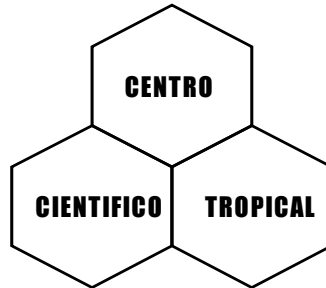


TROPICAL SCIENCE CENTER



ECONOMIC EVALUATION OF THE PAYMENT FOR ENVIRONMENTAL SERVICES IN COSTA RICA, INCLUDING THE FINANCIAL IMPACT TO CONTRACTORS ACCORDING TO MODE

EXECUTIVE SUMMARY

FINAL REPORT

FINANCIAL AND ECONOMIC ANALYSIS

Ronald Mejías Esquivel
Julio Calvo Alvarado
Vicente Watson
Rafael Bolaños
Vladimir Jiménez

Prepared for FONAFIFO
ScalingUpPSA Project

San José, Costa Rica
August, 2006

EXECUTIVE SUMMARY

1. Introduction

With the approval of Forestry Law #7575 from February 5th, 1996, and the implementation of the Payment for Environmental Services Program (PSA) by the National Fund for Forestry Financing (Fondo Nacional de Financiamiento Forestal –FONAFIFO), the process in Costa Rica of recovery and protection of the country's forest cover has been significantly strengthened. After approximately eight years of being operational, the Program has incorporated more than 460.000ha, of which 86.4% are protected forests, 5.8% are commercial forest plantations, and 7.4% are forests under controlled forestry management (FONAFIFO, 2004). This effort represents an investment of approximately 50 billion colones.

The main objective of this study is to determine the private financial contribution (to the contractors) through the PSA mode and the economic contribution (social) that is being generated by the Payment for Environmental Services Program. The appraisal incorporates the four environmental services recognized by Forestry Law #7575 for its payment: water, scenic beauty, biodiversity, and carbon.

2. Methodology

The broadened cost-benefit analysis is used as the methodology to determine the feasibility of said program on a private and social level.

The following formulas are used to estimate the financial feasibility (private) and social feasibility (economic):

$$\text{Financial feasibility: } VAN_x = \sum_{t=1}^n \sum_{i=1}^m [(B_{it} - C_{it}) / (1+r)^t]$$

The formula to estimate the economic or social feasibility differs from the first one in that it incorporates the externalities (E_{it}) and the price adjustment of the financial flows to eliminate distortions.

$$\text{Economic feasibility: } VAN_x = \sum_{t=1}^n \sum_{i=1}^m [(B_{it} - C_{it} \pm E_{it}) / (1+r)^t]$$

Where:

VAN_x : net actual value of basin x.

t: represents time (20-year base).

i: land use (economic activity).

r: discount rate.

B_{it}: benefits generated by the economic activity (land use) i in period t in basin x.

C_{it} : Costs generated by activity i in period t in basin x.

E_{it}: external costs and/or benefits of activity i in period t corresponding to basin x.

The addition symbols represent the accumulation of the costs and benefits generated by the different land uses through time in the respective basin.

The methodology of price adjustment taken from Aylward, et al, (1997), estimates the social prices using border prices, in other words, removing the distortions from tariffs and import taxes on goods and services. This methodology is summarized using the following formula:

$$P^E = P^M / [(1 + t_{DAI} + t_{SC} (1 + t_{DAI}) + t_{LEY} + t_{IV} (1 + t_{DAI} + t_{SC} (1 + t_{DAI}) + t_{LEY}))]$$

Where: P^E : economic price or shadow. P^M : market price. DAI: import tariff rights. SC: consumer selective price. Ley: tax Law #6946 of 1% and IV: sales tax.

Main aspects and variables to take into consideration for the analysis:

- Two analysis levels: financial and economic, by hectare and by basin.
- Four research basins: Potrero, Quebradas, Caño Negro, and Cocles.
- Five alternative agricultural land uses: cattle for meat, coffee, cantaloupe, blackberry, and plantain.
- Four environmental services: carbon, water, biodiversity, and scenic beauty.
- Three types of PSA contracts: protection, plantations, and agroforestry.
- Two scenarios: WITH OR WITHOUT PSA.
- Analysis period: 20 years.
- Social discount rate: 10%

3. Main results

3.1. Economic Value of Environmental Services per Hectare per Year

The following are the economic values of the environmental services per hectare per year. Such values are the result of the multiplication of the selected economic values per service unit times the amount of environmental service determined by their biophysical technical quantification. These results are per year, not yet discounted.

