater management options, reporting on the first year of the project and to present the options that are recommendable to lower the environmental impact of coffee processing.
The report begins with an explanation about the processing of coffee and the origin of the different of by-products and contamination potential. In chapter 3 the various project activities and the results are described. In chapter 4, conclusions, the experiences gained in the project are summarized into recommendations.

2. Coffee processing and contamination potential

2.1 Coffee processing

The process of producing coffee starts with the coffee cherries. A coffee cherry consists of a coffee bean, the endocarpal parchment, a mucilage layer, pulp (mesocarp) and a skin (exocarp), as can be seen in figure 2.1. In Nicaragua the cherries are ripe and ready to be processed roughly from November to February. In this period seasonal labourers pick the ripe, red cherries by hand. At the end of each day the picked cherries are processed.

There are mainly two ways of processing coffee cherries, a dry and a wet process. These processes have two objectives. The first objective is to remove the different layers of which a coffee cherry consists to reveal the coffee bean. The second objective is to improve the taste characteristics of the coffee by fermentation of the mucilage layer that is surrounding the coffee bean. This fermentation process is critical for the development of the taste characteristics that make high-quality coffee.

In the dry process coffee cherries are laid out in the sun to dry. During this drying period fermentation occurs and the pulp around the coffee bean is dried so it can be removed mechanically.

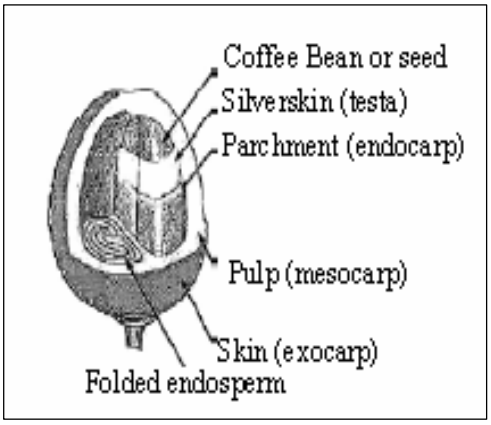


Figure 2.1: Composition of coffee cherry

In Nicaragua mostly the wet process is used. This process is preferred because it offers more opportunities for quality control and classification of the coffee. The in this way produced higher-quality coffee receives a higher market price.

2.2 Origin of by-products

During the depulping process the skin and pulp of the coffee cherries are removed mechanically. The water that is used during depulping gets contaminated with remains of the skin and pulp as well as with part of the mucilage layer that surrounds the coffee bean. After this part of the process the coffee beans are deposited in concrete reservoirs where fermentation of the mucilage layer that still surrounds the bean takes place.

After fermentation the coffee beans are washed to remove the remaining mucilage. In this way the fermentation is stopped to prevent over-fermentation. Another reason for washing of the remaining mucilage and by-products of fermentation is to prevent that moulds grow on the coffee beans.

In these processes originate two by-products, coffee pulp and a wastewater with a high organic content and high acidity. The Chemical Oxygen Demand (COD), a parameter that indicates the organic strength of the wastewater is high. The COD reaches values of between 18.000 and 50.000 mg/l.

2.3 Function of water in coffee processing

In the processing of coffee, as described in the previous two paragraphs, water has several functions. In the first place, water provides for a cheap and smooth transportation of coffee cherries, beans and pulp. In the mountain areas where coffee is grown, traditionally beneficios are located near a water source. In this setup water provides the medium and energy for transportation of coffee. In the more environmentally friendly beneficios more and more transportation parts, traditionally performed by water, are mechanized. In this way the energy demand of the beneficio increases but less water is used.
The benefit of using water as the energy source can be compensated by another energy source, e.g. mechanized transportation. The other function that water has in transportation, being a medium that provides for a smooth transport of coffee beans, however is more difficult to substitute. Mechanized transport of depulped coffee beans is unpopular because of the risk of damages.

A second function that water has in the processing of coffee is that it provides a medium for classifying different qualities of coffee beans. Most simply put light, floating coffee beans have an inferior quality compared to the heavier coffee beans. A light or floating coffee bean can also indicate damages or diseases in the bean.
The classification using the buoyancy and weight of coffee beans takes place before and after depulping and during the washing process. An accepted substitute for this method of classifying is not (yet) available. The only substitute would be not to classify and accept a lower quality of coffee. In Nicaragua this approach is not very popular, because Nicaragua is selling in the quality, not the quantity, market.

