Sustainable Agricultural Productivity Program - Suriname
Report 3
Ex-Ante Evaluation and Capacity to Pay for O&M of Water Boards

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Investment Center – FAO

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1. Executive Summary

With the support of the Inter-American Development Bank (IDB), the Government of Suriname (GoS) embarked on a process of agricultural sector reforms to modernize its agricultural public services through a Programmatic Policy Based Loan. Under this agreement, the IDB has been designing the Sustainable Agricultural Productivity Program (SU-L1052), which has as objective to increase agricultural productivity in Suriname through investments in infrastructure and management of irrigation and drainage systems (Component I); and to improve the conditions for information-based policymaking by increasing information available on agriculture (Component II). As part of the preparation of the program, the Food and Agriculture Organization of the United Nations is collaborating with IDB to analyze producers' capacity to pay for Operation and Maintenance (O&M) of the Irrigation and Drainage (I&D) system as well as the economic viability of the Sustainable Agricultural Productivity Program.

A standard cost-benefit analysis was conducted to assess the financial and economic merit of the program. The financial analysis considered the investment cost and expected benefits of Component I. The economic analysis assesses the program considering total project costs for both components, but only the benefits expected for Component I, given the difficulty to measure the effects of activities in Component II. The financial benefits from Component I come from the net incremental income as a result of higher productivity and the avoided damage of flooding in cultivated area, due to investments for improving the use and management of the I&D systems in the program area (Component I). The economic benefits of the Program also consider the equivalent economic value of water saved and savings in O&M of the I&D system operated by the government, valuated using economic prices.

The information needed to perform the financial and economic analysis and capacity of payment for O&M was based on primary source information of potential beneficiaries in the Nickerie District. The data was collected and validated in two different missions, in March and April, 2018. Besides, important information was obtained from the IDB program team, including technical consultants, and from desk review of the relevant literature on the costs and benefits of similar or related interventions in other countries.

The financial benefit flows in present value are estimated at USD 2.4 million, equivalent to a net present value per hectare of US$167, and an internal rate of return of 14.8%. The economic benefit is estimated at USD 3.6 million, equivalent to a net present value per hectare of US$249, and an internal rate of return of 15.8%. The uncertainty analysis allows to foresee that the program will create financial and economic benefits even if the project faces contingencies that reduce expected yields of paddy rice, delay of benefit generation or there is an increase in investment cost.

However, not all benefits that the project will generate are possible to quantify and predict. Among others, this analysis did not consider the benefit generated by more efficient public policies to support agriculture sector given by better understanding of the evolving situation in the sector and more detailed information; the multiplier effect over paddy rice value chain and related sectors in the economy (transport, services); the improvement of food safety for families; the environmental benefit due to reduction of fertilizers and pesticides usage, associated with a decrease in equivalent carbon emissions per hectare and per ton of paddy rice; and a risk reduction of floods in residential areas due to the improvement of I&D infrastructure. Thus, this analysis underestimated the real positive impacts for society, and should be considered as a lower bound in terms of net benefits.

The financial analysis shows that the incremental net income per year is high enough to allow producers to pay O&M to Water Boards (SRD 150/ha). Two alternatives are recommended to provide within the project incentives to producers to pay O&M to Water Boards, namely: co-financing O&M of Water Boards and land leveling. The advantage of co-financing O&M of Water Boards is that the proposed scheme will motivate farmers to contribute to the O&M costs. On the other hand, land leveling can be used as an incentive not only to pay water fees, but also to generate positive environmental externalities. In any case, both alternatives place incentives in a correct way, since: they promote payment of water fees but also strengthen their organizations to manage I&D system.

The program focuses on governance of Water Boards, engagement of farmers, and efficient use of natural resources and external inputs. It is essential the support of Government after completion of project funding. Public institutions should continue the technical support to farmers and Water Boards, since these organizations are in a start-up phase: local training, farmer field schools, research, extension support and capacity building in management of organizations, among other areas, will help farmers continue gaining knowledge and skills.

2. Introduction

Agriculture plays an important socio-economic role in Suriname. According to the Ministry of Agriculture, Animal Husbandry and Fisheries (LVV) and Suriname Bureau of Statistics, 2016, this sector generates 8% of national employment, 9% of the GDP and more than 4% of total export earnings. In the past thirty years the performance of the sector has been erratic, showing a slowdown in agricultural growth during the 90s and a slow recovery at the beginning of the past decade. During this period, the total cultivated area shrank by 33%, physical yields of traditional agricultural sub-sectors stagnated, and as a whole the sector showed a low rate of growth (in total factor productivity).

In this setting, the Government of Suriname (GoS) acknowledges that a revitalized, more productive, and diversified agricultural sector will contribute to reducing macroeconomic uncertainty by ensuring mitigating downside risks and external shocks, improve food security, and provide opportunities for employment and income generation that will help alleviate poverty in rural areas where about 50% of Surinamese live. To achieve this, productivity should be increased and access to new international markets should be expanded[1].

Rice is Suriname's most important agricultural crop, with the highest share in total value of agricultural production and it is the population's main staple food. Average rice yields in Suriname are 4.8 t/ha. According to the research center in Nickerie, SNRI/ADRON, current potential is 6 t/ha. Moreover, the low productivity challenge is being magnified by climate change impacts. In fact, the decrease in agricultural productivity over the last decades has been linked -in part- to climatic events including changes in precipitation patterns and high winds.

The GoS has identified the need to implement a medium term investment and policy reform strategy that will help promote private farm investment and modernize agriculture, especially in irrigation and drainage (I&D). The main problems observed in I&D are the lack of adequate system's maintenance; and the fact that users do not participate in managing the systems, covering costs of operation and maintenance (O&M)[2]. Water management systems were initially built in colonial times to drain marshy soils and thus allow for production. Since the 1980s, funds for maintaining I&D systems have not been enough to cover adequate operation and maintenance costs and now their capacity is reduced due to deterioration of infrastructure and sedimentation of canals, which affects productivity in the area that can be irrigated. O&M costs of primary and secondary I&D infrastructure (outside farmers' plots) have been traditionally covered by the GoS, generating a significant and unsustainable financial burden. Following international best practices, and considering budgetary restrictions, the GoS aims to transfer the operation and maintenance of the secondary infrastructure to farmers, organized in Water Boards (WB). Currently, there are 14 at various stages of development (all but one in the Nickerie District). However, these WB are still weak and lack adequate capacity to take over the O&M responsibilities.

The Modernization of the Irrigation and Drainage schemes is a key component to increase agricultural productivity. To improve the efficiency of the irrigation schemes, there is a need to introduce bottom-up and top-down approaches. These imply greater involvement and financial contributions from producers by strengthening of users institutions (Water Boards) and introduction of more efficient O&M practices, as well as an improvement of services provided through better coordination at Ministerial level both in the operation

[1] Inter-Ministerial Irrigation and Drainage Coordination Working Group, 2015. Suriname Vision for Sustainable Development of Irrigation And Drainage Sector. 2015.

[2] Garrido, A., Novo, P. and Sumpsi, M. 2013. Suriname - Irrigation and Drainage. Report prepared for the IDB.

and maintenance of the schemes, in the planning and implementation of investments in rehabilitation works as well as in the capacity building of the Water Boards.

Supported by the Inter-American Development Bank (IDB), the GoS commenced a process of agricultural sector reforms to modernize its agricultural public services through a Programmatic Policy Based Loan. This program is supporting the modernization of agricultural I&D and of Agricultural Statistics, among other areas in agriculture. The policy loans set up the foundation for a first investment operation in agricultural health and food safety, agricultural innovation (SU-L1020, approved in 2017), that will be complemented with the proposed operation.

The goal of the Sustainable Agricultural Productivity Program (SU-L1052) is to increase agricultural productivity in Suriname through investments in infrastructure and management of I&D systems; and to improve the conditions for information-based policymaking by increasing information available on agriculture. The operation will have two components.

Component I: Irrigation and Drainage. This component seeks to improve the use and management of the I&D systems in Suriname, especially in Nickerie District, by addressing current infrastructure deficiencies, and weak users' participation in the management and maintenance of the system. The program will include financing for:

a. Rehabilitation/modernization of I&D infrastructure selected to benefit a large number of small and medium farmers through improvements in productivity and/or reduction in risks of flooding or saltwater intrusion;
b. Support for developing and strengthening WB capacity to take over the O&M of I&D systems;
c. Capacity building of government bodies in charge of water resource administration for irrigation;
d. Design and implementation of incentives mechanisms aimed at improving efficiency in farmers' water use and coverage O&M costs.

Activities and investments under this component will include measures to guarantee the sustainability of the water resource for its different uses (agricultural, environmental and human consumption), particularly by taking into account climate change impacts (i.e. in regard to water supply and demand) and considering adaptation measures.

Component II: Agricultural Statistics and Information. The objective of this component is to strengthen the Department of Agricultural Statistics of the Ministry of Agriculture, Animal Husbandry and Fisheries, by improving its information systems and analytical capabilities. The component will finance:

a. Design of the Agricultural Information System;
b. Design and implementation of the agricultural census
c. Design and collection of one or two years of agricultural surveys with probabilistic sampling;
d. Institutional strengthening, and
e. Annual update of the estimates of the public support to the agriculture sector.

As part of the preparation of the program, FAO collaborates with the analysis of producers' capacity to pay for O&M of the I&D system as well as the economic viability of the Sustainable Agricultural Productivity Program.

Following the terms of reference, this report presents the Deliverable No. 3: a preliminary report of the analysis of Nickerie´s agricultural producers´ capacity to pay for the use of the I&D system, including a

preliminary proposal of a fee schedule and an incentive mechanism, and Deliverable No. 4: a preliminary report of the ex-ante economic analysis of the program, including a preliminary sustainability analysis of the investments.

3. Methodology

3.1. Cost-Benefit Analysis

A standard cost benefit analysis was conducted to assess the financial and economic merit of the program. A cost benefit analysis attempts to quantify all incremental costs and benefits that can be directly attributed to the program. In other words, it compares the situation without the program (in terms of financial and economic costs and benefits) with the situation with the program.

The financial analysis considered the investment cost and expected benefits of Component I. The economic analysis assesses the program considering total project costs for both components, but only the benefits expected for Component I - Irrigation and Drainage. The expected benefits of Component II of Agricultural Statistics and Information are not considered into the analysis due to the complexity for estimating the financial and economic impacts of more efficient public policies to support agriculture. As set forward by the IDB guidelines for economic analyses, dynamic and second-order effects (such as the effect of higher incomes from farmers on aggregate demand) were not quantified. Similarly, interaction effects between the different components were not analyzed, likely leading to an underestimation of the overall benefits of the program.

3.2. Benefits of the program

The financial and economic analysis focuses in two effects: i) the net incremental income as a result of higher productivity due to investments for improving the use and management of the I&D systems in the program area, and ii) and avoided damage of flooding in cultivated area (Component I). The benefit of Component II of Agricultural Statistics and Information is not quantified given the difficulty to measure and foreseen the effects of more efficient public policies to support agriculture sector.