3.1.1. Economic Value of Water

The basin in which the forest contributes the most in water environmental service per hectare per year is Caño Negro and the largest contribution comes from the water quality through the control and reduction of erosion and sedimentation; this service is assessed through the costs that are avoided in cleaning of the reservoir due to hydroelectric activity. The basins with the lowest economic contribution per forest hectare per year are Quebradas and Potrero (see Table 1).

Table 1. Assessment Summary of Water Environmental Service: Scenario WITH PSA, per Basin and Service. \$/ha/year

WATER QUALITY			WATER AMOUNT			
Control and reduction of sedimentation			Protection of water sources	Production input		TOTAL
Basin	Potable	Hydroelectricity		Hydroelectric	Irrigation	
Potrero	44.82		(3.02)		(26.04)	15.76
Quebradas	17.40		(6.14)			11.26
Cocles	29.26		10.33			39.59
Caño Negro		1,634.24	(134.46)	(102.78)	(53.86)	1,343.14
Total	91.48	1,634.24	(133.29)	(102.78)	(79.9)	1,409.75

When discussing the **scenario WITHOUT PSA**, the values from Table 1, adopt the opposite sign, in other words, where there was social benefit there would be social loss and vice versa.

3.1.2. Economic Value from Scenic Beauty

The greatest economic values per hectare from scenic beauty are those from the scenario WITH PSA. The Cocles basin has the highest value at \$8.64/ha, followed by \$8.19/ha for the Caño Negro basin (see Table 2).

The highest contribution in scenic beauty per basin, measured from the difference in values between the WITH and WITHOUT scenarios, comes from Cocles in the three PSA modes. The other three basins show similar contributions, slightly larger for Potrero (see Table 2).

As far as Scenic Beauty is concerned, the Cocles and Potrero basins should have priority in the allocation of resources from the PSA Program since these areas have more significant social contributions in comparison to the other basins.

Table 2. Scenic Beauty: Mean Weighted Economic Value per PSA mode and According to Scenario (WITH or WITHOUT PSA). In \$/ha/year

PSA mode	WITH PSA (Actual)	WITHOUT PSA (Deforestation)	Difference in Contribution (WITH- WITHOUT)
POTRERO			
Protection	6.5	3.7	2.8
Plantation	4.5	2.6	2.0
Agroforestry	1.9	1.1	0.8
QUEBRADAS			
Protection	6.01	4.47	1.54
Plantation	4.21	3.13	1.07
Agroforestry	1.2	0.89	0.31
CAÑO NEGRO			
Protection	8.19	6.38	1.81
Plantation	5.73	4.46	1.27
Agroforestry	2.46	1.91	0.54
COCLES			
Protection	8.64	1.9	6.75
Plantation	6.05	1.3	4.73
Agroforestry	2.59	0.57	2.03

3.1.3. Economic Value of Biodiversity

As in scenic beauty, the greatest contribution or difference between the scenarios WITH or WITHOUT PSA occurs in the Cocles and Caño Negro basins, followed by Potrero, and last is Quebradas (see Table 3).

Table 3. Biodiversity in Basins: Economic Values in Scenarios WITH or WITHOUT PSA by Type of Vegetation Cover. In \$/ha/year

Basin	Unintervened Primary Forest	Intervened Primary Forest	Secondary Forest
WITH PSA			
Caño Negro	8.6	6.9	4.3
Cocles River		6.1	3.8
Potrero River		3.2	2
Quebradas		2.5	1.5
WITHOUT PSA			
Caño Negro	5.3	4.3	2.7
Cocles River		1.9	0
Potrero River		1.3	0.8
Quebradas		1.9	1.1

Basin	Unintervened Primary Forest	Intervened Primary Forest	Secondary Forest
DIFFERENCE in Values (WITH – WITHOUT PSA)			
Caño Negro	3.28	2.63	1.65
Cocles River		4.16	3.81
Potrero River		1.89	1.18
Quebradas		0.55	0.35

Comparatively speaking and considering the allocation of resources as far as biodiversity is concerned, the Caño Negro and Cocles basins should have priority due to their annual economic (social) contribution.

