DOCUMENT OF THE INTER-AMERICAN DEVELOPMENT BANK

# SURINAME

# AGRICULTURAL COMPETITIVENESS PROGRAM

# (SU-L1020)

## ECONOMIC ANALYSIS

## FINAL REPORT

*March 2017*

## I. EXECUTIVE SUMMARY

1.1 This report presents the economic analysis for an Investment Loan (IL) provided by the Inter-American Development Bank (IDB) for the Agricultural Competitiveness of Suriname.

1.2 The program consists of 2 key components. The first component – Strengthening Agricultural Health and Food Safety – consists of four subcomponents: strengthening food safety, strengthening animal health, strengthening plant health, and the construction of laboratory complex infrastructure. The second component, Strengthening Agricultural Innovation, consists of research investments to increase the productivity of the agricultural sector through better seed compositions and crop management.

1.3 The analysis estimates costs and benefits associated with these investments, evaluated over a time horizon of 10 year, a timeline that is customary for similar investment evaluations. As is standard for IDB economic analyses, this report evaluates the program from a societal point of view and uses economic prices rather than market prices. The analysis clearly spells out the assumptions, parameters, and sources that are used.

1.4 Overall, we find that the program has an Internal Rate of Return (IRR) of 64.17%. The Net Present Value of the program is SRD 183,004,273 assuming an opportunity cost of capital of 12%. It is worth noting that a conservative approach has been taken. The benefit estimates are based on lower bound estimates, and benefits that are hard to estimate and quantify have been left out of the analysis – even though the costs related to these investments were still factored in. The document clearly highlights why and how the estimates are lower bounds.

1.5 This overall profitability is reflected in the IRR of the different components as well. All components have an IRR that exceeds 50%, and the food safety sub-component has an IRR of 154.81%.

1.6 A sensitivity analysis confirms that the analysis is robust to even more conservative assumptions. First, the program still remains viable when certain productivity assumptions are muted under five different scenarios. The lowest overall IRR obtained under the combined five different stress scenarios is 31.56%. Combining all five stress scenarios yields an IRR of 14.29%.

1.7 Finally, given the precarious fiscal and macroeconomic situation in Suriname, an analysis of the fiscal impact of the program highlights that the program entails a fiscal cost-to-benefit ratio of about 75% and IRR of 25%, indicating the program is expected to have a positive impact on the fiscal budget of Suriname.

## II. Introduction

2.1 This report presents the economic analysis of an Investment Loan (IL) provided by the Inter-American Development Bank (IDB) for the agricultural competitiveness of Suriname. First, however, it briefly describes the objectives of the loan, and then lays out the methodology used to estimate the economic costs and benefits of the supported investment measures. It then describes each component, its rationale, and the assumptions made in estimating its economic effects in detail. Calculated internal rates of return (IRRs) are reported for each component, as well as for the entire program. A sensitivity analysis is presented at the end of the document.

## III. Objectives and background of the IL[1]

3.1 The objective of the IL is to contribute to stimulate and increase the competitiveness of the agricultural sector in Suriname through the improvement of animal health, plant health, food safety, and agricultural innovation services. In order to achieve the above objectives the following components were agreed upon with the Government of Suriname: Component I – strengthening agricultural health and food safety including the subcomponents: (i) strengthening animal health, (ii) strengthening plant health, (iii) strengthening food safety, and (iv) laboratory complex infrastructure; and Component II- strengthening agricultural innovation.

3.2 The agricultural sector accounts for 7% of total export earnings, second to mining, 16% of the labor force and for 9% of total GDP in 2014 (Suriname Central Bank, 2015). Most agricultural production takes place along the coastal plains. Despite the sector importance, agricultural GDP declined between 1991 and 2002. A growth path was recovered from 2003 to 2014, but agricultural growth has constantly been lower than total GDP growth in recent years (Suriname Central Bank, 2014). At present, Suriname shows yield gaps, vis-à-vis the region's best performers, of 75% for rice, 115% for beef production, 92% for milk, 101% for roots, 160% for cabbage, and 150% for oranges (FAOSTAT, 2015). The main challenge for the sector is overcoming its low productivity and competitiveness, as measured for instance by the total factor productivity (TFP) annual growth rate, which was almost zero between 1980-2012. This rate is one of the lowest in the region and considerably lower than Guyana's (1.3%) (Nin-Pratt et al., 2015). Moreover, based on the International Trade Centre's General Index Ranking of Export Performance (ITC), between 2010 and 2014, Suriname's ranking fell from 132nd to 139th out of 180 in terms of competitiveness of its fresh food (ITC, 2015).

3.3 The annual level of total support to the Surinamese agricultural sector amounts to 1.37% of GDP (2012-2014), similar to the average for the LAC region. Overall Producer Support Estimate in Suriname in 2012 – 2014 was 12.7%, lower than the OECD average but close to levels of Mexico. Regional references Jamaica (24.04%) and Guyana (16.38%) both had higher levels of support. The share of support to agriculture in the form of general services (e.g., infrastructure, research, extension, agricultural health, which are considered public goods), is about 40% of total transfers, higher than in most LAC countries, and close to the

[1] See the Annex for the list of all investment actions.

levels of Chile and USA. While the government's commitment to support public agricultural goods and services is a good policy measure and should be sustained, the medium and long term challenge is to diversify the provision of those services, which at the moment are highly concentrated on irrigation infrastructure for rice production in the Eastern part of the country (which is receiving 94% of the general service support, with research and innovation receiving 5% and inspection services the remaining 1%)[2].

3.4 The proposed investment program follows several previous reforms and initiatives in non-sector specific policies that have an impact on agricultural productivity such as trade, infrastructure, and financial markets and has started a divestment strategy of state-owned enterprises. In the last three years, the Government of Suriname has also embarked on specific agricultural sector reforms aimed at modernizing its agricultural public services through IDB supported Policy Loans (SU-L1033 and SU-L1032) that has focused on agricultural health, food safety and innovation through introducing and strengthening legislation, establishing interministerial coordination and working groups, and improving technical capabilities.

3.5 The proposed investment program is aligned with the National Agricultural Strategy (2016-2020), a newly drafted document that prioritizes the provision of public services supporting these two components. The specific investments proposed are discussed in further detail for each component and subcomponent below. These specific investments, as well as the overall strategy, are also consistent with several other initiatives, such as the Institutional Strategy 2010-2020 (UIS), the Corporate Results Framework 2016-2019 (CRF), and the Country Strategy and Sector Strategy.

3.6 The analysis was conducted over several months and fine-tuned on an ongoing basis as new data was verified and obtained. Any relevant findings from new data was communicated to the project team in order to inform and influence the design of the program with a view to ensure economic gains from the reforms are maximized. Conforming to the *Guidelines for the Economic Analysis of IDB-Funded Projects,* the analysis thus sought to help the task team improve program design, as well as the design of any potential follow-up operations.

## Methodology

### Cost benefit analysis (CBA)

A standard cost benefit analysis was conducted to assess the 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 attempts to compare the situation (in terms of economic costs and benefits) without the program with the situation with the program.

The analysis assesses each component separately. 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,

[2] All data in this paragraph come from the IDB Agrimonitor database, 2016.

interaction effects between the different components were not analyzed, likely leading to an underestimation of the overall benefits of the program.

To express the cumulative net value of the project in present monetary terms, a real discount rate of 12% per annum is applied to all future benefit and cost flows. The sums of the flow of costs and benefits discounted at this rate yield the Net Present Value (NPV) of the project.

A positive NPV means that the program is economically viable given the opportunity cost of capital, whereas a negative NPV would indicate that the program should be not be pursued.

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. The Internal Rate of Return of a project/program is the rate that would yield an 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.

### Period of analysis

The CBA will consider costs and benefits accruing over a period of ten years for the different components, as this period was considered the most appropriate given the nature of the interventions. In contrast to the policy loan reforms, these interventions are more likely to exhibit intermediate-term returns, and much of the physical investments and training programs are likely to depreciate in a non-trivial way over this time period. Nevertheless, the investments target important weaknesses in Suriname's agricultural sector, and complement the policy loan interventions; they are therefore likely to pay off over several years to come. Evaluating these interventions over an intermediate-term time horizon therefore makes most sense for this specific intervention.

### Monetary Unit/Numeraire

All costs and benefits are expressed in terms of Suriname Dollars (SRD) at border price levels. All tradeable goods are valued at the domestic currency, as are non-tradeable goods and expenditures that are provided in SRD. Investments and tradeables that are available only in foreign currencies (such as USD or EUR) are converted into SRD using the current exchange rate. In a cost benefit analyses it is important to consistently apply the same numeraire in order to obtain comparable cost and benefit estimates which can then be aggregated into the total Net Present Value of the program.

### Economic costs and shadow prices

Nielsen (2005) points out there are two ways of performing a cost-benefit analysis of a program, where either financial prices or economic prices are used. The main differences between these prices are, among other things, made up of positive and negative externalities, government taxation, foreign exchange premia, and import subsidies.

As set forward by the IDB guidelines, the cost benefit analysis in this report takes into consideration economic prices, meaning the impact of the program is evaluated considering the entire society and the economy at large. For instance, taxes on additional employment created by the program should be netted out as these flow back to the government (and therefore the Suriname society at large). Import subsidies and tariff schemes are also important, but are hard to immediately estimate. Therefore, conversion factors are typically used to translate “market prices” to “economic prices”.

The following adjustments are made. The key channels that generate differences between market and economic prices are i) taxes on additional labor and sales that are generated by the program, and ii) eventual tariffs that are charged for the import of vehicles, lab materials, technologies, etc. that are procured outside of Suriname.

- ***Income taxes***. Subcomponent food safety generates additional employment for meat and vegetable inspectors, and income taxes related to this 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).[3] These tax rates are used to convert market prices to economic prices for policy conditions that generate additional employment.

- ***Sales taxes***. Certain components entail costs that are procured including sales taxes. The sales tax in Suriname is 10%, so this parameter is used to net out these taxes when necessary.[4]

- ***Other Cost adjustments.*** No adjustments were made on the cost side of the analysis. First, Suriname recently moved to a floating exchange rate, decreasing the possibility of exchange rate premiums. Second, while procuring certain technologies, cars, and other inputs abroad might entail tariff costs, the level of detail needed to break this down is not available, so proper estimates cannot be presented.

- ***Import/Export adjustments.*** As pointed out above, conversion factors for imports and exports of agricultural products are calculated. The wedge between economic and financial prices for these products is mainly driven by tariffs. Estimating these correctly requires a substantial amount of detail on tariffs and the composition of export and imports. Since these are not available, two simple conversion factors are proposed.

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

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

- A conversion factor (CF) for exports: as a substantial amount of Suriname exports go to the US and the EU. The EU tends to charge import tariffs of about 5% for Caribbean countries.[5] This means exporting SRD 100 implies SRD 5 of tariff costs for the exporter. Therefore, a CF of 0.95 for exports is assumed.

- A CF for imports: Suriname charges a tariff of, on average, about 17%.[6] This means importing SRD 100 implies SRD 17 of income for the society of Suriname. Therefore, a CF of 100/117=0.85 is assumed on imports that enter Suriname.

- ***Inflation and exchange rate.*** As set forward by the IDB economic analysis guidelines, the analysis is to be done either in real or nominal prices. The latter is preferred when prices are expected to be constant, which is not the case in Suriname. Therefore, the analysis is performed using real prices, applying the exchange rate for 2016 for future cost and benefit flows.[7]

### Non-quantifiable benefits

Some interventions generate benefits that are hard to quantify or predict. For instance, improved food chain surveillance systems and food safety leads to better health outcomes, less sick days and higher productivity, yet estimating these effects would require having access to detailed information and imposing several strong assumptions that may or may not hold. Therefore, no benefits are estimated for such interventions, leading to a more conservative and transparent cost benefit analysis.

Several investments require additional efforts on the part of Suriname in terms of staffing and drafting documents that are not included in the budget for the program. When not budgeted in the program budget, such costs associated with investments are calculated by estimating the time LVV and other administrators spent. It is then assumed that a typical staff member earns about SRD 4,000 per month.[8] LVV administrators reviewed and verified the staff time and wage estimates.

### Sensitivity Analysis

A sensitivity analysis has been conducted to check the robustness of potential economic gains to changes in the assumptions underlying the analysis. The report presents the results of the sensitivity analysis, including thresholds of key variables whose crossing would render the program economically unviable.

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5 Source: http://www.dutycalculator.com/country-guides/Import-duty-taxes-when-importing-into-Suriname/
6 Source: http://trade.ec.europa.eu/doclib/docs/2008/march/tradoc_138081.pdf (Figure 8)
7 This exchange rate is 6.49 SRD/USD
8 The wage scale at LVV ranges from SRD 1,500 to SRD 8,500, making this amount on the high end.

## Data collection and field missions

Relevant data for the analysis was obtained from three sources: First, during two missions to Suriname in June and October 2016, extensive consultations with LVV staff were undertaken. This served to obtain data that the ministry collects on a systematic and regular basis, such as the Ministry's publication on agricultural statistics, as well as expert views on and clarification of specific issues, such as the likelihood of certain animal disease outbreaks or clarifications regarding the budgets to implement certain interventions.

Second, the IDB program team, including the various technical consultants, provided invaluable information on the technical aspects of the program, which informed the economic analysis throughout. Third, a desk review of the relevant literature on the costs and benefits of similar or related interventions in other countries provided important background information and at times bases for estimates.

## Background

Suriname is an upper middle-income country with an estimated population of 534,500 and a surface area of 163,820 $km^2$, yielding a population density of 3.2 per $km^2$.

### Macroeconomic background[9]

Suriname's economy is highly concentrated in the extractive industries—specifically gold and oil—which play a key role in driving growth, employment and government revenues. On average, these sectors account for roughly 30% of Gross Domestic Product (GDP), 90% of total exports and 25% of government revenue. In 2011, sales of gold, oil, and alumina, accounted for 88 percent of exports and 44 percent of government revenues. The Surinamese economy grew at a relatively high average yearly rate (3.8%) for most of the past decade; with macroeconomic stability (the fiscal deficit averaged 0.8% of GDP with an average current account to GDP surplus of 1.2%). These growth rates have also been accompanied by a steady growth in internet access throughout the country, with current levels at 44%, and access to internet rapidly growing over the past years (IWS 2017).[10]

However, Suriname is currently facing challenging conditions in the near term, caused largely by the sharp decline in the international prices of its main commodity exports. The sustained drop in the prices of gold and oil has weakened the external and fiscal positions and significantly reduced international reserves (the foreign reserve position fell by 47% in 2015 to SRD 2,143 million or USD 330.2 million). These developments, combined with the closure of the alumina refinery in late 2015, pushed the economy into

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9 All data is from the IMF's press release of May 27, 2016: https://www.imf.org/external/np/sec/pr/2016/pr16251.htm, except for the exchange rate data which is from the World Bank's World Development Indicators for 2015 and from the Surinamese Central Bank's website for May 2016.

10 http://www.internetworldstats.com/sa/sr.htm

a recession in 2015 (IMF, Concluding statement of the 2016 Article IV Mission). Suriname's current account and fiscal balances have deteriorated. The fiscal balance moved from a small surplus in 2011, prior to the commodity price downfall, to a deficit of 8.8% of GDP in 2015, with the drop in government mineral revenue being responsible for 82% of that change. On the balance of payments side, the current account moved from a surplus of 5.7% of GDP in 2011 to a 15.6% deficit in 2015, although a larger part of the deterioration was due to a sharp increase in imports due to large investments in a new oil refinery and a new gold mine.