Increment in yields and avoided damage of flooding in cultivated area

The most important irrigated crop in Suriname is rice, representing about 85% of the harvested cropland area. Most of the rice production capacity is concentrated in the Nickerie district. In addition, there are two smaller rice production areas in the Coronie and Saramacca districts. Rice production in Suriname is for local consumption as well as for export - about 64,000 tons were exported in 2013. In total, about 55,000 ha have been developed for rice production in Suriname. However, only about half of this area is currently in production (some 26,000/27,000 ha per season). On most rice cropland, two harvests per year are possible. Supply of irrigation water is essential to allow the double cropping[3]. One of the reasons for the reduction of irrigated area for rice production is the lack of proper maintenance of I&D systems and inefficient water use which does not allow the proper regulation of supply of irrigation water and the outflow of excess water. As a result, presently there is a situation of high levels of wastage as well as shortages of irrigation water, and inadequate drainage of the fields. Crop productivity is negatively affected and previously cultivated areas have been abandoned.

To rectify delayed or inadequate maintenance, substantial rehabilitation works both in the main system and WB polder systems need to be undertaken at regular intervals. It is expected that with the implementation of

[3] Vision For Sustainable Development Of Irrigation And Drainage Sector, 2015.

the Sustainable Agricultural Productivity Program, I&D infrastructure and irrigation water will be managed efficiently, through the regulation of water flows. As a result, the delivery of irrigation water into fields will be better controlled, providing the resource on time according to the crop water demand. With this, it is expected that yields will increase, and the risk of flooding in cultivated areas will decrease with the project.

In order to estimate the expected benefits from Component I, it is needed to compare the situation that producers would have in a situation *without project*, with the future situation *with project*, i.e., investments to improve the usage and management of the I&D systems proposed in the Sustainable Agricultural Productivity Program.

To define the benefits obtained by the implementation of the Program, we propose to apply the Marginal Productivity Method. This method consists of estimating the Net Present Value of the highest agricultural production given by the improvement in management of I&D systems as a result of the investments that the Program will fund. It is based in a theoretical agricultural production function which states that yields per hectare depends of a set of productive factors, including management of I&D systems.

$$y_j = f(PC, X)$$

Where:
y_j= yield per hectare of crop j
PC= Productive capacity given by the improvement in management of I&D systems per hectare
X= Matrix of other productive factors per hectare (labor, capital, etc.)

The method is based on the principle that farmers maximize their profits by using water for irrigation (as well as any other productive input) to the extent that the marginal net income generated by using water is equal to the marginal cost of obtaining that additional unit.

The method is also based on the principle of the limiting factor, which states that the production frontier is determined by the productive input that is available at a level that prevents the increase of yields, regardless of whether the other productive inputs are available at levels that would increase production. In this case, it is assumed that water for irrigation is the limiting factor: in the dry season, there is a scarcity of water for irrigation, and in the wet season, there are uncontrolled flows of water that is delivered higher than the demand for paddy rice. Also, in wet season appears floods that affects paddy rice cultivations. In both cases, the reason is the same: the lack of an efficient I&D system that allows controlled delivery of water according to the demand.

For the dry season, the greater availability and control of water for irrigation given by the Program in *a with-project* situation allows farmers to increase their agricultural production compared to the situation *without project*. The financial benefit is, therefore, the difference of the net income between the situation *with project* and the situation *without project*:

$$FBDS = \left[\left(p_f q_{ds}^{wp} - C_f^{wp}\right) - \left(p_f q_{ds}^{np} - C_f^{np}\right)\right] ha^{ds}$$

Where:
FBDS= Financial benefit in dry season
p_f= output financial price of paddy rice

q_{ds}^{wp} = yield per hectare of paddy rice in *with project* situation
C_f^{wp}= financial cost per hectare in *with project* situation
ha^{ds} = hectares of paddy rice in dry season (it is assumed that the area with paddy rice cultivations remains constant)
q_{ds}^{np} = yield per hectare of paddy rice in a *without project* situation
C_f^{np}= financial cost per hectare in *without project* situation

For the rainy season, the benefit will come from the use and management of the I&D systems to regulate water delivery. Two benefits are expected during the rainy season: increase in rice production per hectareand the prevention of floods that affect paddy rice cultivations. The financial benefit is, therefore, the difference of the net income between the situation *with project* and the situation *without project* given by the amount of hectares that will increase productivity and the hectares that will no longer be flooded:

$$FBRS = \left[\left(p_f q_{rs}^{wp} - C_f^{wp}\right) - \left(p_f q_{rs}^{np} - C_f^{np}\right)\right] ha^{rs}$$

Where:
FBRS= Financial benefit in dry season
p_f= output financial price of paddy rice
q_{rs}^{wp} = yield per hectare of paddy rice in *with project* situation
C_f^{wp}= financial cost per hectare in *with project* situation
ha^{rs} = hectares of paddy rice in the rainy season (it is assumed that the area with paddy rice cultivation remains constant)
q_{rs} = yield per hectare of paddy rice in a *without project* situation
C_f^{np}= financial cost per hectare in *without project* situation

Thus, the financial benefit (FB) of the project come from the sum of FBDS and FBRS: net incremental income as a result of higher productivity and avoided damage of flooding in cultivated area.

$$FB = FBDS + FBRS$$

This method assumes that output and input prices are exogenous, meaning that they are not affected by the expected increase in production. It is considered that land under paddy rice production remains constant, and management of agricultural production will improve with the project, in terms of practices, use of inputs and technological advances. Therefore, the incremental financial benefit is directly related to the productive increase and prevention of floods that affects paddy rice cultivations and the improvements in management of agricultural systems promoted by the project.

Total cost of the program is USD 30 million, of which 88% will be allocated for Component I. Component II has a cost of USD1.7 million. The financial analysis considers the cost of Component I, meaning USD26.5 million. The economic analysis considers a total cost of the program: USD30 million.

Table 1. Project Cost.

COMPONENT	USD Million	Proportion
COMPONENT 1: IRRIGATION AND DRAINAGE	**$26.5**	**88.4%**
1.1: Main System Rehabilitation	$13.5	44.9%
1.2: Rehabilitation WB Secondary System	$10.8	36.0%
1.3: Support for WB Transfer O&M	$0.7	2.5%

1.4: Capacity Building I&D Management	$0.0	0.2%
1.5: Improved Water Management	$0.3	1.0%
1.6: Conduct Hydrology Water resource monitoring for Irrigation and Flood control	$0.7	2.3%
1.7: Perform Environmental control and integrated water resources management	$0.5	1.7%
COMPONENT 2: AGRICULTURAL STATISTICS AND INFORMATION	**$1.7**	**5.5%**
2.1: Agricultural census	$1.0	3.5%
2.2: Agricultural surveys	$0.0	0.1%
2.3: Institutional strengthening	$0.6	1.9%
PROJECT AND OPERATIONAL MANAGEMENT	**$1.8**	**6.1%**
3.1: Project Administration	$1.2	4.0%
3.2: Operational Costs	$0.1	0.5%
3.3: Administration Equipment and Furniture	$0.1	0.4%
3.4: Audits	$0.1	0.4%
3.5: Monitoring and Evaluations	$0.3	0.8%
TOTAL	**$30**	**100%**

Source: IDB Team, 2018.

All costs described are accounted for into the financial analysis, since it considers expected costs and benefit flows from the perspective of an individual entity. Input costs, product price, subsidies and/or taxes are based on the actual value paid or perceived by the producer. Financial analysis will provide an estimation of farmer`s private profitability due to the implementation of the project.

Economic analysis for incremental income as a result of higher productivity

The economic analysis considers the same benefits as the financial analysis: net incremental income as a result of higher productivity and avoided damage of flooding in cultivated area, valuated to economic prices.

Following the same approach in financial analysis, economic benefit for net incremental income as a result of higher productivity in dry and raining season are estimated as follows:

$$EBRS = \left[\left(p_e q_{rs}^{wp} - C_e^{wp}\right) - \left(p_e q_{rs}^{np} - C_e^{np}\right)\right] ha^{ds}$$

Where:
EBDS= Economic benefit in dry season
p_e= output economic price of paddy rice
q^{wp} = yield per hectare of paddy rice in *with project* situation
C_e^{wp}= economic cost per hectare in *with project* situation
ha^{ds} = hectares of paddy rice
q_{ds}^{np} = yield per hectare of paddy rice in a *without project* situation
C_e^{np}= economic cost per hectare in *without project* situation

$$EBRS = \left[\left(p_e q_{rs}^{wp} - C_e^{wp}\right) - \left(p_e q_{rs}^{np} - C_e^{np}\right)\right] ha^{rs}$$

Where:
EBRS= Economic benefit in raining season
p_e= output economic price of paddy rice
q^{wp} = yield per hectare of paddy rice in *with project* situation
C_e^{wp}= economic cost per hectare in *with project* situation

ha^{rs} = hectares of paddy rice
q_{rs}^{np} = yield per hectare of paddy rice in a *without project* situation
C_e^{np}= economic cost per hectare in *without project* situation

Thus, the economic benefit (EB) of the project come from the sum of EBDS and EBRS: net incremental income as a result of higher productivity and avoided damage of flooding in cultivated area.

$$EB = EBDS + EBRS$$

The economic analysis also takes into account others benefits: the value of water saved and Savings in O&M of the I&D system.

Economic value of water saved
It is expected that the project will cause a reduction in the water used to irrigate the same amount of hectares that are under rice production. Currently, the pumped water from the Corantijn River (Wakay station) is dispersed into the Nanni Swamp through the open connection at the end of the Corantijn canal. This means that the pumped water first fills up the swamp area along the Surinam Canal, and only becomes usable for irrigation when the water reaches to a sufficient level (NSP +2.50 m) to be gravity supplied into the irrigation canals.

Since there are no markets for water in Suriname, there is not a known value of water and therefore there is not an easy way to measure the value of saved water. Different methods to estimate this value were ruled out due to data constraints. The method chosen estimates the value of the water saved through measuring the income that water would generate if it were to be used to irrigate currently available but unused land.
The method determines the theoretical additional amount of land that could be placed under production with the saved water, and then assigns to each hectare of that land the per-hectare economic benefit expected from the project (as determined above). The formula is the following:

$$EVWS = \left\{\frac{\left(m_{np}^3 - m_{wp}^3\right) * ha}{m_{wp}^3}\right\} * eb$$

Where:
EVWS: Economic value of water saved per year
m^3_{np}: water demand per hectare per year in a *without-project* situation (m^3/ha/year)
m^3_{wp}: water demand per hectare per year in a *with-project* situation (m^3/ha/year)
ha: total hectare
eb: economic benefit per hectare[4].

In Table 2 it is presented the current demand of water for irrigation in paddy rice.