A third function of water is the removal of mucilage after the fermentation period. During the washing process the liquefied mucilage is removed from the coffee bean, cleaning it and preventing over-fermentation and moulds. Up until now there is no washing process that does not use water. There are differences in efficiency of water usage. However for every kilogram of coffee beans a fixed amount of mucilage has to be removed, being in, as a matter of speaking, 1 L or 10 L of water. An alternative is the dry method of coffee processing, which, again, is more suitable for the quantity market. This method is not suitable to process quality Arabica coffee, as produced in Nicaragua.

Figure 2.2: Washing process at a large beneficio

2.4 Contamination potential

In the previous paragraphs the origin of the by-products is explained. There are a lot of (agricultural) activities that generate by-products. What causes coffee processing to have such a high contamination potential?
This can be explained by a combination of two factors, quantity of by-products and management of by-products.

2.4.1 Quantity of by-products

One of the reasons why coffee processing has a high contamination potential is the amount of by-products. Only 18% of the weight of the coffee cherries is sold and actually leaves the country as the dry green coffee bean. This means that 82% of the weight of the coffee cherry consists of by-products. An average small coffee plantation of four manzanas[1], producing 50 quintal oro[2] per coffee season, also produces about 3500 kg of coffee pulp.
Also during the depulping and washing of this coffee easily 50 m^3 of wastewater is produced per season.

2.4.2 Management of by-products

What happens with the by-products after coffee processing is called the management of by-products. Dumping the coffee pulp and wastewater into a river, as is still a common practice, is also a management of by-products, however one with a high contamination potential.
There are other ways to manage the by-products that have a lower contamination potential.

2.4.3 Lowering contamination potential

The objective of FondeAgro´s efforts in this topic is to lower the contamination potential of coffee processing. To achieve this, the project focuses on the two determinants of the contamination potential: quantity of by-products and management of by-products. Improvements in either one of them will lower the contamination potential; the strength however lies in the combination. Lowering the quantity of by-products will make the management of by-products easier, more economical and thus more effective.

[1] 1 manzana corresponds with approximately 7000 m^2 or 0,7 hectares
[2] 1 quintal (qq) corresponds with 100 pounds, Oro is the expression used for dry green coffee beans

3. Evaluation of project activities

The project activities are evaluated on the effects they have on quantity of by-products and management of by-products, as determinants for a lower contamination potential.
The activities that have been executed during the last year are:

- Beneficio improvements,
- Installation and validation of systems for a management of wastewater,
- Management of by-products in a central beneficio,
- Diagnostic of state and contamination potential beneficios.

In this study the focus lies on the by-product wastewater. This focus has been chosen for a number of reasons. In the first place the amount of pulp that is produced in coffee processing is fixed. Working more efficiently does not generate less pulp.
Secondly the management of the by-product coffee pulp on the plantations in the FondeAgro target group does not generate much problems. The coffee producers have experience using the coffee pulp to fertilizer their plantations. Some producers apply it directly on their coffee plantations, others process it first to an organic fertilizer. In this way the usage of coffee pulp generates value for the plantation and diminishes the contamination potential of coffee pulp.
During this project problems with the management of coffee pulp have been seen only at a central beneficio. For this reason the management of coffee pulp will be discussed in the paragraph about the management of central beneficios.

3.1 Beneficio improvements

The management of by-products is something that takes place after the processing of coffee. It is however advisable to start to see if improvements can be made within the origin of the by-products, the actual processing itself. In this way the quantity of by-products can be reduced, which improves the possibilities for a good management of by-products. Also a more efficient coffee processing makes it easier to find time, energy and financial resources to implement a better management of by-products.
At a number of small beneficios in El Cuá and Yalí and at a large beneficio in Yalí the process efficiency and water usage have been analyzed.
The reasons for a favourable or unfavourable process efficiency and water usage being present at certain beneficios have been analyzed to identify what makes for a environmentally friendly and efficient coffee processing.