The Government of Suriname has started its reform plan and has signed an International Monetary Fund Stand-by Arrangement for 24 months, for the amount of SRD 3,102 million (USD 478 million). This arrangement will help smooth the impact of the fall in commodity prices and provide a bridge to 2017 when new productive capacity in the commodity sector is expected to come about. The result will be to reverse the frail macroeconomic outlook and encourage macroeconomic stability of Suriname's domestic and external balances. The program also seeks to strengthen the resilience of the monetary and exchange rate policy framework to further external shocks, through institutional and operation reforms supported by technical assistance. Structural reforms target an improvement in the private sector environment and competitiveness (of importance is the agriculture sector). Consequently, the medium-term growth outlook is forecasted to remain robust in light of the ongoing expansion in the gold mining and oil refinery sector. The International Monetary Fund (IMF) has projected a gross financing gap of SRD 3,154 million (USD 486 million) for 2016 (10% of GDP).

### The agricultural sector

Between 2010 and 2014, the agricultural sector's contribution to GDP was about 9 percent. Much of this contribution comes from rice, banana, fisheries, and poultry. The first three also account for the bulk of agricultural exports. Other exported agricultural products consist mainly of other tropical fruits and vegetables. In 2014, agricultural exports were worth SRD 831 million (USD 128 million), accounting for more than 12 percent of all exports from Suriname. Agriculture is an important source of employment, with about 16 percent of Suriname's labor force active in the sector in 2014.

The sector's performance in the last 30 years has been somewhat erratic, with agricultural growth slowing during the 1990s and slowly recovering at the beginning of the last decade. As a result, national agricultural output in 2010 was still below the level reached in 1991 and the cultivated area shrank by 33 percent during the same period. Yields of traditional agricultural sub-sectors stagnated, and as a whole the sector had a low rate of growth of total factor productivity.

**Table 1:** Contribution of the agricultural sector to the national economy 2010-2013, SRD '000s in current prices unless otherwise stated

| Description | 2010 | 2011* | 2012* | 2013* | 2014* |
|---|---|---|---|---|---|
| **Agriculture, livestock, forestry** | 869,206 | 916,034 | 1,034,203 | 971,720 | 1,002,843 |
| **Fisheries** | 293,565 | 374,580 | 374,292 | 429,871 | 595,044 |
| **Total agricultural sector** | 1,162,771 | 1,290,614 | 1,408,495 | 1,401,591 | 1,597,887 |
| **GDP at current prices** | 11,993,016 | 14,451,881 | 16,433,674 | 16,932,127 | 17,194,136 |
| *contribution of agriculture, %* | 9.7% | 8.9% | 8.6% | 8.3% | 9.3% |

Source: General Bureau of Statistics and Department Agricultural Statistics

** The import and export data of the period August- October 2012 is not available. The available figures are extrapolated.

In this setting, the Government of Suriname acknowledges that a revitalized, more productive, and diversified agricultural sector will contribute to reducing macroeconomic uncertainty by ensuring against downside risks and external shocks, improve food security, and provide opportunities for employment and income generation that will help to alleviate poverty in rural areas where about 50% of Surinamese live.

To achieve this, productivity should be increased and access to new international markets expanded. Cognizant of this fact, the government has identified the need to implement a medium-term investment and policy reform strategy that will help to promote private farm investment and modernize agriculture. The government therefore requested the technical support of the Inter-American Development Bank for a programmatic series of policy loans with the objective to modernize agricultural public services, leading to the Policy Based Loan (PBL) SU-L1032 that aimed at increasing productivity in the Surinamese agricultural sector by strengthening the institutional and legal framework.

**Table 2:** Export Quantity and Value of Agricultural Products

| DESCRIPTION | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| QUANTITY (tons) | | | | | | |
| Rice products | 51.941 | 89.412 | 46.109 | 56.317 | 77.161 | 103.755 |
| Bananas ** | 58.132 | 70.239 | 68.138 | 62.213 | 76.585 | 75.261 |
| Vegetables | 2.757 | 3.239 | 2.723 | 2.476 | 2.806 | 2.717 |
| Fruit (excl. Bananas) | 160 | 1.122 | 1.006 | 611 | 579 | 431 |
| Processed vegetables, fruits and plant parts | 339 | 401 | 792 | 1.409 | 648 | 409 |
| Flowers/Ornamentals | 145 | 102 | 139 | 92 | 54 | 49 |
| Fish products | 20.356 | 21.235 | 22.083 | 18.583 | 25.568 | 28.991 |
| Crustaceans | 3.332 | 6.692 | 3.638 | 3.179 | 4.053 | 2.778 |
| TOTAL EXPORT QUANTITY | 137.162 | 192.442 | 144.628 | 144.880 | 187.454 | 214.391 |
| VALUE (SRD 1000s) | | | | | | |
| Rice products | 58.950 | 105.213 | 99.664 | 103.155 | 132.114 | 179.814 |
| Bananas ** | 73.608 | 67.987 | 110.986 | 89.110 | 110.740 | 109.446 |
| Vegetables | 4.193 | 5.289 | 5.179 | 3.661 | 4.123 | 4.746 |
| Fruit (excl. Bananas) | 217 | 1.238 | 1.517 | 768 | 649 | 505 |
| Processed vegetables, fruits and plant parts | 586 | 711 | 1.689 | 2.717 | 1.681 | 702 |
| Flowers/Ornamentals | 372 | 404 | 778 | 451 | 675 | 401 |
| Fish products | 46.651 | 44.414 | 57.879 | 52.082 | 69.780 | 80.157 |
| Crustaceans | 35.283 | 41.957 | 53.319 | 45.148 | 54.205 | 38.854 |
| TOTAL EXPORT VALUE (SRD 1000) | 219.860 | 267.213 | 331.011 | 297.092 | 373.967 | 414.625 |
| TOTAL EXPORT VALUE (USD 1000) | 79.086 | 96.120 | 101.850 | 91.413 | 115.067 | 127.577 |

Note: 2006-2010: USD1 = SRD 2,78 (Average Customs exchange rate ). 2011-2014: USD1 = SRD 3,25
** Total export ----> S.B.B.S.(2009-2013), Food and Agriculture Industries N.V. (FAI) (2014) + Small scale farming. Source: Customs (ASYCUDA)
Source of table: LVV Agricultural Statistics, 2009 – 2014

The proposed Investment Loan (IL) SU-L1020, that is analyzed in this document, is a complement to these policy loans and provides funds to the government in Suriname to obtain much needed capital and modernized equipment to improve the agricultural sector's productivity performance. As with the PBL, the Inter-American Development Bank provided technical assistance to identify the necessary investments and modernizations.

## Benefits of the program

### Investment for Agricultural Health and Food Safety – Component 1

The current status of Suriname, in terms of agricultural health, is extremely vulnerable because norms and regulations needed to enforce a scientific, risk-based surveillance and control system are currently not in effect. According to the World Organization for Animal Health (OIE) and the Inter-American Institute for Cooperation in Agriculture

(IICA) assessments of the Surinamese Veterinary and Phytosanitary Services (OIE, 2012 and IICA, 2012), the "performance scores" are 42% and 30%, respectively – among the lowest in the LAC region.

These assessments concluded that Suriname lacks a modern institutional and legal framework to support a technically sound agricultural health system. In the case of food safety, a recent diagnostic (FAO 2013) indicates that there is: (i) lack of a legal framework and protocols to support an integrated food safety system with animal and plant health; (ii) a fragmentation of food safety programs across government departments, with minimal coordination; (iii) no clear and formal delineation of competencies among the government agencies; and (iv) no human resources and infrastructure plan for an integrated food safety system. This status undermines efforts to implement an integrated sector-wide approach "from the farm to the table," putting at risk the health of Surinamese consumers as well as that of consumers of trading partners.

The economic repercussions of non-adequate agricultural health and food safety services can be significant in Suriname. For instance, rice blasts affect 70% of rice production and entails an average loss of between 10-30% of yields, representing an economic loss of around SRD 64.9 million annually (LVV, DAS 2012); an outbreak of foot and mouth disease in Suriname would lead to a contraction of the livestock sector at an estimated loss of SRD 51.92 million in a 15-year time (FAO 2013); and agrochemical and contamination of food exports puts in jeopardy SRD 195 million (USD 30 million) of annual exports of fruits, vegetables and fish products. This is evidenced by 15 alert notifications received by Suriname exports of such products to the European Union because of exceeding maximum residue level between 2008- 2011 (RASSF, 2012), as well as the rejection of 38 shipments with food exports from Suriname by the US Food and Drug Administration between 2007 and April 2016.[11]

There is a comprehensive literature that shows that increase in international trade in products from this sector has led countries to reduce risks on natural assets and the health of their consumers, establishing regulations on health and safety measures for access to their markets. A compilation of studies analyzing the impact of six agricultural health and food safety systems financed by the IDB in Argentina, Bolivia, Nicaragua, Peru (2 programs), and Uruguay presents positive evidence of the impact that this kind of intervention has (OVE, 2015). In the case of Peru, the assessments conducted suggest that these interventions significantly reduced the presence of fruit flies and the prevalence of livestock sanitary diseases (particularly foot and mouth disease and swine diseases). For the fruit fly program, the improvements translated into higher prices and better yields of agricultural products (GRADE, 2008a).

In order to remedy the current weaknesses of Suriname's Agricultural Health and Food Safety Services, a number of investments aim to improve the agricultural health and food safety, strengthen coordination between key stakeholders responsible for

[11] http://www.accessdata.fda.gov/scripts/importrefusals/

maintaining agricultural health and food safety, and develop plans for investing in the necessary infrastructure and human resources in order to ensure compliance with international standards.

Three separate analyses were conducted to estimate the economic effects of improved food safety, improved animal health, and improved plant health. The benefits of the fourth subcomponent – the construction of laboratory infrastructure – accrue to the three other subcomponents. Therefore, the costs of the fourth subcomponent are divided over the first three subcomponents in an equal manner. One third of the costs – SRD 9.09 million in total – is attributed to food safety, plant health and animal health each. Additionally, for these three subcomponents, the planned budgetary outlays to upgrade the infrastructure and human resource capacity were juxtaposed with estimates of direct economic benefits resulting from improvements in the three respective areas.

### Food Safety

Food safety refers to conditions and practices that preserve the quality of food and prevent contamination and food borne illnesses.[12] An overhaul of Suriname's national food safety services is warranted both for public health and economic reasons. Table 3 highlights the areas that were selected for investment. Furthermore, Annex 4 contains a detailed breakdown of the costs and benefits for this subcomponent for every year the program is evaluated.

Several components of the food safety component plan entail additional costs beyond the 5 year window of the investment, and should therefore be included in the evaluation horizon of the economic analysis (10 years). The annual workshop that is organized is budgeted not only for years 1 through 5, but also for years 6 through 10. Similarly, the interministerial committee that will be set up to ensure proper implementation is costed for all 10 years. Finally, the budget does not include the costs of hiring National Food safety inspectors. The plan sets out the hiring of 23 food safety inspectors at a cost of SRD 2,000 per month. These costs (23*12*2,000 = SRD 552,000.00) are calculated (and included in the analysis) for all 10 years of the evaluation period.

Other costs are not attributed in years 6 through 10 of the evaluation period. Investments and proposals, such as the food safety assurance system or the fee revenue proposal, are implemented and proposed in the first 5 years and do not entail additional costs in later years. Similarly, costs such as staff training do not entail additional costs after the first five years: the budget does not foresee an increase in employee hiring, just the training of existing employees, implying the staff training costs are fully incurred in the first five years of the program.

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12 Source: Food safety, University of Maryland Medical Center http://umm.edu/health/medical/ency/articles/food-safety#ixzz3bAmM09qn University of Maryland Medical Centre

**Table 3:** Investments for Food Safety (FS)

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|---|
| National Food safety policy & Food safety coordination mechanism (including workshops)<br>SRD 204,435.00 |
| Establishment of Food Safety Entity (FSE) within MAAHF (interministerial committee)<br>SRD 154,462.00 |
| National Codex Committee<br>SRD 12,980.00 |
| Food safety legislation<br>SRD 110,979.00 |
| Food safety assurance systems<br>SRD 1,596,540.00 |
| Registration and inspection system<br>SRD 3,031,193.44 |
| Capability for diagnosis Residue lab<br>SRD 2,013,652.30 |
| Surveillance System for Food Safety hazards<br>SRD 687,940.00 |
| Food Safety Standards<br>SRD 97,350.00 |
| Staff Training Plan<br>SRD 578,259.00 |
| Fee revenue proposal<br>SRD 25,960.00 |
| Awareness campaign Food safety & MAAHF/VKI laboratory services<br>SRD 389,400.00 |
| One third of the laboratory construction<br>SRD 3,028,666.67 |

Heavy metals, methyl mercury in particular, in fish are also a matter of concern since gold extraction with mercury is widespread in Suriname, contaminating running water. In a study that tested mercury levels in sediment and predatory fish in Surinamese localities, 41% of fish samples had mercury levels that exceeded the European Union standard of 0.5 μg/g in blood have been detected. (e.g. Ouboter et al. (2012)). A recent review by Outober (2015) considers the effects of such mercury levels on aquatic environment, animal defects and human health (such as neurological health problems). Additionally, exporters of fruits and vegetables face serious problems because of exceeding maximum residue levels (7 EU RASFF notifications between 2002-2015), and microbiological contamination (2 EU RASFF notifications in 2002 and 2013).[13] These benefits, although important, will not be quantified in this analysis.

More detailed import data from the Netherlands highlight the poor monitoring performance of Suriname in key areas such as vegetables, fruits and rice. While fish exports to the Netherlands have very low rejection rates (about 11 consignments out of 2405 were rejected in 2015), the situation is very different for vegetables. About 20% of vegetables and fruits exported from Suriname between mid-2013 and mid-2015 were rejected because of high residue levels (Nederlandse Voedsel- en Warenauthoriteit, 2015).

[13] Bessy et al. (2013), *Report on the mission to Paramaribo March 1 to 9, 2013*,

There are several benefits to investments in food safety. First, the food safety subcomponent contains budgeted workshops to raise awareness and promote the use of Good Agricultural Practices (GAP) among farmers. Such programs have been demonstrated to increase productivity among farmers (for instance by decreasing the costs or increasing yields). Second, this better quality management throughout the supply chain is expected to lead to better agricultural products that are more likely to meet the export requirements and therefore to a decrease in rejection rates of exports. Third, this in turn will affect market access for Suriname farmers and increase the demand for their goods. Therefore, exports are expected to increase.

Table 4 highlights the costs and benefits that were used in the economic analysis of the investments in food safety, and which benefits have not been quantified. It is important to note all costs have been incorporated, but not all benefits have been quantified. Annex 2.A provides an overview of which investments generate benefits that have been calculated, and which investments have benefits that were not quantified. The budget does not cover the wages for additional inspectors that are to be hired to enforce new regulations and food standards, as these will not be covered by the loan. These costs, however, should be factored in. Standard wages for 23 inspectors are calculated for every year and added to the costs.[14] Additionally, the budget only factors in meetings of the Food Safety coordination mechanism and interministerial committee for the five years of the investment plan. As the analysis covers 10 years, it is assumed these committees will continue to meet past the investment plan.

**Table 4:** Costs and Benefits used in analysis for food safety investments

| Costs | Benefits |
|---|---|
| • Consultant for the different activities<br>• Full costs for several workshops<br>• Cost of laboratory tools and equipment<br>• Cost of the food safety assurance system<br>• Cost of registration and inspection system<br>• Costs of hiring inspectors<br>• Training for the diagnosis residue lab<br>• Staff training plan<br>• Fee revenue proposal<br>• Cost of different awareness campaigns<br>• Hire additional inspectors (Not budgeted)<br>• One third of the laboratory construction<br>• Future additional costs (intereministerial committee and organization of workshops) that are incurred after the 5-year window and are implied by the investment program. | • **Quantified**<br>• Decreases in rejection rates of fruits and vegetables.<br>• Increase in export as a result of increased market access<br>• Productivity increases as a result of GAP.<br><br>• **Not quantified**<br>  ○ Better Health outcomes for humans resulting from foods of higher quality and with less residues.<br>  ○ Effect on rejection rates for fish and rice<br>  ○ Increase in export of bananas |

The different parameter and data assumptions are reported in Table 5. Data on the value of Surinamese agricultural exports from LVV's statistics department is used to forecast the value of exports in the future. Rejection rates are based on two sources.