Table 2. Current water demand for paddy rice

Month	Activity	Demand Without Project (m3/ha)
January	Crop water requirements	1,814
February	Crop water requirements	1,192
March	Harvest	1,711
April	Land preparation	2,825

[4] The economic benefit per hectare (eb) is estimated as follows: eb=EB/ha.

May	Land preparation/ sowing	1,503
June	Sowing	726
July	Crop water requirements	207
August	Crop water requirements	104
September	Harvest	-
October	Land preparation	2,981
November	Land preparation/ sowing	4,536
December	Sowing	2,462
Total (m3/ha/year)		**20,062**

Source: Ritzema, Witmer, and Naipal, 2013[5]; European Commission, 2009[6].

Although it is expected that land under paddy rice production will remain constant, the idea behind this approach is to obtain *proxy* of the shadow price of saved water, in order to quantify its value with its alternative productive use in agriculture. This is a conservative estimate as the net incremental income of switching from a situation of no-production to a situation of adequate production should be larger than the eb used (which measures the benefit of switching from a situation with production under poor I&D infrastructure to a situation of adequate production).

Savings in O&M of the I&D system

Other benefit from water savings due to the improvements of I&D infrastructure and enhancement of water management will be the decrease in O&M costs to operate the I&D system, because less water will need to be pumped from the Corantijn River. In this case, we considered the O&M costs of Wakay pumping station.

The economic value of O&M savings from the Wakay pumping station per year are estimated as follows:

$$EVSOM = TC_{np} - TC_{wp}$$

Where:

EVSOM: Equivalent value of saving in O&M per year

TC_{np}: Total cost of O&M in Wakay pumping station in a *without-project* situation

TC_{wp}: Total cost of O&M in Wakay pumping station in a *with-project* situation

It is expected to marginal increase in the O&M cost of the primary and secondary, since with the project farmers will start paying their water fees to finance their O&M cost of WB (SRD 150/ha/year). The water fee is included into the cost structure of paddy rice production.

3.3. Non-quantifiable benefits

Some of the interventions proposed by the project are difficult to quantify and predict. Among others, benefits that were not considered into this economic analysis are:

- Component II, Agricultural Statistics and Information, has as objective to strengthen the Ministry of Agriculture, Animal husbandry, Fisheries, by improving its information systems and analytical capabilities. As a result of this Component, it is expected that policy-making will be defined based on agriculture statistics and information. Nevertheless, the benefit generated by more efficient public policies to support the agriculture sector given by a better understanding of the evolving situation in the sector and more detailed information is difficult to measure. To evaluate projects that provide accurate and timely information of a sector that feeds public policies, they would

[5] Ritzema, H.P., Witmer, F.P. and S. Naipal, 2013. Collaborative Research To Improve The Water Management In The Nickerie District, Surinam.

[6] European Commission, 2009. Master Plan For The Supply And Distribution Of Irrigation Water For Agricultural Production In The Nickerie District.

require the application of complex models to simulate their financial and economic behavior in with-project scenario. The complexity to quantify the benefits is given by that it is expected that accurate and timely information will support a series of public policies directly related to agricultural and rural development: increase in production, diversification, promotion of climate-adapted agricultural systems, poverty alleviation, food security, employment, transportation and health, among other areas. As many areas will be supported by reliable information, requirement of data to model the financial and economic benefit as a result of having accurate and timely information is very high. In the case of this project, there is not enough information to model this benefits with a reasonable reliability. For this reason, these benefits have not been considered in the analysis. In these cases, in which benefits are difficult to quantify and valorize in monetary terms, a different appraisal technique can be applied: Cost Effectiveness. It consist in estimate the Present Values of Costs of several alternatives that provide the same service and recommend the option which is the most effective to achieve the same benefits.

- The Component I Irrigation and Drainage seeks to improve the use and management of the I&D in Nickerie District, by addressing current infrastructure deficiencies and weak user participation in the management and maintenance of the system. It is expected that efficiency improvements in farmers' water use bring about higher yields of paddy rice. However, this economic analysis focuses on primary production and does not consider:
    - The multiplier effect over the paddy rice value chain.
    - The multiplier effect over other related sectors of the economy

  As in the previous case, the multiplier effect over the value chain and in the entire economy can be estimated only if data and models are available to represent the interdependencies between different sector and show how an output from one industrial branch may become an input to another one (elasticities). In the case of this project, there is not enough information to model this benefits with a reasonable reliability. For this reason, these benefits have not been considered in the analysis.
    - The improvement of food safety which leads to better health and less sickness exposure (days). This benefit has not been quantified because there is no information available to link how the increase in rice production can contribute to the nutritional deficit of the food insecure population, with reliable estimations.
    - Environmental benefits due to reduction of fertilizers and pesticides use, associated with a decrease in equivalent carbon emissions per hectare and per ton of paddy rice. This benefit has not been quantified because is needed the application of a model that allows transforming the amount of chemicals that are not used in terms of tons of carbon equivalent.
    - The effect of the improvement of I&D infrastructure in risk reduction of flooding in residential areas. This benefit has not been quantified because there is no reliable information of flooding costs in Nickerie's urban area.

Table 3 highlights the costs and benefits that were used in the financial and economic analysis of the Sustainable Agricultural Productivity Program, and benefits which were not quantified. It is important to note that all costs have been incorporated, but not all the benefits. Thus, this analysis underestimated the real positive economic impact for society, and should be considered as a lower bound of net benefits.

Table 3. Costs and Benefits considered in the analysis.

Costs[7]	Financial Benefits	Economic Benefits
Quantified - Component I: USD26.5 million - Component II: USD1.6 million (not considered in financial analysis) - Administration, monitoring and evaluation: USD1.7 million (not considered in financial analysis) - Contingencies: USD0.2 million - Total financial costs: USD26.5 million - Total economic costs: USD30 million	**Quantified – Component I** - Productivity increases per hectare - Reduction of flooding in cultivated area - Savings in O&M of the Wakay Pumping Station	**Quantified – Component I** - Productivity increases per hectare - Reduction of flooded cultivated area - Savings in O&M of the Wakay Pumping Station - Economic value of water saved
	Non quantified – Component I - The multiplier effect over the paddy rice value chain, including exports. - The multiplier effect over other related sectors of the economy **Non quantified – Component II** - The effect of more efficient public policies to support agriculture sector and the effect over other related sectors of the economy	**Non quantified – Component I** - The multiplier effect over the paddy rice value chain, including exportations. - The multiplier effect over other related sectors of the economy **Non quantified – Component II** - The effect of more efficient public policies to support agriculture sector and the effect over other related sectors of the economy

Source: Own elaboration, 2018

3.4. Assumptions, parameters and information sources

The project will allow to farmers to manage efficiently the water for irrigation, through the regulation of water flows, controlled delivery into fields and avoiding flooding. Likewise, the through the project, farmers will receive technical assistance of good practices in farm (water use at farm level, rational use of external inputs, diseases and pests management and support to implement efficient technology, farmer field schools) and capacity building in management of organizations. As a result of this intervention, it is expected yields will increase, and the risk of flooding in cultivated areas will decrease with the project

Technical experts from LVV, OWNCP, ADRON and producers, expect that the improvements of I&D infrastructure and enhancement of water management could lead to an incremental yield of paddy rice of at least 12%[8]. This effect is conservative if it is compared with similar projects. The loan agreement signed between the Japanese International Cooperation Agency (JICA) and the Government of the Republic of Indonesia in 2017 for the "Rentang Irrigation Modernization Project", considered in the Ex-Ante Analysis an expected increment in yields of 16% of rice, as a result of the renovation of irrigation facilities and strengthening of the O&M structure in the Rentang Irrigation district in the Cimanuk River basin in West Java Province[9]. The project Resilient Agriculture and Integrated Water Resources Management in Dominican Republic, currently under preparation, is considering in the Ex-Ante Analysis an increment in rice yield of 20% as a result of the enhancement of resilience and management of hydraulic infrastructures[10].[11]. Research conducted in Uruguay indicates that increases in rice productivities have been achieved between 27% and 40% due to the improvement in the efficiency of irrigation systems[12]. The ex post analysis performed in 2015

[7] Other cost identified is the oportunity cost of Water Boards committee members and farmers that attends trainning and capacity building sesions. If its consider i) net income per hectare with project, ii) farmers dedicate 25% of their time to rice production, iii) trainning and capacity building sesions requires half day per month during the six years of project implementation, the oportunity cost estimated is US$233,616. This cost has not been incorporated into the analysis since it represents 0.8% of total project cost. In any case, this report includes a sensitivity analysis, in which it is tested how the project's NPV and IRR changes with variations in key parameter, in which total cost is considered.

[8] The expected increase in yields of 12% does not include the effect of land leveling.

[9] https://www.jica.go.jp/english/our_work/evaluation/oda_loan/economic_cooperation/c8h0vm000001rdjt-att/indonesia_170330_03.pdf

[10] http://documents.worldbank.org/curated/en/521681519881344074/pdf/Project-Information-Document-Integrated-Safeguards-Data-Sheet.pdf

[11] http://documents.worldbank.org/curated/en/521681519881344074/pdf/Project-Information-Document-Integrated-Safeguards-Data-Sheet.pdf

[12] http://www.inia.cl/wp-content/uploads/2015/02/Manual-de-Arroz-PDF.pdf

of the Irrigation and Watershed Management Project in Madagascar, funded by the World Bank, found an increase in 26% in yields of rice production due to irrigation rehabilitation works and Management of Irrigation Schemes.[13]

In this analysis, a conservative scenario is considered, with a paddy rice yield increase in 12%.

Regarding water and O&M savings, the international I&D consultant, technical experts from LVV and OWNCP agreed that the rehabilitation and improvement of I&D infrastructure and management will allow for the reduction of water losses in the distribution system. The actual situation is that pumped water from Wakay Station first fills the Nanni swamp, and only when the water reaches a sufficiently high level can it be supplied by gravity into the irrigation canals. According to LVV and OWMCP, with the implementation of the project, it can be save at least 20% of current water use[14]. In the same way it is assumed that the O&M cost from Wakay pumping station will decrease in 20%, because less water will need to be pumped from the Corantijn River. Similarly, at field level, it is expected a decrease in fuel consumption for water pumping in 20% per hectare in with project scenario (farmers pump the water to irrigate their plots from the secondary I&D system, with the consequent use of fuel, which is part of the cost structure of paddy production).

The financial and economic analysis consider cost and benefits accruing over a period of 20 years, as this period is the most appropriate one given the nature of the interventions. The project seeks the rehabilitation of the primary and secondary system of irrigation infrastructure. This means that important physical investments will be implemented by the project. Considering the time needed to carry out a public bidding process and the required works to rehabilitate the infrastructure, it is likely that the payoff will occur over several years to come. Therefore, evaluating these interventions over a long-term time horizon makes better sense for this specific intervention.

The information to characterize paddy rice production systems was collected from primary sources, namely from future beneficiaries in Nickerie District. Data regarding past, current, and expected yields, inputs and prices, was gathered and validated in two missions, in March and April, 2018. In Annex is presented the cost structure from a representative hectare of paddy rice production in dry and wet season, with and without project.