Table 3.1: Research data depulping process

Type of beneficio	**Size of beneficio**	**Finca/Producer**	**Water usage**	**Processing time**		**Water flow**	**State of beneficio**
	(Small/medium/ large)		(liters/qq oro)	(minutes)	(mts/qq oro)	(liters/ minute)	
Individual	Small	Primitivo Zeledon	860	150	30	28,5	Good
Individual	Small	Julio Sarauz	1550	90	90	17,3	Bad
Central	Large	El Gorríon	230	660	7	-	Bad
Central	Large	El Gorríon	250	135	3	-	Bad
Central	Large	El Gorríon	50	120	3	-	Good
Central	Large	El Gorríon	120	120	3	-	Good
Central	Large	El Gorríon	190	60	3	-	Bad

In table 3.1 it can be seen that the water usage and processing time are significantly lower in a large beneficio. The water usage depends highly on the speed of the depulping process. In the large beneficio the depulping took place 10 to 30 times faster.
Also the result of improvements in water recycling and depulping without water can be seen in this table. The central beneficio of El Gorríon was modified to improve the water usage, processing efficiency and quality. The implementation of a better water recycling and a depulping without water lowered the water usage from 230-250 L per qq oro to 50-120 L per qq oro, as can be seen in table 3.1.
The water usage measurement of 190 L per qq oro was taken during a process where part of the mechanism to depulp without water failed and is not taken into account for the present water usage of the central beneficio.

In table 3.2 it can be seen that in a central beneficio the washing process takes between 150 and 200 L of water per qq oro. In an individual beneficio in a good state the water usage during the washing process is around 450 L of water per qq oro. In an individual beneficio in bad state the water usage, however is much higher, between 1000 and 2000 L per qq oro.
Remarkable is that the highest water usage seen in the study resulted from the lowest water flow of 18 L per minute. This can be explained by a lack of process efficiency. With a higher water flow the washing and classifying of coffee takes place with more efficiency and in the end takes less time and water. A water flow of 50-60 L per minute is recommendable for an efficient washing and classification.

Table 3.2: Research data washing process

Type of beneficio	**Size of beneficio**	**Finca/Producer**	**Water usage**	**Processing time**		**Water flow**	**State of beneficio**
	(Small/medium/ large)		(liters/qq oro)	(minutes)	(mts/qq oro)	(liters/ minute)	
Individual	Small	San Antonio	960	15	23	45	Bad
Individual	Small	San Antonio	1800	30	100	18	Bad
Individual	Small	Primitivo Zeledon	410	23	15	57	Good
Individual	Small	Primitivo Zeledon	550	12	8	68	Good
Individual	Large	Rafael Armuz	382	15	6	63	Good
Central	Large	El Gorríon	154	300	3	-	Good
Central	Large	El Gorríon	228	240	9	-	Good
Central	Large	El Gorríon	140	120	3	-	Good
Central	Large	El Gorríon	154	240	4	-	Good

3.2 Systems for a management of wastewater

As explained in the beginning of this chapter the management of coffee pulp does not generate a high contamination potential. There are three reasons why the management of coffee pulp is working out in practice, the success factors so to speak.
Firstly, coffee pulp has a nutritional value that corresponds with the nutritional demands of coffee plants. Besides supplying nutrients, the organic material of the coffee pulp also helps improve the soil structure. A soil with sufficient organic material has a better capacity to retain water and provides a healthier microbiologic activity.
Secondly the pulp has a form that the producers can handle. Using organic material, processing it to organic fertilizer and applying it to the coffee plants is a type of work that fits within the activities and capabilities of the producers. Thirdly this processing and usage of pulp is technologically simple and cheap.
The wastewater from coffee processing also has valuable nutritional and bacteriological components. To find a successful way to manage the wastewater the goal is to also copy the other success factors of the management of coffee pulp. This means a cheap and technologically simple management of wastewater that gives the opportunity to use the nutrients in the wastewater and of which the operation fits within the activities and capabilities of the producers.
For this reason a number of wastewater management systems are validated on technical, economical and social aspects.

3.2.1 Wastewater infiltration

At two coffee plantations the wastewater of the past coffee season was infiltrated. In one case an existing infiltration pond was used after some maintenance work. At the other plantation an infiltration pond was constructed.
Using this type of wastewater treatment, wastewater is prevented from entering directly into rivers and creeks. The purification capacity of the soil reduces the wastewater strength before it gets into contact with groundwater or surface water.
In this paragraph the wastewater infiltration for small coffee plantations is analyzed on technical, economical and social aspects.