[14] The 23 inspectors match the budget for 9 meat and 14 plant inspectors. The costs are adjusted for income taxes that will flow back to the state.

First, for the main analysis we use estimates of the rejection rates for agro-food exports for developing countries from Jaffee and Henson (2004).[15] Second, as these estimated rejection rates are much lower than those based on the Netherlands import data (from Suriname), they can be considered a lower bound estimate. While these rejection rates are based on Surinamese data, they may overstate the actual rejection rates for Surinamese exports, as other exports may go to markets with less stringent food safety rules.[16]

The specific equation used to quantify the net benefits of this subcomponent is

$$Total\ Benefits = (Total\ Exports) \times (rej_{without} - rej_{with}) \times (g_{with} - g_{without})$$

The $rej_x$ and $g_x$ in the formula above stand for the rejection rate of exports and the growth rate of exports, either with or without the program. The benefits are therefore the net decrease in rejections as a result of the program, adjusted for growth of exports. The total export and $rej_{with}$ parameters are obtained from existing data for fish, rice and fruits and vegetables.

As the rejection rates for rice and fish are relatively low as of now, and the investments don't provide clear ways in which this will decrease, the rejection rates are only assumed to decrease for fruits and vegetables, as these exports face high rejection rates and many investments focus on the supply chain of the fruits and vegetables producers. The increase in exports is assumed to apply to all three categories (fish, rice and fruits and vegetables). The parameters for the growth and the decrease in rejections are taken from a Jamaican case study, discussed in more detail below.

Food safety experts in Suriname, both from LVV and the private sector, expected that these interventions could lead to an incremental decrease in rejection of about a half (50%). This echoes estimates for the JA-L1012 IDB loan program in Jamaica in 2010, where improved monitoring systems were expected to bring about a decrease in rejection rates of 80% over the course of 4 to 5 years. The Jamaican case study for fish, fruits and vegetables is therefore used to obtain parameters of effectiveness.[17] Using data from INTrade, rejection rates of Jamaican products are obtained. The rejection rates decreased by about 100%, 42.5% and 33% for fish, fruits and vegetables respectively when comparing the rejection rates from 2003 – 2009 to 2010 – 2014, as the program was approved and implemented in 2010.[18] This implies rejection rates dropped by 58% on average. Therefore, assuming the rejection rates will drop by 50% seems reasonable and conservative. While the effects were materialized quickly in

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15 Jaffee and Henson (2004), *Standards and Agro-Food Exports from Developing Countries*, World Bank Policy Research Working Paper 3348, 2004

16 A large fraction of the exports, however, go to the EU and US, markets that can be expected to have similar rejection rates as the Netherlands.

17 Rice data do not seem to be available in the INTrade data, so can therefore not be included in the analysis.

18 It is worth noting that these rejection rates correct for growth in exports. For instance, the export of fruits increased by about 80% after the JA-L1012 program was instituted. This means that five rejections in the post-program period imply a lower rejection rate than five rejections in the pre-program period.

Jamaica, this analysis assumes the rejection rates linearly drop from 20% to 10% over 5 years, making the analysis conservative.[19] Specifically, this means that $rej_{with}$ and $rej_{without}$ both start at 20% in the first year of the operation (2017), but $rej_{with}$ drops (linearly) to 10% in 2021 to stay at 10% for the remainder of the evaluation period.

From the same program in Jamaica, it is possible to estimate the increase in exports. Comparing INtrade data from 2010-2014 (with program) to 2003-2009 (without program) shows exports went up by 10% after the introduction and implementation of the program for fruits, vegetables, and rice. As before, this analysis assumes exports grow linearly to 10% over 5 years, making the analysis conservative. Specifically, this means that both that $g_{with}$ and $g_{without}$ both start at 0% in the first year of the operation (2017), but $g_{with}$ increases (linearly) to 10% in 2021 to stay at 10% for the remainder of the evaluation period.

Several studies have looked at the effectiveness of GAP programs. The evidence so far has been somewhat mixed, in part because the take-up rate and awareness among farmers can differ substantially. GAP campaigns typically raise awareness fairly successfully, a result that holds across Latin American and African countries (Carter, 2011; Jaramillo, 2012; Mkanthama, 2013).

**Table 5:** Assumptions and sources for food safety benefit analysis

| **Analysis component** | **Assumptions** | **Source** |
|---|---|---|
| **Value of Exports** | Fish products, fruit and vegetable products, rice products<br>Projected growth of value of exports: moving average of past 3 years | LVV statistics |
| **Rejection Rates** | • Rejection rates for vegetables and fruit: 20%[20]<br>• Decrease in rejection rates: 50%<br>• Export growth: 10% | Dutch Food Authority report, Netherlands import records<br><br>Intrade Jamaica<br><br>Intrade Jamaica |
| **Agricultural production** | Rice and vegetable production<br>Projected growth of production: moving average of past 3 years | LVV statistics. |
| **Impact GAP** | • Parameter estimates<br>○ Awareness after campaigns: 9%<br>○ Fraction of aware farmers adopting GAP: 90%<br>○ Productivity increase after adopting GAP: 10% | <br>Carter, 2011; Mkanthana, 2013<br>Carter, 2011; UTZ, 2013<br>Carter, 2011; UTZ, 2013; World bank, 2013 |

[19] In particular, in the first year (2017) the program has no effect on the export rejection rates. In years 2018 through 2021, the rejection rate 17.5%, 15%, 12.5% and 10% respectively, to stay at 10% in subsequent years.

[20] The rejection rates for fish is close to zero and therefore not incorporated. Additionally, the impact of the program on rice export rejections is also not taken into account.

However, this awareness is not always translated into behavioral changes. Mkanthama (2013), for instance, surveys farmers in Tanzania and finds that they are aware of GAPs, but fail to live by them. Carter (2011) finds GAP programs in Colombia are mostly successful among farmers that are part of farmer groups, indicating leadership, management and organization are particularly important in disseminating these soft skills. Setting up such management structure pays off though, as farmers that adopt GAP witness substantial increases in productivity. Actual productivity increase estimates range from 10% (Carter, 2011; World bank, 2013), driven by substantial investment costs, to 50 % (UTZ, 2012).

This economic analysis is therefore set up in three steps. First, a parameter is estimated for awareness of GAP, resulting from information campaigns. Second, a subset of these farmers is assumed to effectively change their behavior and adopts GAP. Third, it is assumed that these farmers witness productivity increases. The expected productivity increase attributed to the GAP campaign is therefore the result of expected share of farmers that effectively adopt GAP multiplied by their production and productivity increase.[21] This analysis only focuses on rice and vegetables as the GAP initiative is expected to affect the sub-optimal farming practices in these sub-sectors.

The information campaigns that are budgeted under this plan target about 175 farmers out of the 1750 farmers in Suriname.[22] This means about 10% of farmers is targeted. This number is the starting point for this cost benefit analysis. Since large farmers are targeted, they probably account for more than 10% of production, making the economic analysis of this information campaign conservative.

From this targeting percentage, three parameters are estimated: The awareness among the contacted farmers, the take-up rate among targeted farmers, and the productivity increases these farmers experience. Awareness about GAP practices is typically high after information campaigns, a result that holds in several settings and countries. It is therefore assumed that the awareness of the GAP practices will reach 90%, similar to that in previous studies (Carter, 2011; Jaramillo, 2012; Mkanthama, 2013). This number is likely to be lower than 100% as some farmers live in remote places or may be sick. They may therefore not show up, even though enforcement is high. Therefore, about 10%*90%=9% of farmers will be aware of GAP.

Second, a parameter is estimated for the fraction of farmers that successfully implement the practices presented in the workshop. Several studies have shown farmers that show up to information session and know about the new techniques do not always implement them (Mkanthama, 2013). Given the limited number of farmers to follow (about 175) and

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21 Or formulaic: Payoff = (Share farmers aware)X(Share farmers adopt)X(productivity increase)X(baseline production value).

22 The number 1750 refers to farmers with plots over 5 hectares. There are many more small farmers in Suriname, but they are not directly involved in the export sector. Therefore, disregarding the effect of GAP on exports for these farmers is reasonable.

the stringent framework of follow-up and inspection that is set up and supported by the investment loan, it is reasonable to assume the take-up rate will be on the order of 80-90%. This is in line with research that finds adoption rates of GAP are high when the program is mandatory rather than voluntary and the targeted farmers are part of a group or a specific program (Carter, 2011; UTZ, 2013). Taken together, these assumptions imply that farmers will use the new GAPs on 10%*90%*90% = 8.1% of hectares.

Third, and finally, it is assumed that productivity increases by about 10%. This number is in line with recent World Bank projects (World Bank, 2013)[23], although other studies have found estimates as high as 50% (UTZ, 2013).

These parameters are then plugged into an equation as follows:

$$Benefits = (Total\ Production) \times (\%_{targeted}) \times (\%_{aware}) \times (\%_{implementing}) \times (g_{GAP})$$

The production parameters are obtained from the LVV agricultural statistics. The % targeted is 10% as put forward by the food safety plan and budget. The % aware is set to 90% (as discussed above), leading to a 9% awareness. As the program is restrictive and tightly monitored, most farmers that are aware of the program will accurately implement the program. The % implementing is therefore set to 90%, following the literature discussed above. Finally, the productivity increase is set to 10%, following the literature discussed above.

Annex 5 presents an overview of the (quantified) benefits by year. This analysis estimates an Internal Rate of Return of the supported interventions of 154.81 percent. Assuming a capital cost of 12 percent, this is equivalent to a Net Present Value of SRD 88,493,836.60. Given that no health benefits or increased market access benefits are quantified, this estimate is considered to be very conservative.

### Animal Health

There is a vast body of literature estimating the economic costs of animal disease outbreaks, with studies focusing on the consequences of Foot and Mouth Disease (FMD) and Classic Swine Fever (CSF) being particularly common.[24] Much of this literature, however, focuses on the effects of such outbreaks in developed countries with highly developed agricultural sectors and significant meat export industries. Both epidemiological and economic factors which are relevant to estimate the economic consequences of disease outbreaks in such countries are very different from those

[23] See IMPLEMENTATION COMPLETION AND RESULTS REPORT (IDA -45180 TF -99702), November 2013, World Bank.

[24] See, for example, Junker, F., J. Komorowska and F. van Tongeren (2009), *"Impact of Animal Disease Outbreaks and Alternative Control Practices on Agricultural Markets and Trade: The case of FMD",* OECD Food, Agriculture and Fisheries Working Papers, No. 19, OECD Publishing. or
J.K. Niemi , H. Lehtonen a, K. Pietola a, T. Lyytikainen S. Raulo (2008) *Simulated financial losses of classical swine fever epidemics in the Finnish pig production sector*, Preventive Veterinary Medicine 84 (2008) 194–212

prevailing in Suriname, so that some estimates of the benefits of a modernized animal health regime in Suriname need to be necessarily based on assumptions made by experts in animal health with an extensive knowledge of the agricultural sector in Suriname. Table 6 below reports activities that were selected for investment. It is important to note all costs have been incorporated, but not all benefits have been quantified. All investment costs have been incorporated and the additional operating and management costs of hiring additional food inspectors were costed under the food safety component. Therefore, these costs represent a complete picture of the costs imposed by the investment program. Furthermore, Annex 4 contains a detailed breakdown of the costs and benefits for this subcomponent for every year the program is evaluated.

The poor monitoring of incoming pest carriers make these two areas important drivers for better animal health, and hence the target of investments. While several devastating pests have not entered the country yet (such as FMD and CSF), the Suriname climate provides an excellent environment for these pests. Monitoring of incoming plants is virtually non-existent at border posts or the Zanderij airport. The investment program focuses on diagnostic kits (for FMD, CSF, Newcastle Disease, and Bovine TB and Brucellosis) and performing simulation exercises to respond swiftly and efficiently to outbreaks of FMD, CSF and Avian Influenza (AI).

**Table 6:** Investments for Animal Health (AH)

| |
|---|
| Improving the Laboratory Capability for disease diagnosis<br>SRD 14,673,565.50 |
| Installing an integrated Information System<br>SRD 1,033,857.00 |
| Strengthening the Surveillance system<br>SRD 2,471,489.35 |
| Strengthening the Quarantine system<br>SRD 0.00 |
| Ensure a fully functional Animal Identification and Traceability System (AI&T)<br>SRD 1,146,523.40 |
| Trained staff able to support and fulfill the VS activities<br>SRD 292,050.00 |
| Performing Risk Analysis on frequent basis<br>SRD 253,110.00 |
| Setting an Early Detection and Emergency Response System<br>SRD 105,774.02 |
| Norms and regulations<br>SRD 257,653.00 |
| Evaluation of the level of competences<br>SRD 129,800.00 |
| Information and communication on animal health issues<br>SRD 681,450.00 |
| Accreditation system<br>SRD 259,600.00 |
| Manuals and protocols on GAP<br>SRD 0.00 |
| One third of the laboratory construction<br>SRD 3,028,666.67 |

Annex 2.B provides an overview of which investments generate benefits that are quantified, and which investments have benefits that are not quantified. The investment program primarily targets a faster response time to deal with outbreaks of diseases that are currently present in the country (such as Newcastle Disease) and a better screening and faster response time for diseases that are at risk of entering the country (such as CSF and FMD). Other components of the investment program, such as training staff, mainly serve to strengthen the effectiveness of these strategies. The benefits in this analysis will therefore primarily focus on a decrease in losses due to diseases currently in the country, and the decreased probability of absent diseases entering the country. While LVV keeps a list of 87 diseases that are not yet prevalent in the country, the diseases that the investments focus on are those that are expected to have the largest impact. Especially poultry is an important livestock, as its total production value is about five times that of beef and six times that of pork.

Table 7 provides a more complete picture of costs and benefits considered, and the benefits not quantified in this analysis. Health benefits are not quantified for reasons similar as those explained in the food safety section. As pointed out in the previous paragraph, several diseases are also not considered. However, the investments focus on the diseases that were identified as key threats by the experts. Additionally, since Suriname is not an exporter of meat, the effect of these investments on the possibility to become an exporter in the future have not been considered.

**Table 7:** Costs and Benefits used in analysis for animal health

| Costs | Benefits |
|---|---|
| • Investment in Lab, Information System, and Animal Tracking infrastructure.<br>• Strengthening of the surveillance and quarantine sytems<br>• Train staff and implement rapid response strategies.<br>• Drafting manuals and performing evaluations of current performance<br>• One third of the laboratory construction | • **Quantified**<br>• Decrease in the probability of Classic Swine Fever and Foot and Mouth Disease entering the country<br>• Decrease in the prevalence of Bovine Brucellosis and Tuberculosis.<br>• Decrease in the prevalence of Newcastle Disease and Gumboro Disease. |
| | • **Not quantified**<br>• Health benefits for humans in Suriname.<br>• Economic benefits from other diseases (such as Salmonella, Avian Influenza, etc.)<br>• Increase in weight of pigs<br>• Benefits of eradicating FMD and CSF:<br>There is a regional effort to eradicate FMD and CSF, so benefits from this collaboration are not included. Additionally, reaching FMD and CSF free status allows Suriname to impose restrictions on imported foods, something that they can not do for the moment. |

The investments focus on specific diseases that pose the largest threat to the Surinamese agricultural sectors, and these are therefore the diseases that are

considered in the economic analysis. In particular, the economic analysis focuses on Classic Swine Fever (which affects pigs), Foot and Mouth disease (FMD, which affects both pigs and cattle) and Newcastle disease and Gumboro Disease (that both affect poultry). Production statistics are obtained from LVV statistics. The parameters that govern the costs and benefits, such as the probabilities of diseases entering the country with and without the program, were obtained from actual tests or studies whenever available, and from interviews with Surinamese and international experts otherwise.