In the with-project scenario, it is considered that farmers will start paying their water fee to finance the O&M of I&D infrastructure that is under the responsibility of the Water Boards. It is assumed an annual payment of SRD 150 per hectare[15]. Likewise, it is considered a decrease in the loss of paddy rice transported from the fields to the mills due to the poor state of roads. This loss is estimated in SRD 7 per bag of paddy rice[16].

During wet season, cultivated area with paddy rice may be lost due to flooding for intense rainfall. According to experts from LVV, OWNCP, 500 hectares are flooded every year approximately, due to inadequate maintenance in primary and secondary I&D system. It is expected that with the implementation of the Sustainable Agricultural Productivity Program, I&D infrastructure will reduce the risk of flooding in cultivated

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[13] http://documents.worldbank.org/curated/en/253901468197944990/pdf/ICRR14856-P074086-Box394823B-PUBLIC.pdf

[14] [14] A research conducted in Uruguay estimates a water saving between 20% to 30% in water consumption in field due to improvements in irrigation management.

[15] (According to the international consultant on Irrigation and Drainage). This means that farmers will contribute US$ 300,000 per year, considering 15,000 hectares that will be benefited by the project. This contribution does not substitute the financing that the government makes via LVV, OWNCP, it is additional funding to sustain O&M to the I&D.

[16] According to producers.

areas, compared with initial situation. In this analysis, a conservative scenario is considered: around 250 hectares will not flood as a result of the implementation of the project.

It is considered that the increase in yields will be achieved in stages. At year 2 of project implementation, it is expected that 33.3% of land will achieve higher yields. Then, at year 3 of project implementation, other 33.3% of land will achieve expected yields. Finally, at year 4, the las 33.3% will increase yields. This assumption is in line to the planning of rehabilitation and maintenance works of the primary and secondary irrigation infrastructure (it is needed time to establish the Project Management Unit, prepare the bidding process, sign the contracts with companies and perform the physical rehabilitation works in the primary system). This administrative work is considered into the analysis, due to its effects on the timing at which the benefits will be in place.

Total project costs are US$26.5 (Component I) and US$30 million for financial and economic analysis, respectively, to be executed in 6 years: 5% in year 1, 25% in year 2, 25% in year 3, s20% in year 4, 20% in year 5 and 5% in year 6.

It is expected that 15,000 hectares will be benefited by Component I of Irrigation and Drainage

Existing production techniques are assumed to be replaced by the introduction of sustainable and climate smart agricultural practices over the project area. In the "with project scenario", it is assumed that the investment will enhance an efficient use of natural resources, introduction of technologies and practices that reduce or improve use of external inputs as well as reductions in crop losses. With this, it is assumed a reduction in fertilizer and pesticides use of 15% per hectare, but and increment in fungicide use of 20% per hectare.

Table 4. Assumptions considered in the financial and economic analysis.

Variable	Assumptions	Source
Paddy rice yield and cycles per year	It is assumed that there are two cycles per year: dry and wet season. Currently paddy rice yield is approximately 63 bags/ha (5.01 ton/ha) in dry season, and 57 bags/ha (4.5 ton/ha) in wet season. Both yields will increase in 12% with project	LVV, OWMCP and producers
Water saving	It is expected that with the project the system will save 20% of water that currently is being pumped from the Wakay Station	LVV, OWMCP
O&M saving (pumping)	It is assumed that the O&M cost from Wakay pumping station will decrease by 20%, due to the fact that less water will need to be taken from the Corantijn River. For farmers, it is considered that they will save 20% in pumping costs to irrigate their plots with water from the secondary I&D system	LVV, OWMCP
Loss of paddy rice transported from field to the mill	It is considered a decrease in the loss of paddy rice transported from the fields to the mills due to the poor state of roads. This loss is estimated in SRD 7 per bag of paddy rice	Producers
Fee for O&M of Water Boards[17]	It is considered a fee of SRD 150 per hectare per year payable to Water Boards to finance the O&M of I&D infrastructure	International Consultant Irrigation and Drainage
Period of analysis	A 20-year horizon will be considered given the type of investments, as it reflects full revenue stream	Own elaboration
Financial discount rate	It is considered a discount rate of 12% per annum to be applied to all future benefits and cost flows	Own elaboration
Input and paddy rice prices	It is considered that input and output prices remain constant during the evaluation horizon	Own elaboration
Own and rented land	It is considered that 40% of the cultivated land is rented. The cost of renting land is 10% of yields, for dry and wet season.	Producers
Cultivated area loss due to flooding	It is assumed that 500 hectares will stop flooding as a result of the project implementation	LVV, OWMCP
Timing of benefits	It is assumed that at year 2 of project implementation, a 33.3% of land will achieve higher yields. Then, at year 3 of project implementation, other 33.3% of land will achieve expected yields. Finally, at year 4, the las 33.3% will increase yields.	LVV, OWMCP
Project cost[18]	Total project costs are US$28.4 (Component II not included) and US$30 million for financial and economic analysis, respectively, executed in 6 years: 5% in year 1, 25% in year 2, 25% in year 3, 20% in year 4, 20% in year 5 and 5% in year 6	IDB
Benefited hectares	15,000 hectares are considered as benefited area. It is not expected an increase in land under rice production.	International Consultant Irrigation and Drainage
Production techniques	It is assumed a reduction in fertilizer and pesticides use of 15% per hectare, but and increment in fungicide use of 20% per hectare.	Own elaboration

Source: Own elaboration, 2018, with inputs from LVV, OWMCP, producers and IDB.

For the economic analysis, project costs and profits are evaluated from the perspective of society as a whole. It is assumed that the execution of the project will help the development of the economy, and generate environmental services and/or social benefits. The economic analysis considers the valuation of project social costs and benefits, using shadow prices when economic prices differ from market prices. The following adjustments are made:

Opportunity cost of capital

The economic and financial analyses consider a real discount rate of 12% per annum to be applied to all future benefits and cost flows, following the Inter-American Development Bank recommendation. The sum of the flow of costs and benefits are discounted at this rate to generate the financial and economic Net Present Value (NPV) of the project.

[17] It is important to say that the water fee will not replace government expenses, since it is necessary to continue financing the O&M of primary irrigation system, under the responsability of OWNCP.

[18] Others marginal cost are not included: opportunity cost of training WB and capacity building for farmers. These costs have been estimated in approximately US$40,000 and, given their reduced size, they have a minimal impact on the IRR and NPV, and can be considered to be absorbed by the sensitivity analyses.

A NPV greater than zero means that we do not only recover the opportunity costs of the capital investment but also generate a real net worth equal to the positive amount of the NPV. Only projects with positive NPVs are going to be beneficial and hence viable.

In addition to the NPV, the analysis will present other standard measures that are used to assess the economic merits of projects and programs, including the Internal Rate of Return (IRR). The IRR of a project/program is the rate that would yield a NPV of zero if all program costs and benefit flows were discounted by it. In other words, for a project to be viable, it requires an Internal Rate of Return that is greater than 12%, given the assumed opportunity cost of capital.

Economic prices

This report takes into consideration economic prices, or prices without market and fiscal distortions. The incremental economic benefit from agriculture comes from a cost-benefit analysis, which considers the increase in production of agricultural systems, comparing the situation with and without project, but with the difference that the economic analysis includes economic prices. The economic prices considered in this evaluation are the following[19]:

- *Economic value of labor*

The economic value of labor aims to reflect the value for the economy of the set of activities that people who are hired by the project would stop carrying out. As the improvement of I&D infrastructure will generate additional employment for labor in fields, income taxes of additional employment need to be netted out. Suriname has a progressive tax system that ranges from 8% (lowest bracket rate) to 38% (highest bracket rate)[20]. These tax rates are used to convert market prices to economic prices for policy conditions that generate additional employment.

- *Economic value for imports*

The conversion from financial to economic prices requires specific studies that analyses in detail tariffs for imports and exports of products. Since these are not available, a simple conversion factor is applied. Suriname charges a tariff of, on average, about 17%[21]. This means that importing SRD100 generates SRD17 of income for the society of Suriname. Therefore, a conversion factor of 100/117=0.85 is assumed on imports that enter Suriname.

- *Economic value of paddy production sale*

The economic and financial analyses consider the benefits for farmers that produce paddy rice and sell it to mills. It is assumed that producers of paddy rice pay 10% of total income in taxes, following the WB Doing Business Report[22]. This analysis does not consider the benefit in the value chain in paddy rice (meaning the value added by mills to paddy rice, exports, etc.).

Inflation

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[19] The Economic Analysis Agricultural Competitiveness Program (SU-L1020), April 2017, was considered as a reference for the economic prices.

[20] Source: WB Doing Business (http://www.doingbusiness.org/data/exploreeconomies/suriname/paying-taxes/). Up to SRD2,646 per year, the tax rate is 0%. Between SRD2,647 – SRD14,002, the tax rate is 8%. Between SRD14,002 to SRD21,919, the tax rate is 18%. Between SRD21,919 to SRD32,839, the tax rate is 28%. Over SRD32,839, the tax rate is 38%.

[21] Source: http://trade.ec.europa.eu/doclib/docs/2008/march/tradoc_138081.pdf (Figure 8)

[22] Source: WB Doing Business (http://www.doingbusiness.org/data/exploreeconomies/suriname/paying-taxes/)

The economic and financial analyses consider fixed nominal values input and output prices for the evaluation horizon (20 years). With this assumption the price effect on profitability is eliminated. That is, the impact in net income is due solely to the increase in rice yields.

Tradeable goods an exchange rate
All tradeable goods are valued at the domestic currency (costs, prices). Benefits are converted from Suriname Dollars (USD) to United States Dollars (USD) using the current exchange rate (7.5 SRD = 1 USD) for future cost and benefit flows.

3.5. Uncertainty Analysis

Generally, when evaluating investment projects, it is assumed that the variables used have a deterministic character. However, there are a number of variables that do not behave this way. There are variables whose value cannot be accurately predicted, there is some uncertainty in their estimation. This uncertainty may come from contingencies whose occurrence will affect the project, both internally and externally or because the available information is not able to represent reality.

It is expected that values for most project variables are subject to change, and thus are difficult to predict. This introduces uncertainty into the financial project analysis, affecting in different ways the NPV and IRR calculation. Therefore, and due to the impossibility of knowing with certainty every one of the random variables involved in a project, it is necessary to follow a rigorous process of modeling uncertainty and risk analysis to focus efforts on those elements whose relative effect is greater.

To face the problem of the uncertainty inherent in the relevant variables related with project profitability, two methods are applied: Sensitivity Analysis and Scenario Analysis.