3.1.4. Economic Value of Carbon

As observed in Table 4, the greatest economic value per hectare for all basins corresponds to the agroforestry mode. Of the four environmental services, this is the one that contributes the most in economic value per hectare. Caño Negro is the basin with the largest contribution, followed by Quebradas, then Cocles, and last is Potrero.

Table 4. Economic Values of Carbon Absorption, by PSA Type, Basins, and Scenarios. In \$/ha.

Basin PSA Type	Quebradas		Potrero		Caño Negro		Cocles	
	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT
Natural Regeneration (Protection)	1,835	-1,835	435	-435	2,900	-2,900	1,537	-1,537
Plantation	2,174	-2,174	515	-515	3,435	-3,435	1,820	-1,820
Agroforestry	2,372	-2,372	562	-562	3,748	-3,748	1,986	-1,986

3.2. Analysis of the PSA Contribution per Hectare

This section presents the analysis of the contribution or impact of the Payment for Environmental Services per hectare when subtracting the flows to obtain the financial and economic profitability (Net Actual Value (VAN): 20 years and 10%).

3.2.1. Financial Contribution of the PSA per Hectare

When comparing the **financial profitability** of the forestry activities (without including the cost of opportunity) by moving from a scenario WITHOUT PSA to one WITH PSA, the profitability increases significantly. The lesser percent (%) difference is of 31% and corresponds to the plantation mode in the Quebradas

basin. The greatest impact occurs in the Cocles basin with the agroforestry mode, where the % increase is of 6.075%.

When comparing the profitability of the forestry activities WITH or WITHOUT PSA with the profitability of the alternate agricultural activities, in other words, when considering the cost of opportunity of dedicating a hectare to forestry cover and not to an agricultural use, relatively different impacts are obtained, according to the forestry activity and therefore the PSA mode, as well as the cost of opportunity with which it is being compared and also according to the basin. For example, the greatest impact or financial contribution among all the basins and PSA models occurs in Cocles with the plantation mode; when comparing it to the profitability of livestock, the percent increase in the comparative profitability when going from WITHOUT to WITH PSA is 6.361%. In this case, the absolute difference between the profitability of the plantation WITHOUT PSA and the profitability of livestock is (-\$7.28/ha); when including the PSA (WITH PSA) that difference becomes \$456/ha; therefore, the percent growth between those differences, when going from a situation WITHOUT PSA to one WITH PSA CON PSA, is 6.361%; in other words, in this case there is a significant contribution from the PSA to the financial considerations of the contractors. The lesser financial impact of the PSA occurs in Potrero when the protection and agroforestry modes are compared to the Cantaloupe (2%), followed by Cocles, where the protection and agroforestry modes are compared to the profitability of plantain, yielding 3% and 4%, respectively.

When comparing the total average weighted income per hectare that the contractors in the study basins received, (1999-2005 period), for the three PSA modes, and considering the mean annual family income in the rural areas up to 2004, the total amount of PSA protection represents 3%, the amount of PSA plantation is 9%, and the PSA agroforestry is 6%.

Taking into consideration that the average area per contractor in the study basins is 69.8 ha, when comparing the mean annual actual income from the PSA per contractor, and considering the mean annual rural family income, the contractor receives an average financial amount per payment of **PSA protection**, which represents approximately 35% of the mean annual rural family income; for plantation and agroforestry, this amount in the plantation case is equal to the mean annual rural family income, and in the agroforestry case it is above that mean.

3.2.2. Economic contribution of the PSA per hectare

On a basin level (rows) the contribution of the environmental services per hectare per year (without reductions) is greatest for Caño Negro; in the scenario WITH PSA the total contribution (all four environmental services added together) is \$5,096/ha/year. The basin that has the lowest total contribution in the same scenario is Potrero, with \$582.45/ha/year (see Table 5). Quebradas is second in contributions with \$2,385/ha/year and Cocles third with \$2,036/ha/year.

On an environmental service level (columns), the greatest economic contribution per hectare, in the scenario WITH PSA, is for carbon, and the sum total for all four basins for this service is \$8,668/ha/year. The lowest contribution in the same scenario is for biodiversity, with \$9.88/ha/year (see Table 5). The second highest in contribution is water at \$1,410/ha/year, and the third best is scenic beauty with \$12.90/ha/year.