The following equation is used for the different evaluations in this section.

$$Total\ Benefits = (Value\ of\ Livestock) \times (PE_{with} - PE_{without}) \times D$$

In this equation, the value of the livestock depends both on the disease (e.g. Gumboro vs. Classic Swine Fever) and the product (e.g. meat vs. milk for cows). The $PE_x$ parameters refer to the probability of entry or prevalence with or without the program. The *D* parameter refers to the damage (measured in percent) of the disease. For all animal health cases, the damage of the disease is assumed to be unaffected by the program. The investment primarily target keeping diseases out (in the cases of FMD and CSF) or decreasing the prevalence (in the cases of Gumboro and Newcastle disease). The specific parameters used build on the literature and are discussed below.

The probabilities of entry of classic swine fever with and without the program were taken from the economic analysis of the SU-L1033 loan conducted in October 2013, after verifying these probabilities with key LVV personnel during visits to Suriname in June and October 2016. The mortality rate of 20% without vaccination follows international standards (the Center of Food Security and Public Health, 2015) and is therefore likely to be a lower bound estimate for the case of Suriname, given the limited infrastructure to curtail the disease effectively upon spreading.[25] Table 8 provides an overview of the assumptions for Classical Swine Fever.

[25] While Suriname does vaccinate swines, they only do so after diseases break out. The mortality rate therefore is better approximated under the no-vaccination assumption.

**Table 8:** Assumptions and sources for Classic Swine Fever

| Analysis component and Assumptions | Source |
|---|---|
| **Number of Swines**<br>• Growth rate of swine population: ≈ 5%<br>• Assumed growth rate of swine population in future: ≈ 5% | LVV statistics |
| **Swine market value statistics**<br>• Average weight (70.4 kg), cost of animal slaughtering (SRD 519.20)<br>• Market value (SRD 12.33 /kg) | SU-L1033 (IDB) economic impact assessment, verified by LVV experts during June 2016 mission |
| **Mortality rate:** 20% | The Center for Food Security and Public Health (2009) finds 20% to be a lower bound, with virulent strains of CSF causing mortality rates up to 100%. |
| **Probabilities of entrance**<br>• Without program: Low risk ($10^{-3}$ to $10^{-2}$). Set to $10^{-2}$<br>• With program: Very low risk ($10^{-5}$ to $10^{-4}$). Set to $10^{-4}$ | SU-L1033 (IDB) economic impact assessment, verified by LVV experts during June and October 2016 mission |

Table 9 below reports the assumptions and sources for Newcastle and Gumboro diseases. The prevalence for Newcastle Disease (ND) was found to be 60% following a survey conducted in Suriname in 2010.[26] This number is likely too high, as the test may show up positive both for infected and vaccinated animals. Suriname farmers vaccinate for ND, and animal health experts in Suriname feel Gumboro is a much more pressing and important disease. Therefore, the prevalence rate is set to 20%, which is lower than the prevalence rate of Gumboro, and is deemed a conservative estimate by the LVV experts.

ND affects the poultry weight and increases mortality rates, especially among younger chickens. This analysis only considers the effect of mortality, which has been found to be about 25% (Antipas et al, 2012). Farms that use better agricultural practices and use better management display a prevalence rate of Newcastle Disease that is 75 to 100% lower than farms that do not (Mtambo, 1999).[27] In order to obtain a conservative estimate, the decrease of Newcastle Disease prevalence is set to 50% of the original prevalence rate.

[26] Out of 1,040 samples, 664 tested positive for Newcastle Disease.

[27] This program – "Improving the Health and Productivity of the Rural Chickens in Africa" – consisted of testing the productivity of chicken rearing in Tanzania and specifically looked at infection rates between different management systems.

**Table 9:** Assumptions and sources for Newcastle Disease (ND) and Gumboro Disease (GD)

| Analysis component | Assumptions | Source |
|---|---|---|
| **Number of chickens** | 5,098,000 | LVV statistics |
| **Average weight for a chicken**<br>**Average price//kg for a chicken** | 1.76 kg<br>11.16 SRD/kg | LVV statistics |
| **Economic losses of ND** | 25% mortality rate | Mortality rates of Newcastle Disease can reach 100% (the Center for Food Security and Public Health); 20% is deemed a safe and conservative estimate by Surinamese experts. |
| **Economic losses of GD** | • 20% mortality<br>• Equal to mortality losses | Suriname agro-disease survey<br>Van den Berg et al, 2000; LVV expert opinion. |
| **Prevalence of Newcastle Disease without program** | 20.00 %<br>≈664 positives out of 1040 sera tested, but this is likely an overstatement. The numbers are adjusted downward after careful consideration with LVV animal health experts. | Suriname agro-disease survey |
| **Prevalence of Gumboro Disease without program** | 23.00% | Suriname agro-disease survey |
| **Effectiveness of the interventions** | • Newcastle Disease:<br>○ Decrease of prevalence by 50%<br>• Gumboro Disease:<br>○ Not yet considered | Mtambo (1999) find decreases in prevalence between 75 and 100% in similar farm settings (in Africa) that can be ascribed to different management systems. |

Gumboro disease affects poultry and can cause substantial economic losses (van den Berg et al, 2000). Recurrent outbreaks lead to higher economic losses (Musa et al, 2012) so performing more in-depth diagnostics in Suriname in the future can shed more light on the severity of the prevalence of Gumboro. For now, the economic analysis bases its estimates on the 2010 Suriname survey discussed above and literature on the economic losses of Gumboro. The prevalence of Gumboro is 23% following that same 2010 Suriname Survey. Gumboro affects the poultry population mainly through a mortality rate and the survey shows a mortality rate of about 20% among Suriname farmers, which is close to that found in more rigorous studies (Farooq et al, 2003).[28] The economic losses are set equal to the losses of mortality. According to the literature, economic losses are typically more important than direct losses due to mortality (van den Berg, 2000) and also LVV expert Ms. Karg agreed this number constitutes a safe lower bound. However, the precise magnitude of these economic losses is hard to quantify, since Gumboro has a wide range of pernicious consequences.[29] No growth rate on the chicken population is assumed, as their population level is relatively constant.

[28] To be specific, mortality was larger than 15% in 84% of farms, while it was 10-15% in the remaining 16% farms.

[29] As the LVV expert Ms. Karg pointed out, chickens that survive Gumboro need additional vaccinations, are less productive afterwards, more susceptible to disease, among other things.

Foot and Mouth Disease (FMD) may seem less important in terms of direct economic impact, as the production of cows is substantially lower than that of chickens. Yet, this part of the Animal Health investment plan is important as there is a regional effort to eradicate this disease, and it may allow Suriname to impose stricter restrictions on the import of contaminated meats. Estimating the probability of FMD entering Suriname with and without the program was done by following a (simplified) method discussed in Astudillo, Sutmoller, Sarah and López (1997). The probability of importing FMD is broken up into the probabilities of key events and these are then multiplied. The analysis simplifies this model by only estimating two probabilities: the probability that imported meat contains FMD, and the probability the contaminated food is caught during the monitoring. [30] Since there is currently no screening, the probability of contaminated food passing screening without the program is set to 100%. The probability of importing contaminated meat is set to 0.5% following Sutmoller and Wralhsll (1995). The probability of catching contaminated food through monitoring (once a screening system is in place) is set to 12.5%. Typically, devices are much more effective – up to 100% - but the effectiveness is set this low for caution reasons (see, e.g., Niedbalski 2005, Longjam et al 2011). Experts feel this hit rate is an underestimate of the effectiveness of monitoring under the proposed program. I assume FMD impact the existing livestock through an increase in mortality rate. However, since the mortality rate is typically low, it is set to 5% (Arzt et al, 2010).[31] Table 10 provides an overview of the assumptions and sources of information.

**Table 10: Assumptions and sources for Foot and Mouth Disease (FMD)**

| Analysis component | Assumptions | Source |
|---|---|---|
| **Number of cattle (beef and milk) and pigs (see CBA Excel spreadsheet)** | | LVV statistics |
| **Average weight and prices for swine (see Table 8)** | | SU-L1033 (IDB) economic analysis, verified by LVV experts during June 2016 mission. |
| **Cattle market value statistics**<br>• Average weight (178 kg), farmgate price of beef (SRD 3.24/kg)<br>• Milk production ≈ 4 million litres SRD 17.52 million<br>• Cost per liter milk: 3 SRD | | SU-L1033 (IDB) economic anasysis, verified by LVV experts during June 2016 mission<br>Animal Health Document |
| **Probability of importing tainted meat** | 0.50% | Sutmoller and Wralhsll (1995) |
| **Infection rate** | 30.00% | Animal Health Document |
| **Mortality rate (pigs)** | 5.00% | Arzt et al (2010) |
| **Loss Milk production (cows)** | 80% | Ruston et al (2012) |
| **Indirect Costs (cows)** | Twice milk losses | Ruston et al (2012) |
| **Probability of catching tainted meat**<br>• Without program<br>• With program | <br>100%<br>12.5% | Niedbalski 2005, Longjam et al (2011). Verified by technical consultants. |

The investments supported by the IDB Investment Loan include important improvements in the infrastructure and services related to animal health. Increased capability for surveillance, quarantine, and diagnostics will lead to important decreases in the probability of importing CSF and FMD. Additionally, current diseases that affect poultry –

[30] To be more precise, P(import FMD) = P(import infected meat) X [1 - P(caught at entry)]. The first probability is set to the prevalence rate of FMD infection in meat in the region meat is imported from. The second probability can change as Suriname changes its monitoring and animal health policies.

[31] Other productivity losses that result from FMD comorbidity (such as milk production, livestock growth rates, and international trade repercussions) are not taken into account into this analysis, even though these can typically be sizeable and important (Knigh-Jones and Rushton, 2013).

the most important source of protein in the country and production value in livestock – such as Gumboro and Newcastle Disease will be better monitored and controlled, leading to substantial loss reductions.

Annex 6 presents an overview of the (quantified) benefits by year. Overall, this yields an IRR of 59.85 percent for this subcomponent, which is equivalent to a Net Present Value of SRD 27,924,657.00. Similarly as before, the exclusion of several important benefits makes this a lower bound estimate.

### Plant health services

As with animal health services, Suriname's plant health service regime is in need of important investments in its infrastructure and human resource capabilities in order to be able to comply with international standards and to ensure the protection of its agricultural sector from harmful pests. This is particularly important in the case of Suriname, as it is – for now – still free of some important pests, such as Panama Disease Tropical Race 4 (PDR4), Medfly, Citrus greening, khapra beetle, and the Giant African Snail (GAS).

Inaction is very likely to lead to the introduction of such diseases for two major reasons. First, there is virtually no monitoring at the airport of Zanderij where visitors arrive from Brazil (where GAS, medfly and citrus greening are ubiquitous), and they bring in fruits and plants. Furthermore, biweekly flights are scheduled to Barbados and Trinidad, where GAS is pervasive and has severely affected plant health there (Paliwal et al, 2006). Citrus Greening and medfly are also reported in other countries in the Caribbean, and therefore the citrus production in Suriname is also at risk under low monitoring practices. In fact, Suriname has a climate and natural setting that is highly susceptible for GAS (see, e.g., Vogler et al 2013), and several trade and travel activities within Suriname that makes it very vulnerable to an introduction of Khapra beetle and PDR4.[32]

While Khapra beetle and PDR4 are not introduced in the Caribbean as of yet, the region is on high alert for these diseases: the threat factor of PDR4 being introduced in the Caribbean is about 80%, and is forecasted to have devastating economic consequences (Ploetz, 2009). PDR4 affects the Cavendish banana, which is widely grown in the Caribbean region. Furthermore, several people come into Suriname from Indonesia, where the disease has broken out, and anecdotal evidence highlighted that several young Indonesian men are employed in the Saramacca plantations, where most banana plantations are located.

[32] In particular, the plant health consultant pointed out that Panama disease race 4 is present in Indonesia. There are direct flights between Suriname and Indonesia, and Indonesians do work on the banana plantations in Suriname, highlight the possible risk. Similarly, rice imports and exports from regions where the Khapra beetle is a threat occur in Suriname, and pose a threat as screening for these small bugs is very difficult.

**Table 11:** Investments for Plant Health (PH)

| |
|---|
| Establishing SPS control at the borders for effective regulation of imports<br>SRD 2,840,997.50 |
| Strengthening import regulation and procedures to minimize risk associated with imported commodities and movement of people<br>SRD 1,265,550.00 |
| Strengthening export certification to bolster exports, access and maintain markets<br>SRD 1,298,000.00 |
| Establishing and institutionalizing a pest surveillance program to deal with the priorities identified in the related policy paper as well as emerging issues<br>SRD 1,947,000.00 |
| Establishing a diagnostic plant health diagnostic laboratory to provide timely diagnosis with a high degree of confidence to support the selection and application of phytosanitary measures. The superstructure has already been constructed but needs to be equipped and made functional<br>SRD 1,947,000.00 |
| Establishing an area of low pest prevalence against fruit flies as a pilot program that may lead to further exploitation of the measure to boost exports and food substitution<br>SRD 889,130.00 |
| Human Resources development for effective action at all levels of the organization<br>SRD 1,791,240.00 |
| Establishing capability for independent and credible certification of rice quality within the laboratory complex as falls within the mandate of the NPPO<br>SRD 259,600.00 |
| Establishing a Pesticides Management System that regulates import distribution, use, storage, and disposal of chemicals used in plant health, animal health, and human health<br>SRD 1,298,000.00 |
| Manuals, SOPs, guides, videos, books<br>SRD 1,479,720.00 |
| SDPS Information Management System<br>SRD 0.00 (These costs are reported under animal health) |
| One third of the laboratory construction<br>SRD 3,028,666.67 |

The IDB supports LVV in upgrading its infrastructure and human resource capabilities through an investment loan, so that it can target these dangers to plant health. Annex 2.C provides an overview of which investment generate quantifiable benefits, and which investments have benefits that are not quantified in this analysis. The loan focuses on setting up an institutional framework, and establishing a low pest prevalence zone for fruit flies and citrus fruits. The benefits to these investments are hard to quantify, since it is unclear what impact the two minor projects would have on the large-scale production of citrus fruits and rice production.[33] Similarly, productivity increases of better pest management would require many assumptions, so benefits are not quantified.

Finally, several pests (such as Moko disease, tomato borer, and fruit flies) are currently present in Suriname. Moko has broken out at the FAI plantation in Samaracca, and even

[33] For instance, the rice quality is mainly expected to decrease the loss of fixed costs of sending out faulty rice exports. A testing lab in Nickerie will test rice before sending it off, so some of these fixed costs are not lost. Quantifying these numbers is difficult without more precise information on the use and effectiveness of the rice testing capabilities of the Nickerie lab.

though this private investor is expected to carry the cost of eradicating it from its plantation, there are some worries Moko spills over to local smaller farmers that may not be able and willing to carry the substantial costs of eradicating the diseases. While Tomato borer was associated with losses of up to 40 to 50% upon entry in Suriname in 2002-2003, the disease is now relatively well managed and controlled, and therefore does not present a big cost to the agricultural sector of Suriname and therefore is also not a key disease considered for the investment plan.

The key benefits that are considered, therefore, are the benefits of keeping out four important pests mentioned above: Giant African Snail, Panama Disease Race 4, and Medfly. While Khapra Beetle is a disease for which the region is also on high alert and Citrus Greening is prevalent in neighboring countries, there are no studies available to credibly estimate the probability of disease introduction and costs. Therefore, the benefits of the investments in keeping out Khapra beetle are not quantified, even though they are expected to be important. Additionally, the benefits for the Low Pest Prevalence zone of fruit flies are hard to quantify. The importance of this zone for future exports of citrus fruits cannot be underestimated. However, the ability to export citrus hinges on the successful implementation of various activities included in this plan and supposes a sufficiently large production. Benefits associated to this activitity are therefore also not quantified.[34]

Table 11 provides an overview of the different investment proposed. All investment costs have been incorporated and the additional operating and management costs of hiring additional food inspectors were costed under the food safety component. Therefore, these costs represent a complete picture of the costs imposed by the investment program. Furthermore, Annex 4 contains a detailed breakdown of the costs and benefits for this subcomponent for every year the program is evaluated.