3.6. Data collection and field missions

The information needed to perform the financial and economic analysis and capacity for payment for O&M was based on information from primary sources: potential beneficiaries in Nickerie District. Current and expected yields, and costs were collected and validated in two missions: a field trip during the week of March 12th, 2018, and during the week of April 9th, 2018. During both missions, meetings were held with OWNCP (government institution in charge of the O&M of the primary and secondary network of the irrigation distribution system), representatives of Water Boards, rice producers, producer associations (SBPA and VPP), representatives of mills and representatives of the Ministry of Agriculture.

Moreover, important information was obtained from the IDB program team, including technical consultants, and from a desk review of the relevant literature on the costs and benefits of similar or related interventions in other countries.

4. Financial Analysis

4.1. Financial Benefits

A financial benefit was estimated for the program considering an investment cost of USD 26.5 million contributed by the Inter-American Development Bank (Component I and Administration, monitoring and evaluation and Contingencies). With information of rice production system collected and validated, it was modeled the net income for dry and wet season, for rented and own land producers, and with and without project.

Total financial net present value for the program is estimated in USD 2.4 million, with an internal rate of return of 14.8%. This means that, with an investment of USD 26.5 million, it is expected to create financial benefits in excess to the opportunity cost of capital (12%), and produce a bonus of USD 2.4 million. This result is equivalent to a financial net present value per hectare benefited of USD 167, and a financial annual payment of USD 29 per hectare.

However, as stated before, other financial effects were not possible to estimate. Among others, the multiplier effect over the paddy rice value chain, including exportations nor the impact over other related sector of the economy. Thus, this analysis underestimated the real financial impact for society, and shall be considered as a lower bound of the financial benefits.

4.2. Financial Sensitivity Analysis

Sensitivity analysis is a mean of testing how a project's outcomes changes (NPV or IRR) with variations in one key parameter. In this case, the sensitivity analysis considers:

- Variation in expected yields of paddy rice with project. This is the variable that represents the direct effect of the project over producers.
- Delay in benefit generation due to lags in project implementation. A common issue for this type of project is the risk of having delays in its implementation, due to several reasons: lack of technical and administrative staff needed for the project, change in political priorities from the government, problems in the bidding process. As a delay in project implementation affects the timing of benefit generation, profitability indicators can differ substantially, compared with what was planned.
- Increment in investment costs (overruns). This is a frequent problem for this type of projects, due to underestimation of investment cost and contingencies. The effect of overruns is that more resources will be needed to generate the same benefits.

Based on this sensitivity analysis, the overall financial NPV of the program is reduced to zero: with an increment in expected yields of 10% per hectare of paddy rice, with a delay of 1 year in generating expected benefits[23], or with a 15% of increment in project costs.

[23] The delay in generating benefits was estimated by shifting the stream of positive net benefits, leaving the years of delay with zero incremental benefit

Table 5. Financial sensitivity analysis

Variable	Variation	Financial analysis	
		Total net present value (USD million)	Internal Rate of Return
Variation in expected yields of paddy rice	15%	$5.9	18.7%
	10%	$0.1	12.2%
	8%	-$2.2	9.5%
Delay in benefit generation	1 year	$0.1	11.9%
	2 years	-$2.4	9.8%
	3 years	-$4.4	8.2%
Increment in project costs	10%	$0.6	12.6%
	15%	-$0.3	11.7%
	20%	-$1.2	10.8%

Source: own elaboration, 2018.

4.3. Financial Scenario Analysis

It is important to point out that there are no probabilities attached to the values in a range of key variables presented in sensitivity analysis. As a result, sensitivity analysis does not recognize that some values are more likely to occur than others. Also, the sensitivity analysis considers that variables are altered one at a time without taking into account any relationship (correlation) between them. To address these limitations, a Scenario Analysis is performed to test profitability indicators considering simultaneous variations in the same variables used in the sensitivity analysis. Three scenarios are analyzed: pessimistic, optimistic, and neutral (neutral means the results considering initial assumptions). Table 6 presents the assumptions under each scenario and the financial indicators. For a pessimistic scenario (increment of 10% of yields of paddy rice instead of 12%, delay in 1 year in benefit generation and 10% of cost overruns), the financial net present value is - US$ 4.0 million, with an internal rate of return of 8.3%. The optimistic scenario (increment of 20% of yields for paddy rice, no delays in benefit generation and no cost overruns) shows a financial net present value of US$11.5 million, with an internal rate of return of 25.5%.

Table 6. Financial scenario analysis

Variable	Pessimistic Scenario	Neutral Scenario	Optimistic Scenario
Expected yields of paddy rice	Increment of 10% compared with the without project scenario	Increment of 12% compared with the without project scenario	Increment of 20% compared with the without project scenario
Benefit generation	Delay in 1 year in benefit generation	No delays in benefit generation	No delays in benefit generation
Investment costs	10% cost overruns	No cost overruns	No cost overruns
Financial Indicators			
Net Present Value (US$ million)	- US$ 4.0	US$ 2.4	US$ 11.5
Internal Rate of Return	8.3%	14.8%	25.5%

Source: own elaboration, 2018.

5. Economic Analysis

5.1. Economic Benefits

An economic analysis of the Sustainable Agricultural Productivity Program was performed to assess the incremental benefits for the society through the comparison of the without project situation versus the improved situation promoted by the project. The analysis considered the benefits that come from an increase in paddy rice production in the irrigated areas.

It was considered the same methodology and assumptions that were specified for the financial analysis, but with the difference that the economic analysis includes economic prices. In previous section was described the adjustments made to estimate shadow prices when economic prices differ from market prices.

Considering a total investment cost of the program (US$ 30 million), total economic net present value is estimated in US$3.6 million, with an internal rate of return of 15.8%. This means that, with an investment of US$30 million, it is expected to create economic benefits in excess to the opportunity cost of capital (12%), and produce a bonus of US$3.6 million. This result is equivalent to an economic net present value per hectare benefited of US$2433, and an economic annual payment of US$43 per hectare.

However, many other economic effects were not estimated. Among others, environment benefits due to reduction of fertilizers and pesticides (decrease in equivalent carbon emissions), nor the effect over the value chain of paddy rice. Thus, this analysis underestimated the real economic impact for society, and shall be considered as a lower bound of the economic benefits.

5.2. Economic Sensitivity Analysis

The sensitivity analysis is presented considering the same key variables used for financial analysis. The results indicate that the economic NPV is positive even with important changes in key variables. With these results it is possible to foresee that the program will create economic benefits even if the project faces contingencies that reduce expected economic flows from rice production or if there is an increase in project costs.

Table 7. Economic sensitivity analysis

Variable	Variation	Financial analysis	
		Total net present value (USD million)	**Internal Rate of Return**
Variation in expected yields of paddy rice	15%	$7.9	20.4%
	10%	$0.8	12.8%
	8%	-$2.0	9.9%
Delay in benefit generation	1 year	$0.7	12.6%
	2 years	-$2.0	10.4%
	3 years	-$4.4	8.6%
Increment in project costs	10%	$1.6	13.5%
	15%	$0.5	12.5%
	20%	-$0.5	11.6%

Source: own elaboration, 2018.

5.3. Economic Scenario Analysis

The same scenarios were considered to simulate economic indicators when key variables change at the same time. For a pessimistic scenario the economic net present value is - USD 3.8 million, with an internal rate of return of 8.8%. The optimistic scenario shows a financial net present value of USD 15.1 million, with an internal rate of return of 28.8%.

Table 8. Economic scenario analysis

Variable	Pessimistic Scenario	Neutral Scenario	Optimistic Scenario
Expected yields of paddy rice	Increment of 10% compared with the without project scenario	Increment of 12% compared with the without project scenario	Increment of 20% compared with the without project scenario
Benefit generation	Delay in 1 year in benefit generation	No delays in benefit generation	No delays in benefit generation
Investment costs	10% cost overruns	No cost overruns	No cost overruns
Economic Indicators			
Net Present Value (million US$)	- US$3.96	US$3.6	US$15.0
Internal Rate of Return	8.7%	15.8%	28.5%

Source: own elaboration, 2018.

6. Incentive mechanism for farmers to contribute to O&M of I&D system

One of the challenges that modernization of I&D system faces is that Water Boards need to be in charge of the O&M of their infrastructure, including planning and implementation of rehabilitation works. Water boards need to be installed and functional as an essential condition for investment in the rehabilitation of the infrastructure considered into this program. This means at least two conditions: WB must be well organized, with technical and administrative capacities to manage infrastructure and water for irrigation, and farmers have to contribute a fee to the WB to finance the O&M of its system in a long term basis. This mechanism will ensure the sense of ownership of the I&D system and their direct engagement in the planning and implementation of rehabilitations works.

The incentive is considered as a driver for the producers to adopt a certain behavior, which otherwise, could not be generated. This incentive seeks to generate a condition such that the producer receives a benefit if he complies with the expected behavior. In this case, the incentive aims to generate a behavior of payment of the annual fees to finance the O&M of the WB in a regular basis.

There are several alternatives to provide an incentive to farmers so as to pay a fee to the WB. This section describes the options considered, with the advantages and disadvantages.

6.1. Community Paddy Rice Dryer

This alternative consists of providing a paddy rice dryer to WB (or other collective organization), if the members of the organization have their O&M fees paid, during the first 2 or 3 years of implementation of the project. In addition, once the dryer is in place, any member of the WB needs to be up to date with their O&M payments to be allowed to use the dryer. This means that through the program, organizations would have access to a high cost asset and they manage it. In other words, the program can finance the fixed cost related to the acquisition of the dryer (one time), and the organization keeps the responsibility to operate and maintain it (variable cost). This implies that organizations must charge for the use of the dryer to ensure the necessary resources for their O&M.

The advantages of providing a community paddy rice dryer as an incentive mechanism for farmers to contribute to O&M of I&D system are:

- The community dryer is desired by producers because it gives them greater negotiation power to establish prices of paddy rice with mills. Currently, once the rice is harvested, it must be processed by a mill in less than 48 hours before it begins to deteriorate, so producers must sell quickly. If producers had a dryer, they could store the rice for longer (up to two years if it

is stored under the appropriate temperature and humidity conditions) and expect to sell to the mills when the prices are higher.

- It is expected that organizations will be gradually strengthened over time since they will have to manage the paddy dryer (governance)
- It can contribute to improve the long-term performance of the market by balancing the negotiation powers between producers (supply) and mills (demand)

The disadvantages of providing a community paddy rice dryer as an incentive mechanism for farmers to contribute to O&M of I&D system are:

- WB are not organized yet, and do not have technical or administrative capabilities. This creates the risk that in the short term the dryer would no longer be operative or would be captured by member(s) of the organization. Such incentives that require management (O&M and charging fees) are useful in organizations that already have experience in partnership working and governance.
- There is a risk if rice dryers are provided to producers. If this alternative works, producers will have room to negotiate the sale of their rice at better prices, against the interest of mills. The Nickerie rice market behaves like a monopsony, in which a few mills buy rice at a price that is not necessarily defined by supply and demand as in perfect market. This can lead to a social conflict between mills and producers.
- High level of investment cost to buy several paddy rice dryers to provide as an incentive for organizations that will be paid by the project.
- Lack technical knowledge to manage and maintain the dryer from producers.
- Once the rice dryer is received and the project is finished, it could be difficult to enforce to producers to keep paying their water fees or the operation and maintenance cost of the dryer.

6.2. O&M Co-financing of Water Boards

This alternative consists in subsidizing for the first 3 years a portion of the O&M costs of Water Boards, for a total of SRD 250/ha[24]. The idea is that the first year the project contributes with SRD 100/ha, without obligation to farmers to contribute financially. The second year, an additional SRD 100/ha will be provided by the project to be complemented by a mandatory contribution of SRD 50/ha by producers. Finally, the third year the project will contribute SRD 50/ha, complemented with a contribution from producers of SRD 100/ha. From year 4 onwards, producers will pay 100% of M&O of Water Boards, estimated in SRD 150/ha. No project funds should be forthcoming if no contribution will be received from the WB members.

The advantages of providing a subsidy of O&M of Water Boards as an incentive mechanism for farmers are:

- It is expected that with the proposed scheme in which the first year the O&M is paid by the project will motivate and convince most farmers of the use and responsibilities of the WB to contribute to the O&M costs.
- Organizations will be gradually strengthened over time, since WB will have to manage the fee collection and define the annual O&M of I&D system.

The disadvantage of subsidy of O&M of WB as an incentive mechanism for farmers is:

- This is a transitory incentive. Once the contribution from the project to co-finance O&M end, producers will not have the incentive to keep paying their water fees.

[24] This incentive mechanism was proposed by the International Consultant Irrigation and Drainage.

6.3. O&M Co-financing of Water Boards, linked to water efficiency

This alternative consists in providing a subsidy of O&M of Water Boards, according to the efficiency in water use for irrigation by the farmer: the greater efficiency in the use of water for irrigation, the greater subsidy to the fee for O&M. The idea is to promote efficient use of water through a financial incentive to contribute to the payment of water fee. This subsidy only will be received by farmers that can demonstrate that they have decreased their water consumption. According to Ritzema, Witmer and Naipal (2013), and European Commission, 2009 (cited in previus sections) current water consumption is 20,000 m3/ha/year, and with the project the demand can decrease by 20%. As an example, it is presented a subsidy scheme to O&M to be paid by the project linked to efficiency of water use for irrigation.

Table 9. O&M co-financing of Water Boards linked to water consumption

Water consumption (m3/ha/year)	IDB contribution (SRD/ha)	Producer contribution (SRD/ha)	Total (SRD/ha)
Over 18,000	0	150	150
17,000 – 18,000	10	140	150
16,000 – 17,000	20	130	150
15,000 – 16,000	50	100	150
14,000 – 15,000	70	80	150
13,000 – 14,000	90	60	150
Less than 13,000	120	30	150

Source: Own elaboration, 2018

The advantages of providing a subsidy of O&M of Water Boards linked to water efficiency as an incentive mechanism for farmers are:

- The subsidy of O&M can be conditioned to a certain behavior that can generate positive externalities.
- It is expected that with the proposed incentive producers will have a financial benefit if they improve their irrigation system in the field, since it affects directly production cost of paddy rice.
- This mechanism promotes the efficiency use of water in all I&D system: main system, secondary system operated by WB and in-field irrigation system managed by farmers.

The disadvantages of providing a subsidy of O&M of Water Boards linked to water efficiency as an incentive mechanism for farmers are:

- High level of investment to implement, operate and maintain in all fields water meters to measure consumption during the year
- There is a risk that this incentive will not be sustained over time, given the relative abundance of water in the area. The success of this incentive depends on the value that producers assign to water for irrigation, given by its scarcity. Given the abundance of water, especially in wet season, it can lead to producers not perceiving the need to save a resource that is available during an important period of the year.
- This is a transitory incentive. Once the subsidy is received and the project is finished, producers will not have the incentive to keep paying their water fees.

6.4. Land leveling

This alternative consists of providing an incentive equal to a portion of the cost of land leveling for producers, conditioned to the payment of water fees to the Water Boards. If land leveling needs to be implemented at

year 1, producers shall sign a formal commitment to pay water fees during the remaining years of project implementation.

The advantages of land leveling as an incentive mechanism for farmers to contribute to O&M of I&D system are:

- With irrigation water management, land leveling is considered as an important practice to increase yields and reduce cost for pesticides. According to farmers, yields can improve by 10-15% if the field is properly leveled[25].
- This incentive is a good complement with the objective of Component I of the program, since land leveling allows an efficient use of water for irrigation.
- Land leveling is a well-known practice for farmers (different than managing a paddy dryer, which can be unfamiliar for farmers)

The disadvantages of land leveling as an incentive mechanism for farmers to contribute to O&M of I&D system are:

- Land leveling need to be a regular practice in rice production system since it has to be repeated after 3 or 4 years. Due to irrigation and agricultural practices, fields gradually lose their leveling until it is necessary to level again.
- This is a transitory incentive. Once the incentive is received and the project is finished, the producers will not have the incentive to keep paying their water fees.

Table 10 presents a summary of the main advantages and disadvantages of the incentive mechanisms. After analysis of advantages and disadvantages described above, the community paddy rice dryer is not recommended as an incentive for two main reasons: i) the social risk that can be generated among producers and mills, and ii) organizations are not used to manage a community asset such as a rice dryer. The same situation holds with the incentive linked to O&M Co-financing of Water Boards, linked to water efficiency. In this case, the main risk is that the incentive will not be sustained over time, since producers may not perceive the need to save a resource that is available during an important period of the year.

[25] Ritzema, Witmer and Naipal (2013), found in Nickerie Disctric, Suriname, that in levelled field yield increased in 100% due to a more uniform layer of standing water compared with an unlevelled farm.

Table 10. Incentive Mechanisms

	Community Paddy Rice Dryer	**O&M Co-financing of Water Boards**	**O&M Co-financing of Water Boards, linked to water efficiency**	**Land leveling**
Advantages				
Contribute to decrease a market failure (monopsony)	✓			
Organizations will be gradually strengthened over time	✓	✓	✓	✓
The incentive promotes a certain behavior that generates positive environmental externalities			✓	✓
The incentive is considered by farmers as a practice that increases yields and reduces production costs				✓
Disadvantages				
High level of investment cost	*X*		*X*	*X*
Risk of social conflicts with mills	*X*			
Organizations not used to manage the incentive	*X*		*X*	

Source: own elaboration, 2018.

On the other hand, Co-financing O&M of Water Boards is expected to be an effective incentive for farmers to generate the cultural practice of contributing with a water fee. The idea is to stablish a scheme of a decreasing contribution from the IDB, and an increasing contribution from producers to pay the O&M cost of Water Boards, during three years, to collect SRD 150/ha since year 2 onwards. This alternative consists of a total subsidy of SRD 250/ha, meaning SRD 3,75 million for 15,000 hectares (US$ 500,000). Table 11 presents the co-financing scheme.

Table 11. O&M Co-financing of Water Boards

Year	IDB contribution (SRD/ha)	Producer contribution (SRD/ha)	Total (SRD/ha)
1	100	0	100
2	100	50	150
3	50	50	150
4 and onwards	0	150	150

Source: International Consultant Irrigation and Drainage, 2018

The financial analysis for rice producers proves that farmers will have the financial capacity to pay the water fee of SRD 150/ha. Table 12 summarizes the expected financial results for producers, considering: i) dry and wet season, ii) own and rented land, and iii) with and without project. The cost calculation of with-project scenario considers a payment of SRD 75/ha/season (SRD 150/ha/year). The annual incremental benefit, considering the proportion of own and rented land (60% and 40% respectively) is SRD 1,245 (US$166) per hectare[26].

[26] The annual net income for Without Project and With Project is estimated as the sum of net income for dry and wet season, weighted by the proportion of rented and own land (40% and 60%, respectively). Cost structure and incomes are presented in Table 15 to Table 18.

Table 12. Financial analysis

	Without project		With project		Incremental	
	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season
Own land (60%)						
Total cost (SRD/ha)	5,052	4,613	4,968	4,771	-84	158
Yield (bags/ha)	63	57	71	64	8	7
Total income (SRD/ha)	6,025	5,423	6,748	6,074	723	651
Net income (SRD/ha)	973	810	1,779	1,303	807	493
Rented land (40%)						
Total cost (SRD/ha)	5,655	5,156	5,643	5,378	-12	223
Yield (bags/ha)	63	57	71	64	8	7
Total income (SRD/ha)	6,025	6,049	6,748	6,074	723	25
Net income (SRD/ha)	370	268	1,105	696	735	428
Annual net income (SRD/HA)	**1,325**[27]		**2,570**[28]		**1,245**	

Source: own elaboration, 2018

As stated before, the alternative of land leveling consists of providing an incentive to cover part of the cost of land leveling to farmers, conditioned to the payment of water fees. To assess the financial feasibility of this incentive, the expected cash flows per hectare were analyzed considering four scenarios:

- Net income without project (E): this is the financial net income per hectare in the without-project situation.
- Net income with project and without land leveling (F): this is the with-project situation. The expected flows are based on the assumption that the increase in payment capacity is due to improvement of the primary infrastructure and the rehabilitation and the promotion of technical capacities in farmers. It is not included the effect in yields of land leveling.
- Maximum capacity of payment with project and with land leveling (G): this scenario considered a bonus on of yield increase of 10% due to land leveling (conservative scenario), or a total yield increase of 22%, considering the 12% of yield increase due to improvement of I&D system. It was assumed that land leveling will be in place at year 3 and will be repeated after 5 years. As stated earlier, since fields gradually lose their leveling due to agricultural practices, it is considered that the effect over yield is decreasing: 100% of the effect of land leveling is observed in first 1, 85% for year 2, 70% for year 3, 55% for year 4, and 40% for year 5.
- Net income with Project and with land leveling (H): this correspond to the maximum capacity of payment with project and land leveling, but including the contribution from producers to finance the land leveling and O&M cost of Water Boards (SRD 150/ha).

This land leveling incentive will be provided to producers who have their water fees paid. Table 13 presents a simulation for a producer that receives the incentive at year 3 of project´s implementation. During year 1 and 2, the maximum capacity of payment with and without the project (or net income with and without the project) is the same, SRD 1,327/ha. In this case, an IDB contribution was considered of 90% of land leveling, while 10% is paid by producers. According to the International Consultant Irrigation and Drainage, land leveling has a cost of SRD 3,500 per hectare. Considering the effect of the project with land leveling, the

[27] The annual net income per hectare without project is estimated as follows: net income own land dry and wet season weighted by the proportion of own land plus net income rented land dry and wet season weighted by the proportion of rented land. This means (SRD973 + SRD810)*0.6 + (SRD370 + SRD268)*0.4 = SRD1,325. Cost structure and incomes are presented in Table 15 to Table 18.

[28] The annual net income per hectare with project is estimated as follows: net income own land dry and wet season weighted by the proportion of own land plus net income rented land dry and wet season weighted by the proportion of rented land. This means (SRD1,779 + SRD1,303)*0.6 + (SRD1,105 + SRD696)*0.4 = SRD2,570. Cost structure and incomes are presented in Table 15 to Table 18.

maximum producers' capacity to pay is SRD 3,519/ha for the year 3, 8, 13 and 18 (G). This means that producers would have the financial capacity to pay their contribution for land leveling of SRD 350/ha for year 3, and SRD 3,500/ha for year 8, 13 and 18 (H).

Table 13. Expected Financial Flows of co-financing O&M of Water Boards linked to land leveling

	(A) IDB contribution to O&M	(B) Producer contribution to O&M	(C) IDB contribution to land leveling	(D) Producer contribution to land leveling	(E) Net income without project	(F) Net income with project and without land leveling	(G) Maximum capacity of payment with project and with land leveling	(H) Net income with Project and with land leveling (H=G-D)
Year	(SRD/ha/yr)	(SRD/ha/yr)	(SRD/ha/yr)	(SRD/ha/yr)	(SRD/ha/yr)	(SRD/ha/yr)	(SRD/ha/yr)	(SRD/ha/yr)
1	0	$150			$1,325	$1,325	$1,325	$1,325
2	0	$150			$1,325	$1,325	$1,325	$1,325
3	0	$150	$3,150	$350	$1,325	$2,570	$3,519	$3,169
4	0	$150			$1,325	$2,570	$3,377	$3,377
5	0	$150			$1,325	$2,570	$3,234	$3,234
6	0	$150			$1,325	$2,570	$3,092	$3,092
7	0	$150			$1,325	$2,570	$2,950	$2,950
8	0	$150		$3,500	$1,325	$2,570	$3,519	$19
9	0	$150			$1,325	$2,570	$3,377	$3,377
10	0	$150			$1,325	$2,570	$3,234	$3,234
11	0	$150			$1,325	$2,570	$3,092	$3,092
12	0	$150			$1,325	$2,570	$2,950	$2,950
13	0	$150		$3,500	$1,325	$2,570	$3,519	$19
14	0	$150			$1,325	$2,570	$3,377	$3,377
15	0	$150			$1,325	$2,570	$3,234	$3,234
16	0	$150			$1,325	$2,570	$3,092	$3,092
17	0	$150			$1,325	$2,570	$2,950	$2,950
18	0	$150		$3,500	$1,325	$2,570	$3,519	$19
19	0	$150			$1,325	$2,570	$3,377	$3,377
20	0	$150			$1,325	$2,570	$3,234	$3,234

Source: own elaboration, 2018

It is important to highlight that this alternative promotes the payment of water fees by producers, since the incentive of SRD 3,150/ha to finance land leveling provided by the IDB, is higher than the payment for water fees during the 6 years of the project (SRD 900/ha).

7. Conclusions

A cost-benefit analysis was applied to assess the benefits of the project. The economic analysis shows an incremental net present value of US$ 3.6 million considering total project cost of US$ 30 million, with an internal rate of return of 15.8%. The financial analysis proves that the Component I Irrigation and Drainage is feasible, since it creates benefits that are higher than planned investment costs, considering the opportunity cost of capital of 12%. Also, the analysis shows that the incremental net income per year is high enough to allow producers to pay O&M to Water Boards (SRD 150/ha).

The uncertainty analysis indicates that the program will create financial and economic benefits even if the project faces contingencies that reduce expected yields of paddy rice, delays benefit generation or if there is an increase in investment costs.

However, not all benefits that the project will generate are possible to quantify and predict. Among others, this analysis didn´t consider the benefit generated by more efficient public policies to support the agriculture sector associated with better understanding of the evolving situation in the sector and more detailed information; the multiplier effect over paddy rice value chain and related sectors in the economy (transport, services); the improvement of food safety for families; the environmental benefit due to reduction of fertilizers and pesticides use, associated with a decrease in equivalent carbon emissions per hectare and per ton of paddy rice; and the effect on risk reduction of flooding in residential areas due to the improvement of I&D infrastructure. Thus, this analysis underestimated the real impact for society, and shall be considered a lower bound of net benefits.

Two alternatives are recommended for implementation within the project to incentivize producers to pay O&M to Water Boards: co-financing O&M of Water Boards and land leveling. The advantage of co-financing of O&M of Water Boards is that the proposed scheme will motivate farmers to contribute toward the O&M costs. On the other hand, land leveling can be used as an incentive not only to pay water fees, but also to generate positive environmental externalities. In any case, both alternatives place incentives adequately as: they promote payment of water fees and also strengthen their organizations to manage I&D system.

Key elements shall be considered for the project exit strategy and sustainability of the expected results:

- Financial viability: given the positive results of the financial analysis, farmers will have a financial capacity to pay for O&M of Water Boards (WB) and land leveling. Only in the short term, there will be need to provide an incentive to motivate farmers to provide funds to adequately operate their WB.
- The incentives mechanism focuses on governance of Water Boards, engagement and ownership of farmers: this approach will help to ensure that the measures continue to be relevant and viable beyond the life of the project, allowing project support to be withdrawn without jeopardizing measures applied.
- Mainstreaming of measures for rational use of natural resources and practices that reduce or improve use of external inputs: the project will contribute to the implementation of more efficient technology and practices in governance of producers organizations. It is expected that these entities will give continuity to the project approach following the withdrawal of direct project support.
- The government shall continue the technical support to farmers and Water Boards: local training, farmer field schools, research, extension support and capacity building in

management of organizations, among others, will help farmers continue gaining knowledge and skills.

- Effective dissemination of information on benefits, targeted at decision-makers and policy formulators shall be the aim of stimulating Government commitments to assuming the costs of ongoing support to farmer following the withdrawal of project funding

8. Annexes

8.1. Mission Agenda March 12 to March 16, 2018

Table 14. Mission Agenda March 12 to March 16, 2018

<table>
<tr><th colspan="6">Support for the Preparation of the Sustainable Agricultural Productivity Program
Ex-Ante Evaluation and Capacity to Pay for Operation and Maintenance of Irrigation and Drainage Systems</th></tr>
<tr><th></th><th>Monday
March 12</th><th>Tuesday
March 13</th><th>Wednesday
March 14</th><th>Thursday
March 15</th><th>Friday
March 16</th></tr>
<tr><td>AM</td><td></td><td>8:00 Royal Torarica Meeting Jo-Ann and Cristian Rodriguez
9:00-13:00 Travel to Nickerie District Renusha Pritipalsingh and Jo-Ann Monsels will communicate once the mission is in Nickerie.</td><td>9:00-10:30 ADRON Meeting with Mr. Jerry Tjoe Awie Characterization of rice production: seeds, costs, yields, prices, with and without the project in Nickerie
11:00-13:00 Meeting with
Mr. Mahawatkhan Large Local rice producer of Charin's Rice business Characterization of rice production: costs, yields, prices, with and without the project in Nickerie</td><td>9:00-10:30 Focus group with Mr. Oemraw & members of Rice Producers Association Surinaamse Padie Boeren Associatie (SPBA) Characterization of rice production: costs, yields, prices, with and without the project
Nickerie
11:00-12:30 Focus group with Bramdew Rampedarath & members of Rice Producers Association Vereniging van Padie Producenten (VPP) Characterization of rice production: costs, yields, prices, with and without the project
Nickerie</td><td>7:00-8:00 Meeting with Mr. Martin Smith Nickerie

8:00-12:00 Travel to Paramaribo</td></tr>
<tr><td>PM</td><td>15:00 Royal Torarica

Meeting Jo-Ann Monsels and Cristian Rodriguez. Mission Program and questionnaire revision.
Paramaribo.</td><td>13:15-15:00 Meeting with Mr. August Lila from Overliggend waterschap Multi Purpose Corantijn project (OWMCP) Information on Water Boards in Nickerie
15:30-16:45 Meeting with Mr. Nibar from Stichting Seva Micro Finance Institute</td><td>14:00–15:30
Focusgroup with Mr. Dwarka and members of Corantijn Polder Water Board Irrigation Association Characterization of irrigation organization and infrastructure, current and expected cost of O&M, energy cost for pumping water.
Nickerie</td><td>14:00-14:45 Meeting with Mr. Ramadhin of Large Rice Mill
15:30-18:00 Focus group Small Local rice producers of region West Characterization of rice production: costs, yields, prices, with and without the project.</td><td>14:00-15:15
Meeting with Mr van der Kooye - IDB office
15:30-16:00 Jo-Ann Monsels and Cristian Rodriguez. Definition of Next Steps IDB Office
16:00 IDB Debriefing meeting with Mr. Falconi in Paramaribo</td></tr>
</table>

Source: own elaboration, 2018.

8.2. Financial cost calculation for paddy production per ha spring season – Without Project Situation

Table 15. Cost calculation for paddy production per ha spring season – Without Project Situation

Cost calculation for paddy production per ha Spring Season								
			Prices in Surinamese dollars					
			Quantity	**Unit**	**Price**	**Totals**		**Proportion**
1	Land Preparation	Dry processing 1 x V-litter team	1.0	Ha	150	150	1,100	19%
		Dry processing 1 x hydraulic litter team	1.0	Ha	250	250		
		Wet processing	1.0	Ha	700	700		
2	Maintenance ditches and dams	1 liter Glyfosaat	1.0	Liter	28	28	128	2%
		1 liter Gramaxone	1.0	Liter	30	30		
		1 bag Ally	1.0	Bag	20	20		
		Wages	1.0	Post	50	50		
3	Sow	Seed 2 bales @ 70 kg @ srd 150 (including germination, transport)	1.8	Bags	150	271	352	6%
		Sowing paddy costs	2.7	Labourers	30	81		
4	Beetle and snail control	Beetle: 0,5 litr Karate *(Lamdha cypermethrin)*	0.5	Liter	40	20	62	1%
		Snail: 200 gram Brestan *(Fetin Acetate)*	0.2	KG	135	27		
		Wages	1.0	Labourers	15	15		
5	Insecticides/ Fungicides	1 litr Bestac against gadela *(Alpha Cypermethrin)*	1.0	Liter	40	40	620	11%
		1 litr Admajor against bibietvlieg *(Imidacropid)*	1.0	Liter	85	85		
		1 pak Nomina against weeds *(bispyribac sodium)*	1.0	Bag	20	20		
		1 kg *Carbendazim* against fungus (sheat blight)	1.0	Kg	45	45		
		1 litr Fuzi-one against fungus (neck blast) *(Isoprothiolane)*	1.0	Liter	45	45		
		1 litr Admajor against stemborer (ghandi) *(Imidacropid)*	1.0	Liter	85	85		
		Spraying costs incl tank spray costs	12.0	Tank	25	300		
6	Fertilizers	Kalium 60%	0.5	Bag 50 KG	220	110	1,455	26%
		Fosfaat TSP 46%	1.0	Bag 50 KG	210	210		
		Ureum 46%	5.0	Bag 50 KG	160	800		
		Leaf fertilization	2.0	Bags	18	35		
		Sow costs including transport to rice field	1.0	Post	300	300		
7	Water management	Water pumps	3.0	hours	150	450	550	10%
		Contribution maintenance irrigation system	1.0	Post	100	100		
8	Harvest	Combine wage	1.0	Ha	600	600	1,202	21%
		Rent plot in bales of wet paddy	6.3	Bales	95	602		
9	Financing costs	Interest at around 50% of production costs	10%	Capital	1,858	186	186	3%
		Total costs per ha - Rent Land					5,655	
		Paddy sales (yields)	63	Bales	95		6,025	
		Profit per ha (without taxes)					370	
		Net income					370	
		Total costs per ha - Own Land					5,052	
		Paddy sales (yields)	63	Bales	95		6,025	
		Profit per ha (without taxes)					973	
		Net income					973	

Source: own elaboration, 2018, based on producers information.

8.3. Financial cost calculation for paddy production per ha wet season – Without Project Situation

Table 16. Cost calculation for paddy production per ha wet season – Without Project Situation

Cost calculation for paddy production per ha Wet Season								
			Prices in Surinamese dollars					
			Quantity	**Unit**	**Price**	**Totals**		**Proportion**
1	Land Preparation	Dry processing 1 x V-litter team	1.0	Ha	150	150	1,100	19%
		Dry processing 1 x hydraulic litter team	1.0	Ha	250	250		
		Wet processing	1.0	Ha	700	700		
2	Maintenance ditches and dams	1 liter Glyfosaat	0.0	Liter	28	-	-	0%
		1 liter Gramaxone	0.0	Liter	30	-		
		1 bag Ally	0.0	Bag	20	-		
		Wages	0.0	Post	50	-		
3	Sow	Seed 2 bales @ 70 kg @ srd 150 (including germination, transport)	1.8	Bags	150	271	352	7%
		Sowing paddy costs	2.7	Labourers	30	81		
4	Beetle and snail control	Beetle: 0,5 litr Karate *(Lamdha cypermethrin)*	0.6	Liter	40	24	71	1%
		Snail: 200 gram Brestan *(Fetin Acetate)*	0.2	KG	135	32		
		Wages	1.0	Labourers	15	15		
5	Insecticides/ Fungicides	1 litr Bestac against gadela *(Alpha Cypermethrin)*	1.2	Liter	40	48	684	13%
		1 litr Admajor against bibietvlieg *(Imidacropid)*	1.2	Liter	85	102		
		1 pak Nomina against weeds *(bispyribac sodium)*	1.2	Bag	20	24		
		1 kg *Carbendazim* against fungus (sheat blight)	1.2	Kg	45	54		
		1 litr Fuzi-one against fungus (neck blast) *(Isoprothiolane)*	1.2	Liter	45	54		
		1 litr Admajor against stemborer (ghandi) *(Imidacropid)*	1.2	Liter	85	102		
		Spraying costs incl tank spray costs	12.0	Tank	25	300		
6	Fertilizers	Kalium 60%	0.5	Bag 50 KG	220	110	1,615	31%
		Fosfaat TSP 46%	1.0	Bag 50 KG	210	210		
		Ureum 46%	6.0	Bag 50 KG	160	960		
		Leaf fertilization	2.0	Bags	18	35		
		Sow costs including transport to rice field	1.0	Post	300	300		
7	Water management	Water pumps	0.0	hours	150	-	-	0%
		Contribution maintenance irrigation system	0.0	Post	100	-		
8	Harvest	Combine wage	1.0	Ha	600	600	1,142	22%
		Rent plot in bales of wet paddy	5.7	Bales	95	542		
9	Financing costs	Interest at around 50% of production costs	10%	Capital	1,911	191	191	4%
		Total costs per ha - Rent Land					5,156	
		Paddy sales (yields)	57	Bales	95		5,423	
		Profit per ha (without taxes)					268	
		Net income					268	
		Total costs per ha - Own Land					4,613	
		Paddy sales (yields)	57	Bales	95		5,423	
		Profit per ha (without taxes)					810	
		Net income					810	

Source: own elaboration, 2018, based on producers information.

8.4. Financial cost calculation for paddy production per ha dry season – With Project Situation

Table 17. Cost calculation for paddy production per ha season – With Project Situation

Cost calculation for paddy production per ha Spring Season								
			Prices in Surinamese dollars					
			Quantity	Unit	Price	Totals		Proportion
1	Land Preparation	Dry processing 1 x V-litter team	1.0	Ha	150.00	150.00	1,100	19%
		Dry processing 1 x hydraulic litter team	1.0	Ha	250.00	250.00		
		Wet processing	1.0	Ha	700.00	700.00		
2	Maintenance ditches and dams	1 liter Glyfosaat	0.9	Liter	27.50	23.38	119	2%
		1 liter Gramaxone	0.9	Liter	30.00	25.50		
		1 bag Ally	1.0	Bag	20.00	20.00		
		Wages	1.0	Post	50.00	50.00		
3	Sow	Seed 2 bales @ 70 kg @ srd 150 (including germination, transport)	2.0	Bags	168.00	339.51	430	8%
		Sowing paddy costs	3.0	Labourers	30.00	90.94		
4	Beetle and snail control	Beetle: 0,5 litr Karate *(Lamdha cypermethrin)*	0.4	Liter	40.00	17.00	55	1%
		Snail: 200 gram Brestan *(Fetin Acetate)*	0.2	KG	135.00	22.95		
		Wages	1.0	Labourers	15.00	15.00		
5	Insecticides/ Fungicides	1 litr Bestac against gadela *(Alpha Cypermethrin)*	0.9	Liter	40.00	34.00	604	11%
		1 litr Admajor against bibietvlieg *(Imidacropid)*	0.9	Liter	85.00	72.25		
		1 pak Nomina against weeds *(bispyribac sodium)*	0.9	Bag	20.00	17.00		
		1 kg *Carbendazim* against fungus (sheat blight)	1.2	Kg	45.00	54.00		
		1 litr Fuzi-one against fungus (neck blast) *(Isoprothiolane)*	1.2	Liter	45.00	54.00		
		1 litr Admajor against stemborer (ghandi) *(Imidacropid)*	0.9	Liter	85.00	72.25		
		Spraying costs incl tank spray costs	12.0	Tank	25.00	300.00		
6	Fertilizers	Kalium 60%	0.5	Bag 50 KG	220.00	99.00	1,343	24%
		Fosfaat TSP 46%	0.9	Bag 50 KG	210.00	189.00		
		Ureum 46%	4.5	Bag 50 KG	160.00	720.00		
		Leaf fertilization	2.0	Bags	17.50	35.00		
		Sow costs including transport to rice field	1.0	Post	300.00	300.00		
7	Water management	Water pumps	2.4	hours	150.00	360.00	460	8%
		Contribution maintenance irrigation system	1.0	Post	100.00	100.00		
8	Harvest	Combine wage	1.0	Ha	600.00	600.00	1,275	23%
		Rent plot in bales of wet paddy	7.1	Bales	95.00	674.76		
9	Financing costs	Interest at around 50% of production costs	10%	Capital	1,825	182.54	183	3%
10	O&M Fee for WB	Fee for O&M of WB	1	Ha	75.00	75.00	75	1%
		Total costs per ha - Rent Land					5,643	
		Paddy sales (yields)	71.0	Bales	95		6,748	
		Profit per ha (without taxes)					1,105	
		Net income					1,105	
		Total costs per ha - Own Land					4,968	
		Paddy sales (yields)	71.0	Bales	95		6,748	
		Profit per ha (without taxes)					1,779	
		Net income					1,779	

Source: own elaboration, 2018, based on producers information.

8.5. Financial cost calculation for paddy production per ha wet season – With Project Situation

Table 18. Cost calculation for paddy production per ha wet season – With Project Situation

Cost calculation for paddy production per ha Spring Season								
			Prices in Surinamese dollars					
			Quantity	**Unit**	**Price**	**Totals**		**Proportion**
1	Land Preparation	Dry processing 1 x V-litter team	1.0	Ha	150	150	1,100	19%
		Dry processing 1 x hydraulic litter team	1.0	Ha	250	250		
		Wet processing	1.0	Ha	700	700		
2	Maintenance ditches and dams	1 liter Glyfosaat	0.0	Liter	28	-	-	0%
		1 liter Gramaxone	0.0	Liter	30	-		
		1 bag Ally	0.0	Bag	20	-		
		Wages	0.0	Post	50	-		
3	Sow	Seed 2 bales @ 70 kg @ srd 150 (including germination, transport)	2.0	Bags	168	340	430	8%
		Sowing paddy costs	3.0	Labourers	30	91		
4	Beetle and snail control	Beetle: 0,5 litr Karate *(Lamdha cypermethrin)*	0.6	Liter	40	24	71	1%
		Snail: 200 gram Brestan *(Fetin Acetate)*	0.2	KG	135	32		
		Wages	1.0	Labourers	15	15		
5	Insecticides/ Fungicides	1 litr Bestac against gadela *(Alpha Cypermethrin)*	1.2	Liter	40	48	684	13%
		1 litr Admajor against bibietvlieg *(Imidacropid)*	1.2	Liter	85	102		
		1 pak Nomina against weeds *(bispyribac sodium)*	1.2	Bag	20	24		
		1 kg *Carbendazim* against fungus (sheat blight)	1.2	Kg	45	54		
		1 litr Fuzi-one against fungus (neck blast) *(Isoprothiolane)*	1.2	Liter	45	54		
		1 litr Admajor against stemborer (ghandi) *(Imidacropid)*	1.2	Liter	85	102		
		Spraying costs incl tank spray costs	12.0	Tank	25	300		
6	Fertilizers	Kalium 60%	0.5	Bag 50 KG	220	110	1,615	30%
		Fosfaat TSP 46%	1.0	Bag 50 KG	210	210		
		Ureum 46%	6.0	Bag 50 KG	160	960		
		Leaf fertilization	2.0	Bags	18	35		
		Sow costs including transport to rice field	1.0	Post	300	300		
7	Water management	Water pumps	0.0	hours	150	-	-	0%
		Contribution maintenance irrigation system	0.0	Post	100	-		
8	Harvest	Combine wage	1.0	Ha	600	600	1,207	22%
		Rent plot in bales of wet paddy	6.4	Bales	95	607		
9	Financing costs	Interest at around 50% of production costs	0.1	Capital	1,950.43	195	195	4%
10	O&M Fee for WB	Fee for O&M of WB	1.0	Ha	75	75	75	1%
		Total costs per ha - Rent Land					5,378	
		Paddy sales (yields)	63.9	Bales	95		6,074	
		Profit per ha (without taxes)					696	
		Net income					696	
		Total costs per ha - Own Land					4,771	
		Paddy sales (yields)	63.9	Bales	95		6,074	
		Profit per ha (without taxes)					1,303	
		Net income					1,303	

Source: own elaboration, 2018, based on producers' information.