Table 5. Summary: Difference in Economic Contribution of the Environmental Services of the Forest, Scenarios WITH AND WITHOUT PSA, per Basin. \$/ha/year.

Basin	Water		Scenic Beauty		Biodiversity		Carbon		Total	
	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT
Potrero	15.76	(15.76)	2.80	(2.80)	1.89	(1.89)	562.00	(562.00)	582.45	(582.45)
Quebradas	11.26	(11.26)	1.54	(1.54)	0.55	(0.55)	2,372.00	(2,372.00)	2,385.35	(2,385.35)
Cocles	39.59	(39.59)	6.75	(6.75)	4.16	(4.16)	1,986.00	(1,986.00)	2,036.50	(2,036.50)
Caño Negro	1,343.14	(1,343.14)	1.81	(1.81)	3.28	(3.28)	3,748.00	(3,748.00)	5,096.23	(5,096.23)
Total	1,409.75	(1,409.75)	12.90	(12.90)	9.88	(9.88)	8,668.00	(8,668.00)	10,100.53	(10,100.53)
Average	352.44	(352.44)	3.23	(3.23)	2.47	(2.47)	2,167.00	(2,167.00)	2,525.13	(2,525.13)

Profitability Analysis (flow discount)

Table 6 shows that when incorporating the externalities the forest generates through its environmental services and when adjusting the market prices to eliminate distortions in them, there is a significant difference between the economic profitabilities of the forestry activities WITH or WITHOUT PSA, as well as between the financial profitabilities with respect to the economic ones for both scenarios. In other words, the social contribution (economic) of the payment for environmental services is important in all the basins and for all PSA modes. The greatest difference between both profitabilities (financial and economic) WITH PSA is for the Caño Negro basin, followed by Cocles and Quebradas, and lastly Potrero.

Table 6. Comparison: Financial and Economic Profitabilities of the Forestry Activities, Scenarios WITH and WITHOUT PSA. \$/ha.

Basin and PSA Mode	FINANCIAL PROFITABILITY		ECONOMIC PROFITABILITY	
	VAN (WITHOUT PSA)	VAN (WITH PSA)	VAN (WITHOUT PSA)	VAN (WITH PSA)
POTRERO				
Natural Regeneration	(98.76)	155.34	(1,599.42)	1,716.48
Plantation	1,243.72	1,707.01	(312.80)	3,254.33
Agroforestry	424.88	760.09	(1,157.77)	2,155.61
QUEBRADAS				
Natural Regeneration	(98.76)	155.34	(5,963.53)	964.38
Plantation	1,510.34	1,973.63	(5,512.81)	8,676.96
Agroforestry	447.31	782.52	(610.39)	8,324.76
CAÑO NEGRO				
Natural Regeneration	(98.76)	155.34	(18,580.54)	18,697.61
Plantation	817.15	1,280.44	(19,365.91)	21,522.55
Agroforestry	(13.63)	321.58	(21,177.36)	21,501.33
COCLES				
Natural Regeneration	(98.76)	155.34	(5,329.22)	5,446.29
Plantation	814.36	1,277.65	(5,306.70)	7,454.00
Agroforestry	(5.52)	329.70	(6,102.00)	6,966.70

VAN: net actual value to 20 years and at 10%.

When **including the opportunity cost** of the forestry activities and carrying out the comparative analysis between the **economic profitabilities per hectare**, the greatest contribution or economic impact upon incorporation of the Pass occurs in the Caño Negro basin; the impact difference with respect to the other basins is significant. This is mainly a product of the presence of greater externalities in this basin in comparison to the others and of low opportunity costs (profitability of livestock). After Caño Negro, the basin with the greatest economic impact is Quebradas. The impact in Cocles and Potrero is similar, slightly greater for Cocles.

3.3. Analysis of the Financial and Economic Contribution per Basin (Aggregate): WITH amounts current up to 2005 and New Proposed Amounts

3.3.1. Contributions with Current Amounts (until 2005): Basic Situation

Table 7 shows that for the Potrero basin the greatest profitability is obtained in the Economic scenario WITH PSA. This is a result of the increase in the agricultural area, and above all because the high profitability of cantaloupe. Even when this scenario has the greatest social losses due to the non-generated environmental services (lands used for forestry are used for agriculture), the positive effect on the

profitability of the basin from the agricultural activities more than compensates for such a loss.