The strengthening of lab diagnostics, SPS border control, and surveillance programs provide effective ways in which important costs associated to the introduction of these pests could be minimized. Table 12 provides an overview of the costs and benefits that are included into this part of the analysis.

[34] Nevertheless, it is worth noting that there is a shortage of citrus fruits in the region, so the prospect of generating enough citrus production that can be exported could have substantial benefits.

**Table 12:** Costs and benefits used in analysis for plant health

| Costs | Benefits |
|---|---|
| • Institutional strengthening<br>• Citrus and rice quality measures<br>• SPS control costs: infrastructure and personnel costs<br>• Strengthening of import regulation and pest surveillance<br>• Diagnostic capabilities of laboratory<br>• Pest management<br>• One third of the laboratory construction | • **Quantified**<br>• Reduction of risk of outbreak of:<br>○ Giant African Snail<br>○ Panama Disease Race 4<br>○ Citrus Greening<br>○ Medfly |
| | • **Not Quantified**<br>○ The export costs will decrease, as the rice quality center can check the quality of rice before exporting.<br>○ Long term effects of Low Pest Prevalence Zone<br>○ Health benefits<br>○ Khapra beetle |

The equation and formula used to evaluate the effectiveness of the plant health programs is as follows.

$$Total\ Benefits = (PE_{with} - PE_{without}) \times \{(Total\ Value) \times D + IC + FC\}$$

In this equation, the total value depends on the disease (e.g. the total value of banana production when considering Panama Disease Race 4). The $PE_x$ parameters refer to the probability of entry or prevalence with or without the program. The *D* parameter refers to the immediate damage (measured in percent) of the disease, typically measured in percentage of crops lost. *IC* and *FC* stands for immediate and future costs respectively. Different than with animal health, the immediate costs (crops lost) do not include immediate and future monitoring and management costs. For instance, dealing with the Giant African Snail entails important costs to monitor, track and destroy the Giant African Snail. Similarly, as a recent episode of Moko disease at the FAI plantation showed, there are important management costs that are incurred when banana plantations are hit with a disease. These future costs are measured using the following equation.

$$IC + FC = Immediate\ Cost + \sum_{t=1}^{T} \frac{Costs\ in\ time\ t}{(1.12)^t}$$

In this equation, immediate costs and costs in time *t* are calculated either from literature or case studies (e.g. an outbreak of Moko disease at the FAI banana plantation, or the Giant African Snail outbreak in Barbados). Future costs, however, need to be discounted by the relevant cost of capital, which the IDB typically sets to 12%. Therefore, this adjustment is made.

The assumptions for the Giant African Snail (GAS) are reported below in table 13. These parameters build on those obtained during the 2013 mission for the SU-L1033 economic analysis, and were verified during the mission in October 2016. Both the introduction

probabilities and costs of contrasting Giant African Snail have been updated. The introduction rates are provided by experts at LVV, while the cost estimates are obtained through the timing and budget costs Barbados incurred when fighting a GAS outbreak.[35] The introduction rates are provided for a 10-year period. The costs include a six-year recurring monitoring cost once the pest is introduced ($300,000) and a fixed cost in the very first year to set up the program and contrast the initial outbreak ($750,000). In order to obtain the expected cost of dealing with GAS in any given year, the costs should therefore include the full stream of costs. This number is obtained by projecting the start-up and recurring fees into the future for the number of years it takes to control the disease (in this case about six). This flow of costs is then discounted by using the assumed cost of capital (12%), providing a single number that serves as an estimate for the entire cost of the program. This cost is about $ 1.1 million, which is very close to the Barbados experience and therefore serves as a reasonable estimate.

**Table 13:** Assumptions and sources for Giant African Snail (GAS)

| Analysis component | Assumptions | Source |
|---|---|---|
| **Value of production of tuber and vegetables (see CBA Excel spreadsheet)** | | LVV statistics |
| **Probability of introduction of GAS in Suriname**<br>• Without program: 65% (over 10 years), 10% (any given year)<br>• With program: 45% (over 10 years), 5.80% (any given year) | | SU-L1033 (IDB) economic analysis, verified by LVV experts during June 2016 mission |
| **Cost to production** | 15% of output | SU-L1033 (IDB) economic analysis, verified by LVV experts during June 2016 mission.<br>Cost parameters obtained from actual data from a GAS fighting program in Barbados. |
| **Time required to control GAS outbreak** | >5 years (set to 6) | |
| **Annual cost controlling GAS** | SRD 5,857,500.00 | |
| **Annual cost of monitoring and surveillance once GAS is introduced** | SRD 1,947,000.00 | |

For Latin America and the Caribbean as a whole, however, the probability of introduction (either through accidental route or bioterrorism) has been estimated to be well over 80%. While Suriname may be small in terms of trade flows, those trade flows do pose risks (Ploetz, 2009). People fly regularly in from the Philippines, where the disease was introduced, and monitoring at the airport, as stated before, does not happen. Furthermore, monitoring for the introduction of bananas is not enough, as disease agents may be carried over by boots. The fact that several Philippine workers work on plantations in the Saramacca region, where bananas are grown, are therefore worrying.

The assumptions for the Panama Disease Race 4 (PDR4) are reported below in Table 14. These parameters build on studies discussed below, since no preventive plans or estimates so far have been set up at LVV. The introduction of PDR4 without the program in Suriname is set to 60% over 10 years. This is close to the Caribbean-wide estimates in Ploetz (2009), but adjusted downwards given the somewhat smaller trade flows towards Suriname.[36] The risk of introduction with the investments is set to 40%. While

[35] See Annex 2.

[36] For instance, many other diseases that have been introduced in the region seem to not have made it to Suriname.

this number is high, it is important to highlight the risk of this disease is high and the probability of keeping it out will depend in important ways on a regional approach. Additionally, recent research has shown the recent outbreaks across all countries are the result of one single clone of the Fusarium wilt fungus, highlighting that this particular clone has been able to infest many different countries (Ordonez et al, 2015).

The disease is regarded as a major risk that may wipe out the entire Cavendish production (FAO). Cost estimates from Asia are used (Xu et al, 2011), as this region has experience with the disease. The disease has not yet been introduced to the Caribbean region or Latin America, and therefore closer estimates cannot be obtained. Local LVV experts estimate the probability of introduction to be similar to that of the Giant African Snail, but somewhat lower as the disease has not yet been reported in the region. The probability of introduction is about 60% over 10 years in absence of a program, and is lowered to about 40% over 10 years with the investments proposed. This implies the program decreases the probability of introduction in any given year by about 3 percentage points, which is considered conservative.

In terms of losses, Xu et al (2011) find the yield losses of PDR4 to be in the range of 3% to 60%. While losses can be on the higher side, this analysis takes a conservative approach and sets the fraction of revenues and planted area lost to 20% in the year of the outbreak. This number is close to the losses incurred by FAI, a Surinamese banana producer, in 2014 at the height of a Moko outbreak.[37]

Additionally, the analysis assumes replanting and management efforts bring production back to full capacity 3 years after the outbreak. The years after the disease outbreak, the losses in terms of revenues and hectares are about 2% as replanting and monitoring efforts are underway.[38] This is similar to the time it took to control the Moko disease at the FAI plantation, and is deemed a reasonable assumption by LVV experts.

In order to estimate the costs of dealing with the disease control and replanting, statistics on a recent Moko disease outbreak are used (see Annex 4). In particular, replanting and control costs of SRD 20,469.46 and SRD 43,067.64 per hectare respectively.

[37] In particular, of the 1,200 ha of planted area, about 300 ha (or about 20% to 25% of the total planted area) was under Moko management.

[38] This is consistent with the numbers provided by FAI. Most of the lost revenues (about 80 to 90%) are incurred in the first year (USD 8,716,341 or SRD 56,569,053.09 in 2014 and USD 10,195,646 or SRD 66,169,742.54 in 2016). This is consistent with the costs in year 2 being around 25% of those costs incurred in year 1.

**Table 14:** Assumptions and sources for Panama Disease Race 4 (PDR4)

| Analysis component | Assumptions | Source |
|---|---|---|
| **Value of production of banana production (see CBA Excel spreadsheet)** | | LVV statistics |
| **Probability of introduction of PDR4 in Suriname**<br>• Without program: 60% (over 10 years), 8.75% (any given year)<br>• With program: 40% (over 10 years), 5% (any given year) | | LVV experts, Ordonez et al (2015) |
| **Cost to production**<br>• Time required to control PDR4 outbreak: 3 years<br>• Loss of hectares and revenues: 20%<br>• Replanting costs: SRD 20,469.46 / ha<br>• Costs of Moko control (not replanting): SRD 43,067.64 / ha | | FAI statistics and costs resulting from Moko outbreak in 2014<br>Xu et al (2011) |

The assumptions for Medfly are reported below in Table 15. While the country is on lower alert for fruit flies, experts highlight Medfly is an important disease that would affect citrus fruits that so far have not been attacked by other fruit flies. The parameters in table 15 were obtained during the 2013 mission for the SU-L1033 economic analysis, and verified during the mission in October 2016.

**Table 15:** Assumptions and sources for Medfly

| Analysis component | Assumptions | Source |
|---|---|---|
| **Value of production of citrus and bell pepper (see CBA Excel spreadsheet)** | | LVV statistics |
| **Probability of introduction of Medfly in Suriname**<br>• Without program: 90% (over 10 years), 21% (any given year)<br>• With program: 40% (over 10 years), 5% (any given year) | | SU-L1033 (IDB) economic analysis, verified by LVV experts during October 2016 mission |
| **Cost to production** | 10% of output | SU-L1033 (IDB) economic analysis, verified by LVV experts during October 2016 mission |
| **Time required to control Medfly outbreak** | 2 years | |
| **Annual cost controlling Medfly** | SRD 6.49 million | |
| **Annual cost of monitoring and surveillance once Medfly is introduced** | SRD 1,298,,000 | |

Annex 7 presents an overview of the (quantified) benefits by year. Taken together, these cost and benefit streams yield an IRR of 39.13% percent for the plant health subcomponent, with a NPV of SRD 7,513,410.79 assuming the capital cost of 12%. It is worth noting several plant diseases were not considered in the analysis. Similar to the animal health component, the poor monitoring and management practices currently in place in Suriname are expected to lead to a significant improvement in plant health.

### Investment in Agricultural Innovation (AI)

Agricultural research and its application to production processes, agricultural innovation, are two of the main drivers of agricultural productivity growth. Meta-studies report that returns to these activities are typically large and positive (Huffman and Evenson, 2006;

Alston & Pardey et al., 2014; Jin y Huffman, 2016[39]). The marginal real rate of return is approximately 50% (Huffman 2010; Huffman and Evenson 2006a,b). Alston et al. (2010) calculate that the benefit-cost ratio from investing in public agricultural research and extension is about 32. While these findings are based on studies with a focus on the United States, Alston et al. (2000) show that these high returns also seem to hold true for many other regions, such as Africa, Asia and Latin America. In a review of analytical work on the economics of agricultural R&D, Alston et al. report: "A key general finding is that the social rate of return to investments in agricultural R&D has been generally high."[40]

The IDB investment loan supports innovation projects that aim at improving the product and seed mix to the Suriname climate, and update outdated plants and trees in order to increase productivity and yields. The projects that are planned as part of the innovation component are reported in table 16. Furthermore, Annex 4 contains a detailed breakdown of the costs and benefits for this component for every year the program is evaluated.

**Table 16:** Investment components of the investment loan for Innovation

| |
|---|
| Strengthening of the rice sector by better controlling weeds, pests and diseases<br>SRD 9,947,637.71 |
| Strengthening of open-field vegetable production<br>SRD 4,878,159.06 |
| Strengthening of protected vegetable production<br>SRD 4,051,373.58 |
| Strengthening of citrus production<br>SRD 3,969,231.76 |
| Strengthening of minor fruit production, i.e., passion fruit, pineapple and soursop<br>SRD 4,713,653.20 |
| Institutional capacity building<br>SRD 4,142,875.28 |
| Funding window for small agricultural innovation projects<br>SRD 6,757,631.38 |
| Cluster Laboratory<br>SRD 7,139,000.00 |

Annex 2.D provides an overview of which investments generate quantifiable benefits, and which investments have benefits that are not quantified. The first five subcomponents plan to perform research to find agricultural practices (such as improved pesticide use) or improved seed mixes that match the Surinamese climate, providing more cost-effective ways (in the case of improved pesticide use) or productive ways (in the case of better seed mixes) for farmers to grow certain crops. It is difficult to precisely predict the success of these innovation projects. Therefore, the suggested productivity increases or costs decreases are compared to empirical literature that has evaluated

[39] Jin and Huffman, Measuring Public Agricultural Research and Extension and Estimating their Impacts on Agricultural Productivity: New Insights from US Evidence

[40] The Economics of Agricultural R&D, Julian M. Alston, Philip G. Pardey, Jennifer S. James, and Matthew A. Andersen, Annual Review of Resource Economics · October 2009

similar innovation projects. This ensures that the projected benefits are reasonable in light of the current evidence. Whenever possible, the empirical evidence is based on experimental trials. For most products, studies providing experimental evidence were found.

There are also plans to disseminate Good Agricultural Practices (GAP). It is worth noting that this differs from the GAP awareness campaign considered in the Food Safety (FS) subcomponent. The FS campaign targeted large producers that tend to export; these represent about 10% of farmers. For these farmers, new agricultural practices were mandatory to adopt.

The innovation program also focuses on Good Agricultural Practices. However, rather than being mandatory and focused on large producers, this project is voluntary and targets both large and small producers. It tends to do so by informing these producers on the outcomes of the experimentation projects. As voluntary campaigns typically have low adoption rates – despite high awareness – the benefits are not quantified, making this analysis conservative (Carter, 2011; Mkanthana, 2013).

As a recent FAO survey (2010) points out, good or smart agricultural practices may increase production costs, by increasing the quality or quantity of inputs. It is important to note, however, that current practices in Suriname are typically related to *overuse* of inputs and poor crop rotation. For instance, many farmers in Suriname use too much pesticides on their crops, resulting in agricultural products of inferior quality, both because the overuse of pesticide has immediate negative effects on the quality of the product, but also because the overuse of pesticide worsens the quality of the soil. Furthermore, innovations such as hybrid seeds tends to decrease the usage of seeds as the match quality between the soil and the seed has improved. The innovation component, for instance, highlights that the productivity increases for rice innovation stem from reduction in yield losses and pesticide expenditures. Therefore, most good agricultural practices in this section imply that farmers may, if anything, spend less on inputs. The innovation expert on this project agrees with this view.

Nevertheless, to make the analysis conservative, an estimate for additional labor, operation and maintenance costs are added to the innovation components open field vegetables, citrus, minor fruits, and protected agriculture.[41] The innovation expert seemed to find it reasonable to assume there might be an increase here, but no specific estimates could be provided. Therefore, these costs are estimated in two steps. First, it is assumed that in years where there is no yield or productivity increase, there are no additional inputs for farmers. This is not a strong assumptions: as the innovation document highlights, the first years are considered experimentation phases in which the

[41] It is important to highlight here that the productivity increases from rice innovations stem from improved use of pesticides and reductions in yield losses net of additional labor. Additionally, the funding window and institutional capacity building do not impose additional costs to farmers. Therefore, these additional input cost assumptions only apply to these four innovation projects.

investment plan is followed and used to find successful innovations. Second, in years in which there is a return to innovation, it is assumed that farmers incur additional costs (labor, maintenance and operational). These costs can be incurred in terms of opportunity costs (learning about the new methodology, tailoring the new methodology to the farmer's specific farmer or production technology) or costs of additional inputs. Rather than estimating these separately, it is assumed these costs combined amount to 5% of the production value of the crop of interest. This number is taken from studies estimating these costs for implementation costs of new production methods in Morocco and Thailand (Manarungsan et al, 2004; Aloui and Kenny, 2004). These studies focus not only on additional labor costs, but also additional operational and maintenance costs, making these studies ideal for parameter estimation. These costs in these studies are typically estimated at about 1 to 3%, making the 5% estimate proposed in this analysis conservative. Additionally, as productivity increases are expected to come from better use of soil and more efficient (and decreased) use of pesticides, this parameter is set relatively high and conservatively.