Technical analysis
An infiltration pond is simple to construct. Hardly no material is needed, only labour. The operation of an infiltration pond is also minimal. If the infiltration rate is low, wastewater will be present in the infiltration pond for a longer time. In this case lime can be added to reduce smell and flies or mosquitoes. The maintenance needed for infiltration ponds is minimal, and only needs labour.
Implemented on small coffee plantations it is difficult to control the impact of the wastewater on ground water or surface water. For this reason the contamination potential of wastewater infiltration, in comparison with the other types of treatment systems, is still regarded high.

Economical analysis
The new infiltration ponds cost approximately $25 in labour and $25 in material. The existing infiltration pond most likely has a higher construction price, because of the usage of gravel and sand at the bottom of the pond to facilitate infiltration. The cost of construction of this infiltration pond is estimated between $150 and $200. The costs for operation and maintenance are negligible.

Social analysis

An infiltration system does not offer the opportunity to reuse the water and nutrients of the wastewater. Because of this the return the producer gets from the system is limited. This is an disadvantage for a successful implementation.

The capacities and material needed for construction, operation and maintenance are generally available with the producer and within the plantation. This is an advantage for the implementation of wastewater infiltration.

3.2.2 Overland flow system

The second option that was evaluated is an overland flow system. In this type of system the wastewater passes through an area where the terrain and vegetation creates resistance for the wastewater flow. This gives the water time to infiltrate in the upper soil layer and to be consumed by the vegetation.

In practice this means that the water coming from the beneficio first needs to be captured at the end of the washing canal. After this the water is diverted to a terrain between the beneficio and the river that is planted with a dense vegetation, preferably one that has value for the producer. Some minor changes in the terrain might be necessary to create more resistance for the water flow. In figure 3.1 a collection device is shown that makes it possible to redirect the wastewater to a desired area. This concrete collector has a secondary benefit of functioning as a support where the producer can place the wooden case commonly used to collect the washed coffee. Collecting the wastewater in this way also keeps the working area of the beneficio clean from mud, wastewater and coffee pulp. In figure 3.2, in the background, the overland flow area can be seen. The wastewater is diverted from the beneficio and distributed in this area planted with malanga. This system was implemented at two plantations.

Figure 3.1: Concrete wastewater collector

Figure 3.2: Beneficio with overland flow area

Technical analysis

This type of system is simple to construct. Producers can make it largely with material available on the plantation and only labour is needed. It hardly needs an effort to operate it and the only maintenance that is needed is to maintain the vegetation dens before the coffee season and harvest the plants afterwards.

Just as infiltration systems, this system prevents wastewater from entering directly into rivers and creeks. Soil and vegetation absorb the water and nutrients and in this way lower the

contamination potential. The system however has a low efficiency. For this reason it needs a fairly large space between the beneficio and river.

Economical analysis
To construct this type of system an investment of about $30 in material is needed. A concrete collector has to be constructed and some tubes are necessary to divert the wastewater to the destined area. The cost for the labour needed to maintain the vegetation can be compensated by the production of valuable biomass, such as, in the case explained above, malanga.

Social analysis
The system offers the opportunity to reuse the water and nutrients. This is an advantage for a successful implementation. Besides this it is simple to construct, operate and maintain. It requires the same capacities as needed to maintain any other kind of crop that is grown at the farm.

3.2.3 Wastewater treatment system

The third treatment option that is evaluated is an ecological wastewater treatment system. At three plantations an ecological wastewater treatment system was set up.
An ecological wastewater treatment system is a treatment system designed to benefit from the purification capacity of natural surface water. In this type of system natural physical, biological and chemical processes take place in a controlled environment with the objective to make wastewater suitable for reuse or discharge in natural surface water, such as rivers. A benefit is that part of the treatment takes place through the production of biomass. The biomass coming from the treatment system can have a value for the owner.
This type of treatment system for coffee wastewater is still in development. During the last coffee season the potential of this treatment option was demonstrated, which makes it possible to compare it with the other two treatment options.

Figure 3.3: Ecological treatment system in El Cuá

Technical analysis
Technically this treatment system is the most difficult to construct. It can be made largely from locally available material, but needs more labour and the design is more specific. In the operation especially the water flows and pH control are important.