The difference in profitability between the Financial WITHOUT PSA and Economic WITHOUT PSA scenarios excluding opportunity costs is due to the improvement in the profitability of the second one, by eliminating the distortions through the adjustment of the item prices of the alternative agricultural activities and forestry activities.

When the opportunity cost is included, the lesser profitability in the Potrero basin also occurs in the Financial WITH PSA scenario, when opportunity cost is understood to be the profitability of the cantaloupe activity (see Table 7).

It is important to mention that for the Potrero basin, even when incorporating the externalities of the forest and the adjustment of prices (Economic Scenario WITH PSA), it is insufficient to overcome the profitability of the Economic WITHOUT PSA scenario (\$9.98 million for the entire basin); this occurs because of the larger contribution to the profitability from the agricultural activities, especially cantaloupe.

Table 7. Potrero Basin: Summary of Financial and Economic Profitability per Basin and Scenarios (WITHOUT and WITH PSA). In millions of \$

Scenario	VAN (Without Opportunity Cost)	VAN (With Opportunity Cost)	
		Meat	Cantaloupe
BASIC SITUATION			
Financial WITHOUT PSA	8.71		
Financial WITH PSA	4.45	3.69	1.20
Economic WITHOUT PSA	9.98		
Economic WITH PSA	8.28	7.81	4.09
WITH PROPOSED AMOUNTS			
Financial WITHOUT PSA	8.71		
Financial WITH PSA	4.78	4.03	1.54
Economic WITHOUT PSA	9.98		
Economic WITH PSA	8.62	8.15	4.43

Table 8 shows that for the **Quebradas basin** the largest profitability is obtained in the Economic WITH PSA scenario (\$2.68 million). Unlike Potrero, the economic contribution from the environmental services and the adjustment of the financial prices of the activities in this basin plays a relatively greater participation regarding the contribution (profitabilities) of the agricultural activities. This is reflected in the Economic WITHOUT PSA scenario, with the least profitability of all, with and without opportunity cost; in most of the cases, the social loss this scenario presents is mainly due to the externalities of the forest environmental services that are not produced. The difference in profitability between the two scenarios, Financial WITHOUT PSA and Economic WITHOUT PSA, in favor of the second one,

precisely consists of the social loss from the external benefits of the environmental services of the natural forest that are not produced.

When the opportunity cost is included, the lesser profitability for the Quebradas basin also occurs in the Financial WITH PSA scenario, when opportunity cost is the profitability of the livestock activity; this is especially the case due to the many lands dedicated to this use (see Table 8).

Table 8. Quebradas Basin: Summary of Financial and Economic Profitability per Basin and Scenarios (WITHOUT AND WITH PSA). In millions of \$

Scenario	Van (without Opportunity cost)	Van (with Opportunity Cost)		
		Meat	Coffee	Blackberry
BASIC SITUATION				
Financial WITHOUT PSA	0.98			
Financial WITH PSA	0.97	0.56	0.91	0.81
Economic WITHOUT PSA	(5.76)			
Economic WITH PSA	2.68	2.49	2.42	2.44
WITH PROPOSED AMOUNTS				
Financial WITHOUT PSA	0.98			
Financial WITH PSA	1.3	0.88	1.23	1.14
Economic WITHOUT PSA	(5.76)			
Economic WITH PSA	3.01	2.82	2.75	2.77

VAN: 20 years and 10%.

The **Caño Negro** basin generates the largest amount of environmental services, a similar situation as in Quebradas, which means that the greatest profitability for this basin is in the Economic WITH PSA scenario (\$124.37). On the other hand, the Economic WITHOUT PSA scenario shows the most critical situation, with a VAN of -\$76.45 without opportunity cost; in other words, the benefits from the forest environmental services that are not produced generate important social losses (see Table 9).