The final two projects will use estimates from meta-studies, and apply these returns to the investments planned. Meta-studies provide more reliable estimates for the broad investments of these two projects. Table 17 provides an overview of the benefits and costs considered in this part of the analysis, as well as an overview of the benefits that are not quantified. It is important to stress that the cluster laboratory, at a cost of SRD 7,319,000.00, is included in the analysis. Therefore, all costs related to the innovation component have been taken into account.

**Table 17:** Costs and benefits used in analysis for plant health

| Costs | Benefits |
|---|---|
| • Institutional strengthening<br>• Costs of setting up the research projects<br>• Costs of reaching farmers and providing the information in a useable format<br>• Costs associated with GAP awareness campaigns<br>• Additional input costs as a result of GAP<br>• Cluster Laboratory | • **Quantified**<br>• Productivity increases following research and experimentation for:<br>  ○ Vegetables<br>  ○ Citrus fruits<br>  ○ Other fruits (such as passion fruit)<br>  ○ Rice<br>• Returns to open funding window and institutional strengthening<br>• Make Suriname's agriculture more resilient to weather and climate shocks. |
| | • **Not Quantified**<br>  ○ Adoption of GAP by smaller farmers, leading to higher productivity among these non-adopting farmers. |

Table 18 reports the parameters that are used for the estimation of the benefits of this component. For the first five projects, each innovation hinges on two crucial parameters. The first parameter is a realistic estimate of the increased productivity the research project can provide. For this, several studies are available that look at experimental

programs and adaptive experimentation studies that report yield increases. For instance, for the first project (Strengthening of the rice sector by better controlling weeds, pests and diseases), studies on innovative rice growing techniques have been used. The second parameter is a realistic estimate of the dissemination of this agricultural innovation that indicates the fraction of farmers that will actually be reached and will adopt the new techniques.

The technical note provided by the consultant who designed the innovation component provides information on the expected returns and dissemination. By comparing this to the literature, it is possible to verify whether these estimates are realistic. The dissemination parameter provided by the consultant makes assumptions about both the timing and the success rate of the dissemination. It was verified whether these dissemination rates were reasonable, by verifying these numbers with LVV experts. In particular, they were compared to memberships of farmers to cooperatives, since farming groups are important for the adoption of new techniques (Carter, 2011; Prawiranegara, 2015).

The productivity increase for rice production is expected to reach five percent, and this value is expected to be achieved linearly over five years. These productivity increases are in line with studies on rice research. Studies that are based on credible, adaptive experimentation methods have typically found the return on rice research to range in the order of 10% to 60% (Balasubramanian et al, 1999; Chang et al, 2016; Dhital, 2011; Valdez and Fernandez, 2008; Virmani et al, 1991). These studies focus on a variety of research options, such as using better fertilizer, hybrid seeds, or good agricultural practices in growing and maintaining the crops. The consultant assumes that, over time, productivity is expected to increase to about 10% as the result of research. However, limited dissemination of maximum 50% reduces this to an effective 5% productivity increase. Local experts were of the opinion at least 50% (and likely more) of the farmers get in contact with farmer cooperatives for rice, making the dissemination parameter reasonable.

For open field vegetables, planting density, quality of seeds and effective use of proper pesticides can increase productivity substantially, as highlighted by various experimental studies that show returns of about 15% to 60% for plants such as French beans, cucumbers or eggplant (Idowu et al, 2014; Shaheb et al, 2015; Staub et al, 1992). For protected vegetable production, numbers are typically comparable, and, if anything, slightly higher (Elwan and El-Hamahmy, 2009). The consultant assumes the return to research for vegetables typically increases productivity by about 10 % to 30%. If research activities are as successful in the studies surveyed, this assumes about 50% of farmers end up adopting these techniques, which is again in line with the expectations of LVV experts.

Research on citrus growing, for instance by changing the rootstock, has typically found fairly large returns of about 60% (Economides and Gregoriou, 1993; Wheaton et al,

1991). Results for minor fruits, such as pineapple, are typically in the same range when looking at the literature (Ajayi et al, 2016). As before, the dissemination that is expected falls within the expectations of LVV experts.

The returns to the final two projects are estimated using a meta-study that provides specific returns to innovation in the Latin American and Caribbean (LAC) region (Evenson, 2000). The return is set to the median return for this region, which is 44%. Alston et al. (2000) provide a similar number of 42.9%, highlighting that the return to these investment is indeed quite high in the region.

**Table 18:** Rates of return and dissemination of agricultural innovation

| **Analysis component and Assumptions** | **Source** |
|---|---|
| **Returns of specific crop innovation projects** | |
| • Rice<br>  ○ Productivity increase: linearly from 0 to 5% increase over 6 years<br>  0/1/2/3/4% in year 1/2/3/4/5; 5% beyond year 5 | Chang et al, 2016; Dhital, 2011; Valdez and Fernandez, 2008; Virmani et al, 1991; FAO, 1999 |
| ○ Vegetables Productivity increase long yard bean: 0/0/5/10/15% in year 1/2/3/4/5; 30% beyond year 5<br>○ Productivity increase bitter gourd: 0/0/4/8/12% in year 1/2/3/4/5; 20% beyond year 5<br>○ Productivity increase okra: 0/0/3/6/9% in year 1/2/3/4/5; 15% beyond year 5<br>○ Productivity increase tomatoes: 0/0/5/10/15% in year 1/2/3/4/5; 30% beyond year 5<br>○ Productivity increase chili peppers: 0/0/2/6/8% in year 1/2/3/4/5; 10% beyond year 5<br>○ Productivity increase eggplant: 0/0/4/8/12% in year 1/2/3/4/5; 20% beyond year 5<br>○ Productivity increase sweet potato: 0/0/5/10/15% in year 1/2/3/4/5; 30% beyond year 5<br>• Additional inputs cost: 5% | Staub et al, 1992<br>Elwan and El-Hamahmy, 2009<br>Idowu et al, 2014<br>Shaheb et al, 2015 |
| ○ Minor fruit Productivity increase pineapple: 0/5/10/15/20% in year 1/2/3/4/5; 25% beyond year 5<br>○ Productivity increase passion fruit: 0/0/5/10/15% in year 1/2/3/4/5; 30% beyond year 5<br>• Additional inputs cost: 5% | Ajayi et al, 2016 |
| ○ Citrus fruit Productivity increase oranges: 0/0/5/10/15% in year 1/2/3/4/5; 30% beyond year 5<br>• Additional inputs cost: 5% | Economides and Gregoriou, 1993<br>Wheaton et al, 1991 |
| **Rate of return to agricultural institutional innovation Use for both open window and institutional strengthening**<br>• Latin America: 44% | Evenson (2000) |

Annex 8 presents an overview of the (quantified) benefits by year. Taken together, these costs and benefits streams yield a NPV of SRD 59,072,368.88 which translates into an IRR of 42.19%.

### Combining all results

Combining all the results from Food Safety, Animal Health, Plant Health, and Innovation investments yields a NPV of SRD 183,004,273.28 assuming a capital cost of 12%. The overall IRR of the investment plan is 64.17%.

### Context of results

Rather than overestimating the benefits (or underestimating the costs) of the different interventions of the program, this analysis has taken a conservative approach and been cautious when estimating benefits. In order to provide information on the different factors that explain the conservative nature of the estimates of the returns, Table 19 provides an overview (by component) of which assumptions make this analysis a conservative one.

**Table 19:** Overview by component of why benefit estimates are conservative

| **Component** | | **Assumption** |
|---|---|---|
| *Food Safety* | Decrease in rejection rates | The analysis uses the average rejection rates for rice, fish and fruits and vegetables for low-income countries. However, looking at actual data from Netherlands import data, these estimates are conservative. |
| | Effectiveness of program | The decrease in rejection rates is estimated from a case study (real data) from Jamaica, where a similar program was instituted in 2010. Instead of applying the instantaneous effect that was found in Jamaica, it is assumed the effect only phases in over 3 years. |
| | GAP | About 10% of farmers are targeted. Even though these likely account for a larger fraction of hectares, the analysis assumes this translates into 10% of hectares being targeted. |
| | Other | Four important domestic consequences of improved food safety are not factored in.<br>• The first is the lower domestic rejection rates (e.g. at the local market) and quality improvements of the products.<br>• A second is improvements of public health and productivity increases as a result of better health as a result of improved food safety. While hard to quantify, studies suggest these effects tend to be large and important (Karunasagar, 2008)<br>• Increased market access: as food safety increases, Suriname will be able to export to more markets. While possibly important, these effects are hard to credibly quantify *ex ante* and therefore not included.<br>• Increase in export of bananas. |
| *Animal Health* | Classic Swine Fever | Mortality assumed at 20%, which is a low number according to the literature. |
| | Newcastle Disease | Effect of higher mortality among young chickens not included, since modeling the age profile of the chicken population is beyond the scope of this analysis. Mortality rates of 20% are deemed a |

| | | |
|---|---|---|
| | | conservative estimate. Effectiveness of the program has generally been found to be larger than the assumed 50% (between 75 and 100% in some studies).<br>Even though 60% of sera tests positive for Newcastle Disease, these tests may also be picking up the fact that Suriname farmers actually vaccinate for this disease. After careful consideration with several animal health experts in Suriname, the prevalence rate is set to 15%, likely a lower bound. |
| | Gumboro | The economic losses are set equal to the mortality rate, even though economic losses of Gumboro tend to be more important (van den Berg et al, 2000). The effectiveness of the program is set to 50% – as in Newcastle Disease – which LVV experts consider to be low. |
| | Foot & Mouth Disease | The infection rate is a safe and conservative estimate according to the Animal Health consultant and several studies. Similarly, milk losses for cows and mortality rates for pigs are on the conservative side. The effectiveness of monitoring is assumed to be 87.5%, even though the literature finds diagnostic kits to be more effective (somewhere between 90 and 100%). |
| | Other | • About 80 possible diseases not included in the analysis. Growth rates for livestock populations were only assumed for swine.<br>• Health benefits again not considered<br>• The most important benefits to FMD and CSF are not in production, but in joining the efforts in the Caribbean region to eradicate this disease. Additionally, these efforts allow Suriname to impose more stringent regulations on meats coming into the country, which is to have an important reinforcing effect on decreases in outbreaks and infection rates.<br>• Weight increases of pigs not quantified in the analysis. |
| *Plant Health* | Overall | The probabilities of entries were deemed to be lower bound estimates by the experts in Suriname, as the monitoring of food safety in Zanderij airport is very poor at this moment. Additionally, many travelers come from regions that are infected with Giant African Snail, Medfly, Citrus Greening and Panama Disease Race 4. |
| | Other | Several other important diseases (tomato boarer, citrus greening, and rice blast among others) not considered in the analysis. No growth rates of the production of any vegetables or fruit were assumed. Where possible, the number of years to combat a disease was overstated rather than understated (e.g. for GAS, it is expected the time it takes to control the disease is more than 5 years, so the number was set to 10). |
| *Innovation* | GAP campaign | Gap campaign geared towards smaller farmers not considered in benefits.<br>GAP campaign imposes additional costs for farmers, these costs are set relatively high (at 5% of production value of the crop of interest). |

## Sensitivity Analysis

A sensitivity analysis was conducted, in which some key assumptions underlying the estimates reported above were varied. Several parameter changes were undertaken.

**Scenario 1**

First, for the food safety subcomponent, we take a stringent stance. Even though the GAP campaign is mandatory and highly focused on certain key stakeholders, it is assumed this GAP campaign has no effect. Additionally, the decrease in rejection rates is assumed to be 25% – only half as successful as in Jamaica – to provide a more conservative estimate. Finally, exports are assumed to only increase by 5% rather than 10%. Changing these three parameters at the same time changes the IRR of the Food Safety subcomponent to 80.60% (from 154.81%) and the overall IRR to 51.60% (from 64.17%).

**Scenario 2**

Second, it is assumed that the supported measures to improve animal and plant health in Suriname reduce the likelihood of outbreaks of animal diseases and plant pests by only half the originally assumed rates. The rates are reported below in Table 20. This leads to a decrease of the Animal Health subcomponent IRR to 17.65% (from 59.85%), the Plant Health IRR to 13.57% (from 39.13%), and the overall IRR to 52.69% (from 64.17%), everything else equal.

**Table 20.** Overview of the parameter changes for animal and plant health

| | Adjusted parameter | Without program | With program | Sensitivity With program | **Overall IRR** |
|---|---|---|---|---|---|
| **Food Safety** | Effectiveness of program in reducing rejection rates | 0% | 58% | 29% | **51.60%** |
| | Increase of exports | 0% | 5% | 2.5% | |
| | Productivity increase GAP campaign | 0% | 10% | 0% | |
| **Plant and Animal Health Sensitivity** | Classic Swine Fever (Probability of entrance) | $10^{-2}$ | $10^{-4}$ | $5.05^{-3}$ | **52.69%** |
| | Foot and Mouth Disease (Fail rate monitoring) | 100% | 12.5% | 56.25% | |
| | Gumboro (Prevalence) | 23% | 11.50% | 17.375% | |
| | Newcastle Disease (Prevalence) | 20% | 10% | 15% | |
| | Giant African Snail (Annual Risk of introduction) | 9.97% | 5.80% | 7.67% | |
| | Citrus Greening (Annual Risk of introduction) | | | | |
| | Panama Disease Race 4 (Annual Risk of introduction) | 8.76% | 4.98% | 6.70% | |
| | Medfly (Annual Risk of introduction) | 20.57% | 4.98% | 9.97% | |
| **Innovation** | Productivity increase over 5 years and beyond | 0/0/0/0/0/0 | 0/1/2/3/4/5 | 0/0.5/1/1.5/2/2.5 | **56.57%** |
| | Rice: | 0/0/0/0/0/0 | 0/0/5/10/15/30 | 0/0/2.5/5/7.5/15 | |
| | Long yard bean: | 0/0/0/0/0/0 | 0/0/4/8/12/20 | 0/0/2/4/6/10 | |
| | Bitter gourd: | 0/0/0/0/0/0 | 0/0/3/6/9/15 | 0/0/1.5/3/4.5/7.5 | |
| | Okra: | 0/0/0/0/0/0 | 0/0/5/10/15/30 | 0/0/2.5/5/7.5/15 | |
| | Tomatoes: | 0/0/0/0/0/0 | 0/0/2/6/8/10 | 0/0/1/3/4/5 | |
| | Chili peppers | 0/0/0/0/0/0 | 0/0/4/8/12/20 | 0/0/2/4/6/10 | |
| | Eggplant | 0/0/0/0/0/0 | 0/0/5/10/15/30 | 0/0/2.5/5/7.5/30 | |
| | Sweet potato | 0/0/0/0/0/0 | 0/0/5/10/15/30 | 0/0/2.5/5/7.5/15 | |
| | Citrus | 0/0/0/0/0/0 | 0/0/5/10/15/30 | 0/0/2.5/5/7.5/15 | |
| | Passion fruit | 0/0/0/0/0/0 | 0/5/10/15/20/25 | 0/2.5/5/7.5/10/12.5 | |
| | Pineapple | | | | |
| | Institutional return to innovation | 0% | 44% | 22% | |

## Scenario 3

Third, measures to support innovation may be less effective than assumed. Therefore, the productivity increases are assumed to be only half as large as the literature would predict. This leads to a decrease of the Innovation Component IRR to 23.89% (from 42.19%), and the overall IRR to 56.57% (from 64.17%), everything else equal.