The system offers an excellent efficiency on a small area. The production of useful biomass also is much more efficient. For this reason this system has the biggest influence on contamination potential.

Economical analysis
Of the three treatment options this system is the most expensive. The costs vary between $400 and $800. Of this amount about 20% is labour and 80% is material. Also for the operation some costs have to be made. The pH control costs between $10 and $15 per coffee season. The costs for maintenance only consist of labour and are negligible.
The production of biomass is the highest compared to the other types of systems. The value of this production however cannot be made financial, because the produced plants will most likely be used within the plantation.

Social analysis
This type of system offers the most direct benefit, in production of biomass and treatment efficiency. This is positive for a successful implementation. The construction and operation of this type of system however is more complicated. Only at the plantations where the producers were trained more intensely, the systems were maintained well and reached a good treatment efficiency and biomass production.

3.2.4 Recommended management of wastewater

Below the validation of the three treatment options on economic, technical, and social aspects is summarized.

Table 3.3: Validation of three treatment options

	Economic (Price)	**Technical (environmental impact after treatment)**	**Social (operating willcomplexity)**
Wastewater infiltration	Medium	High	Low
Overland flow system	Low	Medium	Low
Wastewater treatment	High	Low	High

A wastewater treatment system is the most expensive and complex option of the three. It does give the best opportunity to reuse water and nutrients and is the only option that has a sufficient efficiency to be used when a limited area is available.
For this reason it is recommendable to investigate in each specific case if it is viable to change the location of coffee processing so that an actual wastewater treatment system is not necessary. When sufficient area can be created between the river and beneficio one of the other two options can be chosen. In this case an overland flow system, as explained in paragraph 3.2.2, is preferred over wastewater infiltration because it generates a lower environmental impact, gives the opportunity to reuse water and nutrients from the wastewater for a lower price and the same low operating complexity as an infiltration system.

3.3 Management of by-products at a central beneficio

A centralized processing of coffee has several advantages, such as lower per-unit production costs and better commercialization possibilities. For this reason FondeAgro and other institutions are assisting groups of coffee producers in forming cooperatives and, as a next step, developing a centralized processing of coffee.
From an environmental point of view processing coffee centrally instead of at a large number of small beneficios results in a relatively lower water usage (see paragraph 3.1). Also the management of by-products will be more cost-effective at a larger scale.
However the quantity of by-products at a central beneficio is relatively high and the management of by-products is more difficult, as will be explained further on in this paragraph. For these reasons central beneficios have a high contamination potential.
The base for this study on the management of by-products in central beneficios is the pilot project that was set up at the central beneficio of cooperative El Gorríon in San Sebastian de Yalí, the central beneficios FondeAgro is in process of realizing and the central beneficio of cooperative Coopsaec, Pueblo Nuevo, Jinotega.

3.3.1 Difficulties in the management of a central beneficio

In comparison to an individual beneficio there are a number of factors that make the management of a central beneficio more difficult.
First of all the central beneficio is owned, or at least used, by a group of people. To achieve the same level of coordination, a better organization is needed. Also the sense of responsibility over the beneficio and its contamination potential is less, which is a common sociological phenomenon in groups.
Secondly the fact that the beneficio is not located and integrated in a coffee plantation has a number of effects:

- Operating crew; After the harvest the operating crew of a beneficio normally would have work on the rest of the plantation. In this way experience and capabilities are kept within the plantation to have a capable crew for next year's coffee processing. In a central beneficio it is more difficult to maintain a capable and experienced crew for each coffee season.
- Resources; A beneficio at a coffee plantation will have the resources of the plantation available during the coffee season. Because a central beneficio is only the processing unit and only used for three to four months per year it has less resources. A number of practical examples are the unavailability of a truck, tools or man-hours.
- Area; A central beneficio is usually located at a central point between the plantations of the members. It usually does not have extra area available and misses the security of being located at a plantation.

3.3.2 Effect on the management of by-products

All of the factors mentioned in paragraph 3.3.1 make a good management of by-products in a central beneficio more difficult.
The probability that the beneficio is operated by a less-experienced crew can reduce the process efficiency and result in a higher water usage. It also makes a good operation of a treatment system more difficult. It should be made sure that experienced people with the knowledge needed to maintain and operate a wastewater treatment system stay available for the operation each year.
Besides this in general less area is available, which makes it more likely that a more efficient, technologically less simple, wastewater treatment has to be chosen.