Table 9. Caño Negro Basin: Summary of Financial and Economic Profitability per Basin and Scenarios (WITHOUT and WITH PSA). In millions of \$

Scenario	VAN (without Opportunity Cost)	VAN (with Opportunity Cost)
		Meat
	BASE SITUATION	
Financial WITHOUT PSA	2.02	
Financial WITH PSA	1.48	1.03
Economic WITHOUT PSA	(76.45)	
Economic WITH PSA	124.37	123.92
	WITH PROPOSED AMOUNTS	
Financial WITHOUT PSA	2.02	
Financial WITH PSA	2.59	2.14
Economic WITHOUT PSA	(76.45)	
Economic WITH PSA	125.48	125.04

The largest aggregate profitability for the Cocles basin is generated in the Financial WITHOUT PSA scenario, especially as a result of the change in land use, mainly towards the agricultural activities (see Table 10). The smallest profitability corresponds to the Economic WITHOUT PSA scenario (\$0.63), when incorporating meat as the cost of opportunity.

Table 10. Cocles Basin: Summary of Financial and Economic Profitability per Basin and Scenarios (WITHOUT AND WITH PSA). In millions of \$

Scenario	VAN (Without Opportunity Cost)	VAN (With Opportunity Cost)	
		Meat	Plantain
	BASIC SITUATION		
Financial WITHOUT PSA	3.53		
Financial WITH PSA	0.86	0.63	0.81
Economic WITHOUT PSA	1.82		
Economic WITH PSA	0.87	0.64	0.81
	WITH PROPOSED AMOUNTS		
Financial WITHOUT PSA	3.53		
Financial WITH PSA	1.49	1.26	1.44
Economic WITHOUT PSA	1.82		
Economic WITH PSA	1.5	1.27	1.44

VAN: 20 years and 10%.

Final Comments. On a Basic situation level, in other words, without an increase in the amounts, the Caño Negro basin shows the largest and smallest profitability

per basin, with the scenarios Economic WITH PSA (\$124.37 million) and Economic WITHOUT PSA (-\$76,45) respectively; in other words, the greatest benefits and the greatest social losses. The second best basin in the Economic WITH PSA contribution is Potrero. As far as the Economic WITHOUT PSA scenario is concerned, and unlike Caño Negro and Quebradas which present elevated social losses, for Potrero and Cocles this scenario is positive because of the high profitabilities of cantaloupe and plantain, respectively; it more than compensates for the social loss from externalities in these areas.

3.3.2. Contribution with New PSA Amounts

3.3.2.1. Analysis of the Contribution of a Basin Level (Aggregate)

Tables 7, 8, 9, and 10 show that when the PSA amounts are increased so do the financial and economic profitabilities, with respect to the Basic situation (without an increase in prices).

For the **Potrero** case, when going from the Economic WITH PSA scenario without an increase in prices (without opportunity costs) to the same scenario but with an increase in amounts, the profitability increases by 4% approximately. With the Financial WITH PSA scenarios, the profitability increases by approximately 7%; in other words, the impact from an increase in the amounts is greater than the financial profitability with respect to the economic one (see Table 7).

In **Quebradas**, when considering the same situation as Potrero, the profitability increases by approximately 34%. For the case of the **Economic WITH PSA** scenario, the profitability increases by approximately 12%. When carrying out the analysis with the opportunity costs according to the profitability of blackberry, and the difference amongst the Economic WITH PSA scenarios, between the Basic situation and with the Proposed Amounts, the profitability increases by 13.5% (see Table 8).

For the **Caño Negro** case, when the amounts are increased the financial profitability increases by approximately 75%. For the case of the Economic WITH PSA scenario, the profitability increases by approximately 4%. When carrying out the analysis with the opportunity costs according to the profitability of livestock, the difference amongst the Economic WITH PSA scenarios, between the Basic situation and with the Proposed Amounts, increases by 0.1% (see Table 9).

For **Cocles**, when the amounts are increased, the financial profitability increases comparatively, by approximately 73%. For the case of the Economic WITH PSA scenario, the profitability increases by approximately 72%. When carrying out the analysis incorporating the opportunity costs according to the profitability of plantain, the difference in profitabilities with the Economic WITH PSA scenarios, between the Basic Situation and with the Proposed Amounts, increases by 77%, (see Table 10).

On an aggregate level and comparing the profitabilities of the WITH PSA scenarios between the Basic situations (without an increase in the amounts) and With an Increase in the PSA Amounts (without cost of opportunity) the greatest impact on the **financial profitability** occurs with the Caño Negro basin, with a 75% increase in the profitability, followed by Cocles with 73%, Quebradas with 34%, and Potrero with 7%. If the cost of opportunity is included, the basin with the greatest impact in the Economic WITH PSA scenario is Cocles, when discussing the production of plantain.