**Scenario 4**

Finally, we change all the parameters at the same time: scenarios one through four are combined. This changes the IRR for Food Safety to 80.60% (from 154.81%), for Animal Health to 17.65% (from 59.85%), for Plant Health to 13.57% (from 39.13%), and for Innovation to 23.89% (from 42.19%). Overall, this changes the IRR to 31.56% (from 64.17%).

**Scenario 5**

The current analysis does not take into account implementation costs incurred by farmers, as they were deemed negligible. In order to present a more conservative estimate, costs related to the increased monitoring and reporting (for farmers) were considered in this scenario. In order to estimate these effects, studies estimating these costs for similar measures implemented in Morocco and Thailand (Manarungsan et al, 2004; Aloui and Kenny, 2004) were considered. These studies find that compliance costs are about 2 percent of the values of exports for shrimp farmers in Thailand, or about 3 percent of total costs for farmers in Morocco.

In order to keep the analysis extremely cautious and conservative, it is assumed that there is a one-time implementation cost of 5% of total agricultural GDP the first year, and a recurring implementation cost of 1% of total agricultural GDP for every following year. Not only are these cost percentages higher than in the benchmark studies, these percentages are also multiplied by total agricultural output rather than cost. It is therefore no surprise that the calculated costs are very high, and therefore highly conservative. Even under this stringent scenario, the overall IRR is still 38.91%.[42]

**Scenario 6**

Finally, applying the implementation costs of scenario 5 along with the stringent stress tests of scenario 4 reduces the overall IRR to 14.29% (from 64.17%).

Table 21 provides an overview of the IRR by component and overall for the different scenarios. The IRRs that change in the different sensitivity analyses are highlighted in bold.

[42] The returns to the components don't change, as it is assumed that the costs hold for the project overall. Assigning these implementation costs separately for each component would require several assumptions. Therefore, a simple look at the overall IRR should be sufficiently informative.

**Table 21.** Overview of IRRs for different sensitivity scenarios

| | Component | | | | Overall |
|---|---|---|---|---|---|
| | **1.a Food Safety** | **1.b Animal Health** | **1.c Plant Health** | **2 Innovation** | |
| **Baseline IRR** | 154.81% | 59.85% | 39.13% | 42.19% | 64.17% |
| **Overall NPV (SRD)** | 88,493,836.60 | 27,924,657.00 | 7,513,410.79 | 59,072,368.88 | 183,004,273.28 |

| **IRR Sensitivity Analyses** | | | | | |
|---|---|---|---|---|---|
| Scenario 1 | ***80.60%*** | 59.85% | 39.13% | 42.19% | ***51.60%*** |
| Scenario 2 | 154.81% | ***17.65%*** | ***13.57%*** | 42.19% | ***52.69%*** |
| Scenario 3 | 154.81% | 59.85% | 39.13% | ***23.89%*** | ***56.57%*** |
| Scenario 4 | ***80.60%*** | ***17.65%*** | ***13.57%*** | ***23.89%*** | ***31.56%*** |
| Scenario 5 | 154.81% | 59.85% | 39.13% | 42.19% | ***38.91%*** |
| Scenario 6 | ***80.60%*** | ***17.65%*** | ***13.57%*** | ***23.89%*** | ***14.29%*** |

## Analysis of the fiscal impact

The above analysis highlights the program is expected to have substantial returns for the Surinamese economy and the agricultural sector. Nevertheless, given the precarious fiscal and macroeconomic situation in Suriname, it is worth investigating the fiscal impact of the program.

In order to perform this exercise, fiscal prices rather than economic prices are used. A simple example illustrates why this is the case. When the health situation for pigs improves, and pigs have lower mortality rates and higher weight, the farmer benefits. He or she faces lower losses (mortality) and can sell one pig for more money because of the increased weight. This farmer will need to pay taxes for these additional returns resulting from the program, but the government receives these returns. So from the point of view of the Surinamese society, the taxes do not have an effect: they are just money changing hands. When considering the fiscal impact, this is very different. These tax incomes actually do accrue to the government, and when assessing the impact of the entire program on the government budgets, the fact this farmer needs to pay these does not cancel out.

Government revenues can be largely divided in two parts. First, certain investments allow the government to directly recover some of the costs. For instance, employing people to draft legislation or implement certain parts of the Food Safety program will result in income taxes, while the construction of the laboratory will result in income tax revenues. Second, several program result in increased production or exports, that will provide the government with fiscal benefits resulting from the sales tax.

Table 22 gives an overview of the costs and benefits that are included in this analysis. As before, some benefits are understated, so this analysis is expected to be

conservative. For completeness, table 22 also gives some important factors that are overlooked in the analysis, but are expected to have a substantial impact on the government budgets. For a full set of non-incorporated benefits, table 19 gives a complete overview. An important benefit that is not quantified in this exercise, however, is the effect on animals. The animal health component considered the value of the livestock to farmers. The government only receives funds when these animals or their products are sold. It is ex ante also not necessarily clear the program will increase demand for these products. Therefore, this fiscal income channel from animal health is not quantified, leading to a more conservative analysis. As plants are typically sold and consumed over the production cycle, it is assumed that all additional production of plants is eventually sold, leading to increased tax income for the government.

**Table 22:** Costs and benefits used in analysis for plant health

| Costs | Benefits |
|---|---|
| • Additional administrative costs for all components<br>• Staff Training plan (Food Safety)<br>• Regional and International Liaison (Plant Health)<br>• National Food safety policy & Food safety coordination mechanism (Food Safety)<br>• Interministrial committee (food safety)<br>• National Codex Committee (food safety)<br>• Food Safety legislation (Food Safety) | • **Quantified**<br>• Tax recovery on employment<br>• Tax recovery on building the laboratory<br>• Tax recovery on incremental sales of<br>  ○ Increased exports as discussed in the Food Safety component<br>  ○ Increased production as a result of Food Safety GAP standards discussed in the Food Safety subcomponent<br>  ○ Lower losses of plants as a result of controlling the diseases discussed in the Plant Health subcomponent.<br>  ○ Increased yield and productivity as a result of the innovation projects discussed in the innovation component. |
| | • **Not Quantified**<br>  ○ Healthcare costs that may decrease as a result of improved food safety<br>  ○ Taxes on the sale of animals that increased in value following the investments discussed in the Animal Health subcomponent. |

The overall cost-to-benefit ratio of the program is 75%. As an investment program, it has an IRR of 25% for the government of Suriname, and a NPV of SRD 3,558,355.50 assuming a capital cost of 12%.

## Annex 1:
## A. Food safety: investments, benefits quantified and not quantified.

| Investments | Effect |
|---|---|
| National Food safety policy & Food safety coordination mechanism | Supporting legal framework: benefits not quantified, costs only |
| Interministerial committee | |
| National Codex Committee | |
| Food safety legislation | |
| Fee revenue proposal | |
| Food safety assurance systems | Direct effect on food quality: norms and regulations that are directly enforced. Benefit 1: fewer export rejections. |
| Registration and inspection system | |
| Capability for diagnosis Residue lab | |
| Surveillance System for Food Safety hazards | |
| Food Safety Standards | |
| Staff Training Plan | |
| Awareness campaign Food safety & MAAHF/VKI laboratory services | Benefit 2: adoption GAP will lead to higher productivity among adopting farmers |

## B. Animal Heath: investment points, benefits quantified and not quantified.

| Investment points | Effect |
|---|---|
| Installing an integrated Information System | Supporting role: benefits not quantified, costs only |
| Strengthening the Surveillance system | Enforced norms and regulations, diagnosing ability, risk analysis, contingency plans, improved monitoring at ports of entry. Benefit 1: Decrease in severity of current diseases, decreased probability of diseases entering country |
| Strengthening the Quarantine system | |
| Improving the Laboratory Capability for disease diagnosis | |
| Ensure a fully functional Animal Identification and Traceability System (AI&T) | |
| Trained staff able to support and fulfill the VS activities | |
| Performing Risk Analysis on frequent basis | |
| Setting an Early Detection and Emergency Response System | |
| Norms and regulations | |
| Evaluation of the level of competences | Supporting role that strengthen the benefits: benefits not quantified, costs only |
| Information and communication on animal health issues | |
| Accreditation system | |
| Manuals and protocols on GAP | Part of FS |

## C. Plant Heath: investment points, benefits quantified and not quantified.

| Investment points | Effects |
|---|---|
| Establishing SPS control at the borders for effective regulation of imports | Benefit 1: Lower probability of importing certain pests |
| Strengthening import regulation | |
| Export certification | Analyzed under Food Safety |
| Pest Surveillance | Decrease in prevalence of current diseases |
| Establishing a plant health diagnostic laboratory | Benefit 2: Lower prevalence of current diseases |
| Establishing an area of low pest prevalence for fruit flies | Benefits to be quantified (?) |
| Human Resources Development | Benefit 2: Lower prev. of current diseases |
| Rice quality management | Benefits not quantified, costs only |
| Pesticides Management Programme | Benefits not quantified, costs only |

## D. Innovation: investments, benefits quantified and not quantified.

| Investment points | Effects |
|---|---|
| Strengthening of the rice sector | Benefit 1: Higher yields for farmers as a result of research, that gets disseminated among farmers. |
| Strengthening of open-field vegetable production | |
| Strengthening of protected field vegetable production | |
| Strengthening of citrus production | |
| Strengthening of minor fruit production | |
| Institutional capacity building | Benefit 2: An institutional framework that supports and strengthens research activities leads to higher yields, benefits calibrated using meta-studies. |
| Funding window for small agricultural innovation projects | |

## Annex 2. Costs of Giant African Snail program in Barbados

**Resources used during the period October, 2000 until March, 2016 to combat the Giant African Snail.**

| Title | Cost ($) |
|---|---|
| Town Hall Meetings | 9,257.92 |
| Chemicals | 1,750,053 |
| Vehicle | 67,420.48 |
| Cleaning of area | 21,440 |
| Bounty payments | 514,568 |
| Factsheets | 5,000 |
| Equipment | 6,000 |
| Total | 2,373,739.40 |

## Annex 3. Costs of managing Moko at FAI.

| Cost Implications Moko Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2012 | | | | |
| | **Unit** | **2007** | **2008** | **2009** | **2010** | **2011** | **2014** | **2015** | **2016** | **2017** | **2018** |
| Total Planted Area (initial planting) | | | | | | | 1,170.85 | | | | |
| Area out of production due to Moko (direct impact) | ha | 41.0 | 11.0 | 11.6 | 10.3 | 13.15 | 67.02 | 77.44 | 40.93 | | |
| Area out of production due to Moko (indirect impact) | ha | | | | | 95.63 | 33.84 | | | | |
| Total area under Moko Management (cumulative) | ha | 41.0 | 52.1 | 63.7 | 74.0 | 182.8 | 283.6 | 361.1 | 402.0 | | |
| Average potential bunches/mat/year (ratooning) | | 1.37 | 1.37 | 1.37 | 1.37 | 1.37 | 1.37 | 1.37 | 1.37 | | |
| Average potential box/stem ratio | | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | | |
| Average potential box price FOT | USD | | | | | | $ 13.57 | $ 10.26 | $ 11.20 | | |
| | | | | | | | | | | | |
| ***Loss of Revenues (cumulative) due to Moko*** | | | | | | | | | | | |
| Total Plants Lost | | | | | | | 538,859 | 685,996 | 763,760 | | |
| Total Boxes Lost | | | | | | | 642,266 | 817,639 | 910,326 | | |
| Total Containers Lost | | | | | | | 595 | 757 | 843 | | |
| Total Revenues lost | USD | | | | | | $8,716,341 | $8,392,993 | $10,195,646 | | |
| | | | | | | | | | | | |
| ***Cost of Moko Control*** | | | | | | | | | | | |
| Elimination of banana plants | USD/ha/year | | | | | | | $ 204 | $ 204 | | |
| Soil fumigation w. Dazomet fumigant (one application) | USD/ha/year | | | | | | | $ 6,170 | $ 6,170 | | |
| Weed Control w. Glyfosate herbicide (annual application) | USD/ha/year | | | | | | | $ 261 | $ 261 | | |
| Total cost of control/ ha | | | | | | | | $ 6,636 | $ 6,636 | | |
| | | | | | | | | | | | |
| ***Cost of Replanting Moko Area*** | | | | | | | | | | | |
| Program of replanting | ha | | | | | | | | 35 | 171 | 196 |
| Cost of Replanting Moko Area | USD/ha | | | | | | | | $ 3,154 | $ 3,154 | $ 3,154 |
| Total cost of replanting Moko area | USD | | | | | | | | $ 110,404 | $ 539,404 | $ 618,198 |
| | | | | | | | | | | | |
| ***Loss of Job positions*** | | | | | | | | | | | |
| No of workers | man/ha | | | | | | | | 1 | 1 | |
| Jobs lost due to Moko | | | | | | | | | 402 | - | |

## Annex 4. Quantification Costs and Benefits by year and subanalysis (in '000s).

| COMPONENTS | Amount | Currency | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Food Safety** | | | | | | | | | | | | |
| Costs | | | | | | | | | | | | |
| *Total Admin costs* | | SRD | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 | 425 |
| *Total Costs Budgeted* | | SRD | 5,171 | 2,999 | 2,423 | 723 | 545 | 22 | 22 | 22 | 22 | 22 |
| Benefits | | | | | | | | | | | | |
| See 'FS CBA' Sheet for Benefits | | | | | | | | | | | | |
| *Total Benefits* | | SRD | 182 | 7,177 | 14,035 | 20,749 | 27,319 | 27,319 | 27,319 | 27,319 | 27,319 | 27,319 |
| ***Net Benefits*** | | | ***-5,414*** | ***3,754*** | ***11,187*** | ***19,600*** | ***26,349*** | ***26,872*** | ***26,872*** | ***26,872*** | ***26,872*** | ***26,872*** |
| **NPV** | **88,494** | SRD | | | | | | | | | | |
| **IRR** | **154.81%** | | | | | | | | | | | |
| **Animal Health** | | | | | | | | | | | | |
| Costs | | | | | | | | | | | | |
| *Total Admin costs* | | SRD | | | | | | | | | | |
| *Total Costs Budgeted* | | SRD | 18,901 | 1,817 | 1,063 | 1,163 | 1,402 | 0 | 0 | 0 | 0 | 0 |
| Benefits | | | | | | | | | | | | |
| See 'AH CBA' Sheet for Benefits | | | | | | | | | | | | |
| *Total Benefits* | | USD | 7,464 | 7,716 | 7,991 | 8,292 | 8,619 | 8,975 | 9,361 | 9,781 | 10,236 | 10,728 |
| ***Net Benefits*** | | | **-11,437** | **5,899** | **6,928** | **7,128** | **7,217** | **8,975** | **9,361** | **9,781** | **10,236** | **10,728** |
| **NPV** | **27,925** | | | | | | | | | | | |
| **IRR** | **59.85%** | | | | | | | | | | | |
| **Plant Health** | | | | | | | | | | | | |
| Costs | | | | | | | | | | | | |
| *Total Admin costs* | | SRD | 112 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| *Total Costs Budgeted* | | SRD | 5,017 | 5,044 | 3,210 | 2,843 | 2,201 | 0 | 0 | 0 | 0 | 0 |
| Benefits | | | | | | | | | | | | |
| See 'PH CBA' Sheet for Benefits | | | | | | | | | | | | |
| *Total Benefits* | | SRD | 2,057 | 4,129 | 4,147 | 4,130 | 4,136 | 4,138 | 4,134 | 4,136 | 4,136 | 4,135 |
| ***Net Benefits*** | | | ***-3,072*** | ***-926*** | ***926*** | ***1,275*** | ***1,923*** | ***4,126*** | ***4,122*** | ***4,124*** | ***4,124*** | ***4,123*** |
| **NPV** | **7,513** | | | | | | | | | | | |
| **IRR** | **39.13%** | | | | | | | | | | | |
| **Innovation** | | | | | | | | | | | | |
| Costs | | | | | | | | | | | | |
| *Total Admin costs* | | SRD | | | | | | | | | | |
| *Total Costs Budgeted* | | SRD | 21,220 | 7,322 | 7,592 | 5,209 | 4,283 | 0 | 0 | 0 | 0 | 0 |
| Benefits | | | | | | | | | | | | |
| See 'INN CBA' Sheet for Benefits | | | | | | | | | | | | |
| *Total Benefits* | | SRD | 0 | 6,170 | 6,935 | 14,723 | 19,522 | 33,426 | 31,026 | 31,062 | 31,056 | 31,048 |
| ***Net Benefits*** | | | **-21,220** | **-1,152** | **-657** | **9,514** | **15,239** | **33,426** | **31,026** | **31,062** | **31,056** | **31,048** |
| **NPV** | **59,072** | | | | | | | | | | | |
| **IRR** | **42.19%** | | | | | | | | | | | |
| **Overall** | | | | | | | | | | | | |
| ***Total Costs*** | | SRD | 50,846 | 17,618 | 14,724 | 10,375 | 8,868 | 459 | 459 | 459 | 459 | 459 |
| ***Total Benefits*** | | SRD | 9,703 | 25,192 | 33,109 | 47,893 | 59,595 | 73,858 | 71,840 | 72,298 | 72,747 | 73,230 |
| ***Total Net Benefits*** | | | **-41,143** | **7,575** | **18,384** | **37,518** | **50,727** | **73,399** | **71,381** | **71,839** | **72,288** | **72,771** |
| **NPV** | **183,004** | | | | | | | | | | | |
| **IRR** | **64.17%** | | | | | | | | | | | |