In the management of coffee pulp at a central beneficio the lack of resources, like a truck to transport coffee pulp, and an area to deposit the coffee pulp, make a good management of coffee pulp more difficult. At an individual beneficio usually one of the trucks of the plantation is used during depulping to directly transport the coffee pulp to a location on the coffee plantation.
It is recommendable to handle/transport the coffee pulp at least on a weekly basis to avoid a pile-up of coffee pulp as is shown in figure 3.4.
In the construction plans of a central beneficio it should be taken into account where the pulp will be deposited, what is needed to transport and process the pulp and what infrastructure is needed as a temporary storage of coffee pulp when the pulp is not directly transported.

Figure 3.4: Mountain of pulp at central beneficio Yalí

Because of the lower sense of responsibility of the users of a central beneficio, in comparison to having one individual owner, for both the management of wastewater and coffee pulp, it should be taken into account that a management of by-products should be well-planned and implemented. This is necessary to make it as easy as possible to maintain a good management of by-products and prevent a high environmental impact.

It is not said that an efficient process or a good management of by-products at a central beneficio cannot be achieved. It is merely emphasized that a central beneficio has certain disadvantages in comparison with an individual beneficio, which should be taken into account to achieve the same efficiency and environmental impact as an individual beneficio.

3.4 Diagnostic state and contamination potential beneficios

So far in this evaluation a number of factors have been identified as important for the contamination potential.

- Quantity of by-products,
    - Size of the production and efficiency of process,
- Management of by-products,
    - Distance and specifications of area between river and beneficio.

These factors have been included in a diagnostic to investigate the contamination potential of the beneficios of coffee producers assisted by FondeAgro. The diagnostic also gives an overview of the state of the beneficios. This is a topic of interest for FondeAgro´s components Technical Assistance and Agri-Business, as well as being an indicator for an efficient process. The diagnostic, as executed under the FondeAgro target group, is presented in Annex A.

3.4.1 Setup of diagnostic

The principal objective of the diagnostic is to determine the contamination potential of the beneficios. A number of producers do not process their coffee at their own plantation, but use the beneficio of a neighbour. For this reason only those plantations where an actual processing takes place were included in the diagnostic. Using this definition to determine the target group of the diagnostic, 862 plantations were included in the diagnostic.

In this diagnostic a beneficio is defined as the installation where coffee processing takes place, being a depulper and a bag to collect the depulped coffee or a beneficio with fermentation reservoirs, washing canal and other infrastructure.

As explained above the state of the beneficios is important for the contamination potential. The state of the fermentation reservoir and washing canal in this sense are most important. These parts of the beneficio get in contact with water and, if not in at least a fair condition, will cause the water usage to rise.

The following classification has been used to categorize the state of the beneficios:

Table 3.4: Classification of state of beneficios

Classification	Description
Very bad	The beneficio technically does not permit a processing of coffee
Bad	The beneficio has one or more serious technical defects
Regular	The beneficio permits a processing of coffee without technical difficulties
Good	The beneficio permits a processing of quality coffee

This functional classification was elaborated in cooperation with Serviteca (organization executing the technical assistance for FondeAgro). A strict technical classification of beneficios proved to be difficult to execute because of the technical differences in the beneficios that are used within the target group. The functional classification is explained below.

Beneficios that fall in the category very bad technically do not permit a processing of coffee. The producers using these beneficios have a serious problem getting their coffee processed at all.
In the beneficios categorized as bad, coffee is processed in a way that affects quality, causes damages to the beans and losses of coffee. Furthermore these beneficios are in a state of

deterioration. If they are not maintained on short notice in two or three years most likely they will also fall in the category very bad.
A beneficio is classified as regular if it permits a processing without technical difficulties and losses of coffee. Beneficios that fall in the category good permit a processing of quality coffee.