It is important to mention that the New Proposed Amounts have a positive impact on the profitability of the forestry activities and therefore on the financial considerations of the contractors. There are two additional aspects that contribute to the positive impact on the financials of the contractors; the first one is that the amount is approved in dollars and is paid using the exchange rate effective on the payment date, therefore protecting the contractor from the negative effects of devaluation and depreciation that the national monetary unit suffers as had been the case until now. On the other hand, in the case of the plantation mode, which presents the greatest maintenance and assistance costs, the amounts increase considerably and are distributed throughout more years (from 5 to 10), with a similar amount as the previous one for the first year (46%). A greater distribution of the payments throughout more years provides the contractor with disposable income while the most productive thinnings and the final logging arrive.

3.3.2.2. Contribution Analysis on a Hectare Level

As was expected with the new amounts, the profitabilities of the forestry activities WITH PSA increase. In other words, this increase has a positive impact on the financial aspect of the contractors; relatively speaking, the difference in profitabilities shifts from a 108% increase for the protection mode to a 9% (approximate mean) for plantation. Agroforestry has a percent increase in profitability from 14% (Potrero and Quebradas basins) to 34% for the Caño Negro case (see Table 11).

Table 11. Financial Profitability Comparison: % Difference in the Scenarios WITH PSA, Basic Situation, and Proposed New Amounts. \$/ha and %

Scenario	Scenarios WITH PSA		CONTRIBUTION (% Difference)
	VAN Basic*	VAN With New Amounts**	
POTRERO			
Protection	155.34	323.56	108%
Plantation	1,707.01	1,831.24	7%
Agroforestry	760.09	869.87	14%
QUEBRADAS			
Natural Regeneration	155.34	323.56	108%
Plantation	1,973.63	2,097.86	6%
Agroforestry	782.52	892.30	14%
CAÑO NEGRO			
Natural Regeneration	155.34	323.56	108%
Plantation	1,280.44	1,404.67	10%
Agroforestry	321.58	431.36	34%
COCLES			
Natural Regeneration	155.34	323.56	108%
Plantation	1,277.65	1,401.88	10%
Agroforestry	329.70	439.48	33%

*Referring to the VAN calculated with the mean weighted paid amounts in the study sites, from 1999 to 2005.

**Referring to the VAN calculated with the new proposed amounts as of 2006.

4. Conclusions

- According to the results of the **financial analysis per hectare in the Basic situation (without an increase in the amounts)**, the Pass have an important impact on the financial aspect of the contractors. This impact varies from basin to basin, according to the PSA MODE and the profitability of the alternate activities with which it is compared.
 - In the analysis of the financial profitabilities per hectare of the forestry activities, without including the cost of opportunity, when shifting from a situation WITHOUT PSA to one WITH PSA, the lesser percent difference (%) in profitability is 31% and corresponds to the plantation mode in the Quebradas basin. The greatest impact occurs in the Cocles basin for the agroforestry mode, where the % increase is 6.075%.
 - When comparing the profitabilities of the forestry activities WITH and WITHOUT PSA, with the profitability of the alternative agricultural activities (in other words, when including the opportunity cost),

different impacts are obtained. The greatest impact or financial contribution of all the basins and PSA modes occurs in Cocles with the plantation mode when comparing it to the profitability of livestock, where the percent change from WITHOUT to WITH PSA is 6.361%. The most reduced financial impacts occur in Potrero and Cocles, when compared to Cantaloupe (2%) and Plantain (3%), respectively.