## Annex 5. Food Safety: Quantification Costs and Benefits by year (in '000s).

| FOOD SAFETY COMPONENT | | | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Production Statistics** | | ***Units*** | | | | | | | | | | |
| Value of producation without GAP | | | | | | | | | | | | |
| Rice | Value add. yielc | SRD | 187,869 | 185,208 | 186,830 | 186,636 | 186,224 | 186,563 | 186,474 | 186,421 | 186,486 | 186,460 |
| Vegetables | Value add. yielc | SRD | 36,862 | 34,842 | 35,839 | 35,848 | 35,510 | 35,732 | 35,697 | 35,646 | 35,692 | 35,678 |
| Increase from GAP | | | | | | | | | | | | |
| Rice | Value add. yielc | SRD | 188,022 | 185,358 | 186,981 | 186,787 | 186,375 | 186,714 | 186,625 | 186,572 | 186,637 | 186,611 |
| Vegetables | Value add. yielc | SRD | 36,892 | 34,871 | 35,868 | 35,877 | 35,538 | 35,761 | 35,725 | 35,675 | 35,720 | 35,707 |
| *benefits* | | | 182 | 178 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 |
| **Export Statistics** | | | | | | | | | | | | |
| Without program | | | | | | | | | | | | |
| Export value of fish | | SRD | 80,157 | 80,157 | 80,157 | 80,157 | 80,157 | 80,157 | 80,157 | 80,157 | 80,157 | 80,157 |
| Export value of fruits and vegetables | | SRD | 114,192 | 114,192 | 114,192 | 114,192 | 114,192 | 114,192 | 114,192 | 114,192 | 114,192 | 114,192 |
| Export of rice | | SRD | 179,814 | 179,814 | 179,814 | 179,814 | 179,814 | 179,814 | 179,814 | 179,814 | 179,814 | 179,814 |
| With program | | | | | | | | | | | | |
| Export value of fish | | SRD | 80,157 | 82,161 | 84,165 | 86,169 | 88,173 | 88,173 | 88,173 | 88,173 | 88,173 | 88,173 |
| Export value of fruits and vegetables | | SRD | 114,192 | 117,047 | 119,902 | 122,756 | 125,611 | 125,611 | 125,611 | 125,611 | 125,611 | 125,611 |
| Export of rice | | SRD | 179,814 | 184,309 | 188,805 | 193,300 | 197,795 | 197,795 | 197,795 | 197,795 | 197,795 | 197,795 |
| Losses of rejections without program | | | | | | | | | | | | |
| Fruits and vegetables | | SRD | 22,838 | 22,838 | 22,838 | 22,838 | 22,838 | 22,838 | 22,838 | 22,838 | 22,838 | 22,838 |
| Losses of rejections with program | | | | | | | | | | | | |
| Fruits and vegetables | | SRD | 22,838 | 20,483 | 17,985 | 15,345 | 12,561 | 12,561 | 12,561 | 12,561 | 12,561 | 12,561 |
| *benefits* | | | 0 | 6,999 | 13,855 | 20,568 | 27,139 | 27,139 | 27,139 | 27,139 | 27,139 | 27,139 |
| **TOTAL FOOD SAFETY BENEFITS** | | | 182 | 7,177 | 14,035 | 20,749 | 27,319 | 27,319 | 27,319 | 27,319 | 27,319 | 27,319 |

## Annex 6. Animal Health: Quantification Costs and Benefits by year (in '000s).

| ANIMAL HEALTH COMPONENT | | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Assumption and parameters:** | ***Parameter Unit*** | | | | | | | | | | |
| **I. INTRODUCED DISEASES** | | | | | | | | | | | |
| Losses | | | | | | | | | | | |
| Newcastle Disease | | | | | | | | | | | |
| without program | | 5,001 | 5,001 | 5,001 | 5,001 | 5,001 | 5,001 | 5,001 | 5,001 | 5,001 | 5,001 |
| with program | | 2,501 | 2,501 | 2,501 | 2,501 | 2,501 | 2,501 | 2,501 | 2,501 | 2,501 | 2,501 |
| Gumboro | | | | | | | | | | | |
| without program | | 9,202 | 9,202 | 9,202 | 9,202 | 9,202 | 9,202 | 9,202 | 9,202 | 9,202 | 9,202 |
| with program | | 4,601 | 4,601 | 4,601 | 4,601 | 4,601 | 4,601 | 4,601 | 4,601 | 4,601 | 4,601 |
| *benefits* | *SRD* | *7,102* | *7,102* | *7,102* | *7,102* | *7,102* | *7,102* | *7,102* | *7,102* | *7,102* | *7,102* |
| **II. AT-RISK DISEASES** | | | | | | | | | | | |
| **Classic Swine Fever** | | | | | | | | | | | |
| Farmgate value of entire pig population | | | | | | | | | | | |
| without program | SRD | 28,421 | 29,774 | 31,192 | 32,677 | 34,233 | 35,863 | 37,570 | 39,359 | 41,233 | 43,197 |
| with program | SRD | 28,623 | 30,057 | 31,562 | 33,143 | 34,803 | 36,547 | 38,377 | 40,300 | 42,318 | 44,438 |
| Slaughtering costs | | | | | | | | | | | |
| without program | SRD | 18,631 | 19,534 | 20,482 | 21,475 | 22,516 | 23,608 | 24,753 | 25,953 | 27,212 | 28,531 |
| with program | SRD | 18,764 | 19,720 | 20,726 | 21,782 | 22,892 | 24,059 | 25,286 | 26,575 | 27,929 | 29,353 |
| *benefits* | *SRD* | *133* | *186* | *244* | *307* | *376* | *451* | *533* | *622* | *718* | *822* |
| **Foot and Mouth Disease** | | | | | | | | | | | |
| Drop in milk production | | | | | | | | | | | |
| without program | SRD | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| with program | SRD | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Drop in milk production | | | | | | | | | | | |
| without program | SRD | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 |
| with program | SRD | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Benefits from program (Cows) | SRD | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| Pig population without program | SRD | 38 | 40 | 42 | 44 | 46 | 49 | 51 | 54 | 56 | 59 |
| Pig population with program | SRD | 38 | 40 | 42 | 44 | 45 | 48 | 50 | 52 | 54 | 57 |
| Benefits from program (Pigs) | | 181 | 380 | 597 | 834 | 1,093 | 1,373 | 1,678 | 2,009 | 2,368 | 2,756 |
| *benefits* | *SRD* | *230* | *428* | *645* | *882* | *1,141* | *1,421* | *1,727* | *2,057* | *2,416* | *2,804* |
| ***TOTAL PLANT HEALTH BENEFITS*** | *SRD* | *7,464* | *7,716* | *7,991* | *8,292* | *8,619* | *8,975* | *9,361* | *9,781* | *10,236* | *10,728* |

## Annex 7. Plant Health: Quantification Costs and Benefits by year (in '000s).

| PLANT HEALTH COMPONENT | | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panama disease race 4** | | | | | | | | | | | |
| Value of banana production | SRD | 94,394 | 97,363 | 96,076 | 95,944 | 96,461 | 96,161 | 96,189 | 96,270 | 96,207 | 96,222 |
| Planted area of banan production | ha | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Control costs | SRD | 16,541 | 16,504 | 16,543 | 16,529 | 16,525 | 16,533 | 16,529 | 16,529 | 16,530 | 16,530 |
| Replanting costs | SRD | 3,375 | 3,367 | 3,375 | 3,373 | 3,372 | 3,373 | 3,373 | 3,373 | 3,373 | 3,373 |
| Total losses | SRD | 42,570 | 43,238 | 42,977 | 42,929 | 43,048 | 42,985 | 42,987 | 43,007 | 42,993 | 42,995 |
| Losses | | | | | | | | | | | |
| without program | SRD | 3,727 | 3,786 | 3,763 | 3,759 | 3,769 | 3,764 | 3,764 | 3,765 | 3,764 | 3,765 |
| with program | SRD | 2,120 | 2,153 | 2,140 | 2,138 | 2,144 | 2,141 | 2,141 | 2,142 | 2,141 | 2,141 |
| *benefits* | *SRD* | *1,607* | *1,633* | *1,623* | *1,621* | *1,625* | *1,623* | *1,623* | *1,624* | *1,623* | *1,623* |
| **Giant African Snail** | | | | | | | | | | | |
| Value of tuber and vegetable production | SRD | 73,326 | 70,880 | 72,272 | 72,160 | 71,771 | 72,068 | 71,999 | 71,946 | 72,004 | 71,983 |
| Losses | | | | | | | | | | | |
| without program | SRD | 2,281 | 2,245 | 2,266 | 2,264 | 2,258 | 2,263 | 2,262 | 2,261 | 2,262 | 2,261 |
| with program | SRD | 1,328 | 1,307 | 1,319 | 1,318 | 1,315 | 1,317 | 1,317 | 1,316 | 1,317 | 1,317 |
| *benefits* | *SRD* | *953* | *938* | *946* | *946* | *943* | *945* | *945* | *944* | *945* | *945* |
| **Medfly** | | | | | | | | | | | |
| Value of citrus and bell pepper productic | SRD | 99,649 | 100,027 | 101,249 | 100,308 | 100,528 | 100,695 | 100,511 | 100,578 | 100,595 | 100,561 |
| Losses | | | | | | | | | | | |
| without program | SRD | 2,049 | 2,057 | 2,082 | 2,063 | 2,068 | 2,071 | 2,067 | 2,069 | 2,069 | 2,068 |
| with program | SRD | 496 | 498 | 504 | 500 | 501 | 501 | 501 | 501 | 501 | 501 |
| *benefits* | *SRD* | *1,553* | *1,559* | *1,578* | *1,564* | *1,567* | *1,570* | *1,567* | *1,568* | *1,568* | *1,567* |
| ***TOTAL PLANT HEALTH BENEFITS*** | *SRD* | *4,113* | *4,129* | *4,147* | *4,130* | *4,136* | *4,138* | *4,134* | *4,136* | *4,136* | *4,135* |

## Annex 8. Innovation: Quantification Costs and Benefits by year (in '000s).

| INNOVATION COMPONENT | | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Return** | | | | | | | | | | | |
| Value of rice production | SRD | 199,643 | 200,906 | 201,114 | 200,555 | 200,858 | 200,842 | 200,752 | 200,818 | 200,804 | 200,791 |
| *Benefits* | SRD | 0 | 2,009 | 4,022 | 6,017 | 8,034 | 10,042 | 10,038 | 10,041 | 10,040 | 10,040 |
| Innovation and Research for open field vegetables | | | | | | | | | | | |
| Innovation and Research for protected vegetables | | | | | | | | | | | |
| Benefits for Long yard bean production | SRD | 0 | 0 | 994 | 1,994 | 2,970 | 5,962 | 5,962 | 5,954 | 5,959 | 5,958 |
| Benefits for bitter gourd production | SRD | 0 | 0 | 261 | 522 | 779 | 1,303 | 1,302 | 1,301 | 1,302 | 1,302 |
| Benefits for Okra production | SRD | 0 | 0 | 385 | 763 | 1,132 | 1,907 | 1,901 | 1,898 | 1,902 | 1,900 |
| Benefits for Chili peppers | SRD | 0 | 0 | 478 | 1,456 | 1,909 | 2,401 | 2,405 | 2,397 | 2,401 | 2,401 |
| Benefits for tomatoes production | SRD | 0 | 0 | 796 | 1,581 | 2,356 | 4,745 | 4,734 | 4,730 | 4,736 | 4,734 |
| Benefits for eggplant production | SRD | 0 | 0 | 604 | 1,210 | 1,795 | 3,013 | 3,010 | 3,005 | 3,009 | 3,008 |
| Benefits for sweet potatoe production | SRD | 0 | 0 | 151 | 297 | 450 | 899 | 897 | 899 | 898 | 898 |
| Benefits for open field vegetables | SRD | 0 | 0 | 2,119 | 4,735 | 6,790 | 11,574 | 11,569 | 11,551 | 11,565 | 11,562 |
| Benefits for closed field vegetables | SRD | 0 | 0 | 1,551 | 3,089 | 4,602 | 8,656 | 8,641 | 8,634 | 8,644 | 8,640 |
| *Benefits* | SRD | 0 | 0 | 642 | 1,272 | 1,887 | 3,814 | 3,801 | 3,797 | 3,804 | 3,800 |
| *Implementation costs* | | 0 | 0 | 642 | 636 | 629 | 636 | 634 | 633 | 634 | 633 |
| Innovation and Research for minor fruit | | | | | | | | | | | |
| Value of passion fruit production | SRD | 8,581 | 8,436 | 8,434 | 8,484 | 8,451 | 8,456 | 8,464 | 8,457 | 8,459 | 8,460 |
| Value of pineapple fruit production | SRD | 4,697 | 4,130 | 4,323 | 4,383 | 4,279 | 4,328 | 4,330 | 4,312 | 4,324 | 4,322 |
| *Benefits* | SRD | 0 | 422 | 1,060 | 1,711 | 2,332 | 3,413 | 3,415 | 3,408 | 3,412 | 3,412 |
| *Implementation costs* | | 0 | 628 | 638 | 643 | 636 | 639 | 640 | 638 | 639 | 639 |
| Innovation and Research for citrus | | | | | | | | | | | |
| Value of orange production | SRD | 57,082 | 61,072 | 60,845 | 59,666 | 60,528 | 60,346 | 60,180 | 60,351 | 60,293 | 60,275 |
| Value of soursop production | SRD | | | | | | | | | | |
| *Benefits* | SRD | 0 | 0 | 3,042 | 5,967 | 9,079 | 18,104 | 18,054 | 18,105 | 18,088 | 18,082 |
| *Implementation costs* | | 0 | 0 | 3,042 | 2,983 | 3,026 | 3,017 | 3,009 | 3,018 | 3,015 | 3,014 |
| Innovation and Research for open window | | | | | | | | | | | |
| *Benefits* | | | 2,607 | 840 | 840 | 831 | 850 | | | | |
| Innovation and Research for institutional strengthening | | | | | | | | | | | |
| *Benefits* | | | 1,760 | 1,650 | 3,179 | 1,650 | 1,496 | | | | |
| **TOTAL INNOVATION BENEFITS** | | 0 | 6,170 | 6,935 | 14,723 | 19,522 | 33,426 | 31,026 | 31,062 | 31,056 | 31,048 |