3.4.2 Results contamination potential

To determine the contamination potential of the beneficios, the production size of the plantations has been related to the distance between a river and the beneficio. The criteria to classify a beneficio as having a high contamination potential are:

Table 3.5: Criteria to determine contamination potential

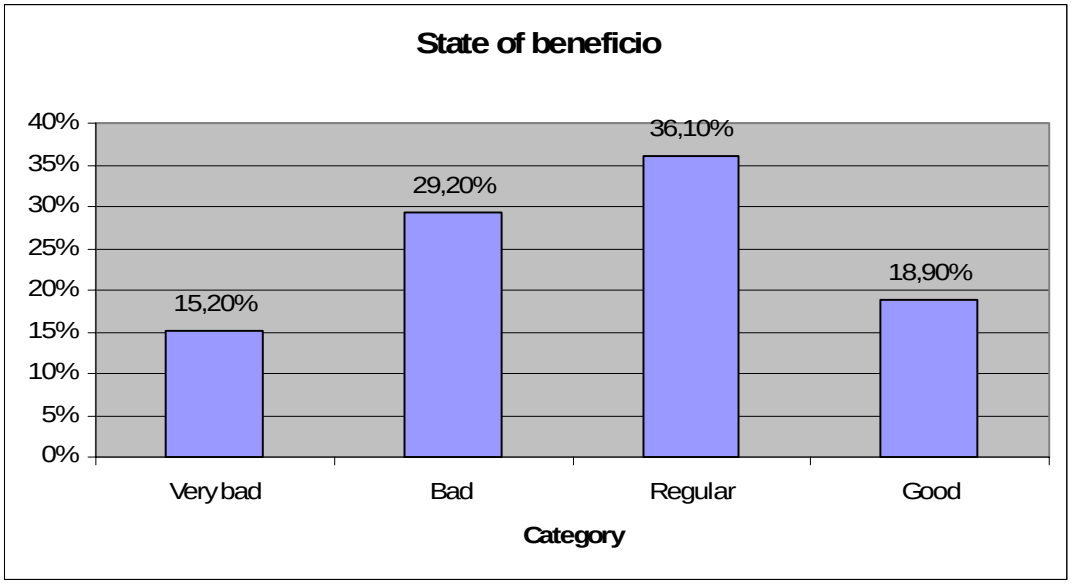
Production (quintal/year)	Minimum distance river-beneficio (meters)
0 – 25	20
26 – 100	50
101 and above	100

Figure 3.5: Examples of location of beneficios in El Cuá related to water sources (dep. Jinotega)

Using this categorization the diagnostic indicated that 44% of the beneficios have a high contamination potential, adding up to 379 producers with a beneficio too close to a river. Of these producers a group of 166 producers have their washing canal practically in a river or creek.
In the beneficios with a high contamination potential approximately 27.300 qq oro is produced in a way that contaminates rivers and creeks. (This amount is based on the production data from the coffee harvest 2005/2006).

3.4.3 Results state of beneficios

Graph 3.1: State of beneficios



In graph 3.1 the results of the diagnostic of the state of the beneficios is presented. For reasons of efficiency of processing, quality of processing and water usage the producers having a beneficio in very bad or bad state should be assisted in improving their beneficio. This group consists of 44,4% of the producers in the target group, meaning 383. Based on the production data from the coffee harvest 2005/2006, 16.000 qq oro per year is processed in these beneficios.
Another important result from the diagnostic, that affects processing efficiency and quality, is the number of 186 producers with a beneficio (21,5%) that have problems with the availability of water. These producers do not have enough water available during the harvest season for a good an efficient coffee processing.

Quality of coffee processing
Quality in coffee production is regarded as a way to secure farm income and improve production and living conditions. In this way production quality contributes to the economic sustainability of coffee production. An improved quality of coffee processing has short-term and long-term advantages.
On a short-term an improved coffee processing will prevent serious defects in quality, damages of coffee beans and losses of coffee. In this way a larger amount of saleable coffee will be produced from the same amount of coffee cherries.
More on the long-term, the benefit will be an improvement in the overall quality and uniformity of coffee coming from the area. This can improve the commercialization possibilities of coffee from the Nicaraguan country side.

Figure 3.6: Examples of the technical state of beneficios in El Cuá and Plan de Grama (dep. Jinotega)

3.4.4 Other results from the diagnostic

- There is a category of 179 (20,7%) producers with a beneficio that fall both into the category of beneficios with a high contamination potential as well as in the category of beneficios in a bad or very bad state. This group can be regarded as a priority group to improve both the contamination potential as well as the quality of processing.

- From the plantations with a beneficio 23 (2,7%) presently are certified as organic plantations.