- When comparing the mean weighted income per hectare that the contractors in the study basins earned (1999-2005 period) for the three PSA modes, with respect to the mean annual family income in the rural area, the total amount of PSA protection represents 3%, the PSA plantation amount 9%, and 6% for the agroforestry PSA.
- When considering the average area per contractor in the study basins (69.8ha), and comparing the annual actual mean income per contractor in the study area with respect to the mean annual rural family income, the contractor is found to receive an average amount for payment of the **PSA protection**, which represents approximately 35% of the mean annual rural family income; for **plantation and agroforestry**, this amount is equal to the mean annual rural family income in the plantation case and is higher in the agroforestry case.
- According to the economic analysis, it can be concluded that the PSA Program resources are being well assigned, since there is an important contribution or social impact from these per hectare, as well as on an aggregate level per basin. As in the financial case, there are differences in the economic contribution from the PSA according to the basin, PSA mode, and the cost of opportunity being discussed:
 - On a basin level, the annual contribution per hectare (without discounts) from the environmental services is greatest for Caño Negro, where the scenario WITH PSA has a total contribution (all four environmental services added up) of \$5,096/ha/year. The basin with the least total contribution in the same scenario is Potrero, with \$582.45/ha/year (see Table 5). Quebradas is second with a contribution of \$2,385/ha/year, and Cocles is third with \$2,036/ha/year.
 - On an environmental service level (columns), the greatest economic contribution per hectare in the scenario WITH PSA, is for carbon; the total amount for the four basins for this service is \$8,668/ha/year. The least contribution in the same scenario is for biodiversity, with \$9.88/ha/year (see Table 5). The second best contribution is from Water \$1,410/ha/year, and the third best is for scenic beauty with \$12.90/ha/year.

- This conclusion is reinforced, continuing on an economic level but with **discounted flows, without opportunity costs**, as long as the economic profitabilities grow substantially, when making the comparison with the scenario WITH PSA as well as when comparing between the financial and economic, (see Table 6). The economic contributions from the PSA vary according to the basin and mode.
- When including the cost of opportunity from the forestry activities, and when the comparative analysis between the **economic profitabilities per hectare** is carried out, the greatest contribution or economic impact with the incorporation of the Pass occurs in Caño Negro; the difference in impact with respect to the other basins is significant. This is mainly due to the presence of greater externalities in this basin, in comparison to the others, and of lower opportunity costs (profitability of livestock). After Caño Negro, the basin with the next greatest economic impact is Quebradas. The impact in Cocles and Potrero is similar, slightly better for Cocles.

On an aggregate level per micro-basin, the analysis reflects the results per hectare; in other words, the PSA has an important private and social impact or contribution.

- On a Basic situation level, meaning without the increase in the PSA amounts, the Caño Negro basin has the highest economic profitability in the scenario WITH PSA (\$124.37 million) and lowest in the scenario WITHOUT PSA (-\$76.45), in other words, the greatest social benefits and losses. The second best economic contribution WITH PSA, is for the Potrero basin. As far as the Economic scenario WITHOUT PSA is concerned, unlike the Caño Negro and Quebradas basins which present elevated social losses, this scenario is positive for Potrero and Cocles since these areas have the high profitabilities of cantaloupe and plantain (respectively); this more than compensates for the social loss from externalities.
- Using the economic analysis WITH PSA in the Basic Situation and with New Amounts, it can be determined that there are some agricultural activities in the study areas that are socially desirable, since they generate comparatively more economic profitability than the forestry activities, even when including the PSA amounts in the proposed magnitude and at the same time adding the forest externalities from the environmental services and the adjustment of prices for the distortions. Such is the case in Potrero with the cantaloupe activity, in Cocles with the production of plantain, and in Quebradas with blackberry, although with this last one the situation occurs only when compared with the protection mode. Therefore, to provide PSA in said areas would mean generating significant social losses.

- **On aggregate**, when comparing the profitabilities of the scenarios WITH PSA, between the Basic Situation (without increasing the amounts) and With an Increase in the PSA Amounts (without cost of opportunity), the greatest impact on the financial profitability occurs in the Caño Negro basin with a profitability increase of 75%, followed by Cocles with 73%, Quebradas with 34%, and last is Potrero with 7%. If the cost of opportunity is included, the basin with the greatest impact in the Economic scenario WITH PSA is Cocles, when it deals with the production of plantain.
- Generally speaking, the priority basins in the allocation of PSA resources, taking into consideration the generation of social benefits (positive externalities) should be in order of importance: Caño Negro, Cocles, Quebradas, and Potrero. However, if the level is specific by type of environmental service, there are important differences that must be taken into consideration, depending on the weight that the decision makers place on the various environmental services.
- The PSA Program generates considerable financial and social benefits, as has been shown in the study, but in a scenario WITHOUT PSA, in other words, without a Program of Environmental Services, there would be social losses of the same magnitude.