- From the plantations with a beneficio 9 (1%) presently are in the process of obtaining a certification.

- At 573 (66,4%) beneficios the producers use water during the depulping process. Depulping with water is not a necessity, and depulping without water can even benefit the fermentation process. At these plantations there is an opportunity to decrease the water usage by training the producers in using a depulping process without water. This lowers the dependency of water of the coffee processing and the environmental impact.

- A large majority of the producers (71,1%) has a positive attitude towards processing coffee in a small group of neighbouring producers. Forming small groups of producers, to process their coffee together, is an opportunity to make an investment in a beneficio improvement more viable (split costs), to get a more efficient water usage and to unite the producers to sell their coffee in a larger quantity, which gives them more negotiating power in the commercialization of coffee.

4. Conclusions

A better beneficio, on a better location, with a better management of by-products

From the before mentioned diagnostic it can be concluded that a category of 179 producers assisted by FondeAgro have a high contamination potential as well as a beneficio that does not permit a processing of coffee or a beneficio that has a number of serious defects.
For improvements in both the contamination potential as well as quality of processing the beneficio is the central point.

The beneficio, where the actual processing takes place, is the origin of the by-products. To improve, meaning lower, the quantity of by-products, an efficient process in a beneficio in good technical state is important. For this reason it is recommendable to improve the technical state of beneficios and the capacities of the producers in coffee processing.
Secondly the management of by-products has to be set up well. For a good management of by-products a sufficient space between the beneficio and a river is important. Also, for a sustainable implementation it is important to find ways in which the coffee producers can benefit from the by-products of coffee.

Within the management of by-products the treatment of wastewater is the most difficult. Compared to the coffee pulp it has a higher contamination potential and is more difficult to treat and to reuse.
Preferably the wastewater should be treated in an overland flow system. This type of wastewater management system offers the possibility to reuse water and nutrients at low cost and operating complexity. For this reason it is recommendable to review in each specific case if it is viable to change the location of coffee processing so that an overland flow system can be used. This is necessary because this type of system has a low efficiency and for that reason requires a relatively large area between the beneficio and a river.
If area is limited a system with a higher efficiency will be needed. In this situation an ecological wastewater treatment system is recommended. It has a higher operating complexity, but can be implemented successful for small coffee producers, giving them the opportunity to reuse water and nutrients from the wastewater.

An integrated approach to help improve both the environmental impact as well as the quality of processing will be most effective to assist producers in improving their coffee processing: in a better beneficio, at a more appropriate location, modifying the terrain between the beneficio and river to function as an overland flow system to implement a better management of by-products.

Regarding the usage of water for coffee processing there are two specific areas where the producers can be assisted. A category of 186 producers does not have sufficient water available during the harvest season to process their coffee in an appropriate way. Besides this the large majority of producers assisted by FondeAgro uses water to the depulp coffee. This increases their dependency of water, increases the contamination potential and is not beneficial for the fermentation process.

Annex A. Diagnostic beneficios FondeAgro

Finca

1. Nombre de la finca:
2. Nombre del productor:
3. Municipio y communidad:
4. Distancia hasta la carretera (tiempo a pie en minutos):
5. Nombre del técnico:
6. Producción (QQ oro):

Cíclo 2004/2005	Cíclo 2005/2006	Cíclo 2006/2007

7. Área en producción (Manzanas):
8. Despulpado:

En seco	Con agua

9. Disponibilidad de agua para procesar café:

Bastante	Suficiente	Muy poco

Estado del beneficio

10. Material:

Madera	Cemento

11. Estado:

Bueno	Regular	Malo	Muy malo

12. Cuantos productores estan procesando en el beneficio:

13. Nombres de los vecinos con asistencia tecnica de Serviteca en café:

14. Disposición para procesar juntos:

Si	No

Ubicación del beneficio

15. Lugar del beneficio:

Siempre el mismo	Mueve el beneficio

16. Distancia entre el río y el beneficio (varas):
17. Distancia entre el beneficio y la casa (varas):
18. Terreno entre el río y el beneficio:

Terreno:	Plano	Pendiente
Tipo de cultivo:		
Tipo de suelo:	Arcilloso	Franco arenoso

19. Certificación:

Certificado	En proceso	Interés	No interés

20. Tipo de certificacíon: