# Strengthening of the rice sector by better controlling weeds, pests and diseases


## Abstract

Yield losses in rice due to weeds, pests and diseases run up to 30-40% of the attainable rice output. This project aims at developing and introducing better coping strategies based on Integrated Pest Management (IPM). Training farmers in those strategies will not only raise yields, but also reduce pesticide costs and negative externalities of widespread mix- and over-use of pesticides in the rice sector.

# Introduction

For Surinam, rice production is a major economic activity. In 2014, it was by far the principal crop in terms of area harvested (62,211 ha/year), value of production at farm gate (US$ 60.6 million), and export income generated (US$ 51 million).[1]

In the 1950s and 1960s, Surinam built what was considered at that time one of the most advanced rice industries in the world. Rice yields/ha ranked among the highest in the world. Since then, however, Surinam has lost a great deal of its competitive edge to other countries (including neighbouring Guyana) as it failed to improve its productivity at a sufficient rate and keep up its infrastructure. Low export prices between 1997 and 2007 caused a substantial contraction of rice production in Surinam. However, better prices in the international market after 2007, have reversed this trend. The steady growth in rice production between 2009 and 2014 (3.8% per annum) is based in part on an expansion of the harvested area (2.7% per annum) and on a yield increase per hectare (1.1% per annum). [2]

Further expansion of rice production in the future will require, among many other things, (a substantial investment in) the development and introduction of cost-reducing and yield-boosting methods of rice production.

# Background

In total, about 55,000 ha have been developed for rice production in Suriname. Double cropping is in principle possible, but in practice shortage of irrigation water limits the sowing intensity to 1.5 at best (which is equivalent to 82,500 ha). In 2014, about 62,211 ha of rice were harvested. This indicates that there is still quite a bit of rice land out of production that, if the rice price is sufficiently high, could be brought back into production after some rehabilitation.[3] Much will depend on the availability of irrigation water, which is at times problematic due in part to enormous spillage of water.

In 2014, some 275,851 ton of dried paddy was produced. After taking account for rice seed, de-husking, animal feed and field losses, some 194,641 ton of cargo rice was left of which 56,022 tons was exported and the remainder (138,619 ton) destined for local processing. After processing, about 113,668 ton of white rice was left in 2014, of which 47,733 ton was exported and the remainder (65,935 ton) used for local consumption or for topping up stock. In 2014, roughly 59% of the cargo rice was exported (either as cargo rice or as white rice) – up from only 35% in 2009.

The bulk of the rice production capacity in Surinam is concentrated in the Nickerie district. In addition, there are two smaller rice production areas in the Coronie and Saramacca districts. There is also some upland rice cultivation in the interior where rice is cultivated in between other crops on the agricultural fields. As rice is not cultivated monoculture basis in the interior but in between crops, it is difficult to estimate what the total cultivated area is in the interior. The production of upland rice is very low (less than 2 tons/Ha) in comparison with irrigated rice.

Rice production in Suriname is for local consumption (it is the principal staple food) as well as export (59% of the rice production in 2014). Traditionally, most of the rice export went to Europe because of

[1] LVV. 2016. Agricultural Production Statistics 2009-2014. Paramaribo: LVV.
[2] LVV. 2016. Agricultural Production Statistics 2009-2014. Paramaribo: LVV
[3] In 1986, apparently a top year, 76,000 ha were sown producing 326,000 ton of paddy (White Paper on Rice).

preferential access to the EU market. However, this preferential treatment has been phased out, and rice export has now shifted to the Caribbean (in particular Jamaica and Haiti).

In 1995 an area of approximately 55,000 hectares was registered for rice production, which was distributed as follows: Region East -- 860 hectare; Region Center-- 5.000 hectare; Region West -- 47.200 hectare. The distribution of the rice area by rice farm size at that time is depicted in table 1. It shows that farm size varied greatly -- at one end of the spectrum many small producers, but the bulk of the production capacity (some two-thirds) was concentrated in just 55 rice farms of 75 ha and more. Hence the technology adopted in rice production in Suriname is very much large scale and mechanized.

**Table 1: Distribution of rice area by rice farm size, 1995**

| Size | Number of farms | Total area |
|---|---:|---:|
| 0.1-12 ha | 4,300 | 15,020 |
| 13-24 ha | 110 | 2,440 |
| 25-75 ha | 17 | 1,060 |
| 76-250 ha | 28 | 5,000 |
| 251-750 ha | 19 | 13,340 |
| > 750 | 8 | 18,140 |
| Total | 4,482 | 55,000 |

Source: LVV. 2011. Beleidswitboek Rijst. Paramaribo: LVV.

Over the past 20 years, a lot of structural changes have taken place in the rice sector. At one end of the size spectrum, several of the real large, state-owned rice estates (750 ha and more) have collapsed. The government has been trying to sell them off – either as an estate or to groups farmers– or rent them out. At the other end of the farm size spectrum, the number of small rice farms has also dropped dramatically. A study by ADRON in 2008, counted some 1,116 rice farms in the category of 0-140 ha.[4] This is less than a quarter 13 years earlier. Unfortunately, no more recent farm size data is available, but the impression is that the consolidation of rice production into mid-sized farms has continued also after 2008. It is also observed that nowadays farmers often plant multiple plots. To a large extent this is made possible by a very active rice-land rental market.

A recent study by Kesharie (2016)[5] surveying some 200 small rice farmers (i.e., less than 100 ha) obtained information on the status of the land on which they plant (see table 2). Three-quarter of the farmers surveyed indicated that they rented land to plant rice.

Rice yields reached in 2014 on average 4.4 ton per hectare – small-scale rice farmers (12ha <) achieved better yields (4.8 ton per hectare) than large-scale rice farmers (4.1 ton). With a rice yield of 4.4 ton, Surinam ranks about average for the region, but is far away from the three best performing countries in the region: Uruguay, Peru and Argentina, which report an average yield of 7.5 ton per hectare (FAOSTAT). Hence there is a major potential to catch up.

[4] LVV. 2011. Beleidswitboek Rijst. Paramaribo: LVV.
[5] Kesharie, R. 2016. Master Thesis, University of Suriname, Paramaribo.

**Table 2: Status of the land on which farmer plant (N= 200)**

| Status of the land | N | % |
|---|---|---|
| Land owned | 51 | 25.5 |
| Land leased from the Government | 25 | 12.5 |
| Land leased from individuals | 72 | 36 |
| Land owned and land leased from individuals | 52 | 26 |
| Total | 200 | 100 |

Source: Kesharie, 2016

Major bottlenecks in the rice production in Suriname are: (a) The lack of proper maintenance of the irrigation and drainage systems; (b) Lack of coordination and cooperation within the rice sector; (c) Lack of transparency regarding price setting within the sector; (d) Lack of affordable credit; (e) Rather old machinery park. Machinery renting services underdeveloped; (f) High dependency on imported inputs; and (g) Given the importance of the crop (and despite the fact that it is the only crop in Surinam with its own dedicated research institute), rather limited rice research and extension services; and (h) Lack of expertise and research staff which can offer problem solving techniques to the rice farmers.

According to the strategic plan 2015-2020[6] of the Foundation for National Rice Research (SNRI), which is ADRON's supervising body, four critical interventions are needed to raise the productivity of the rice sector, namely:

- Improved rice varieties. The focus is on high quality, high yield and resistance or tolerance against pest and diseases;
- Improved soil and water management (including soil fertility);
- Improved control of weeds, pests and diseases;
- Improved post-harvest processing and storage

With regard to interventions 1 and 2, ADRON will collaborate through the Ministry of Agriculture with the Malaysian Agricultural Research and Development Institute (MARDI). Specifically, four components will be collaborated on:

- Introduction of aromatic rice varieties with the inclusion of a specific breeding program
- Implementation of a specific training component including training of Surinamese scientists in breeding, certified seed production, crossings and selection
- Soil and plant sampling and analysis will be conducted, and a map will be developed showing the fertility/nutrient status of the rice areas in Nickerie.
- Implementation of an integrated water management system in Nickerie.

The focus of the IDB project will be primarily on the control of pests, diseases and weeds and hence complements the activities of MARDI, financed by the Islamic Development Bank.

In a stakeholder's meeting on July 20, 2016, fifteen farmers provided input on weeds, pests and diseases occurring in their rice fields in Nickerie. The information of the inputs is incorporated in the following paragraph on common weeds, diseases, and pests in Suriname.

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[6] SNRI. 2015. Strategic Plan 2015-2020. Nickerie: SNRI.

Common diseases in rice in Surinam (based on a scale of low [1] to high occurrence [5]), in descending order of economic loss, are:

- Leaf and neck blast [5]: Blast disease is caused by a fungus (*Pycularia grisea)*. The infection grade varies from year to year and by field. The infection grade depends on climate and environmental conditions, and on cultural measures used. Leaf blast is characterised by diamond shaped leaf spots, with a grey or white centre which often lead to complete dying of young rice production. Neck blast is characterized by infection of the plums, which often results in dead plums or partly filled plums. Usually blast resistance rice varieties are recommended. At the moment chemical control is usually used;
- Brown spot (*Helminthosporium*) [3]: Damage of brown spot is recognized by circular or oval spots with grey to light brown kern and a reddish brown edge of the leaves. Damage is caused in the tillering stage of the rice plant. Water and nutrient stress needs to be prevented since rice plants are more sensitive for brown spot. Seeds are usually pre-treated with fungicides. In serious cases, fungicides are sprayed in the tillering and flowering stages;
- Narrow brown spot (*Cercospora)* [3]: Narrow spot damage is usually diagnosed by short, narrow ellipsoidal brown spots on especially the leaves. Damage occurs during the entire growth period. Narrow spot is known to cause early ripening, grain discoloration, and an increase of calcium content. In serious cases, the fields are sprayed with fungicides; and
- Sheath blight (*Rhizoctonia Solani*) [1]: 1-3 cm oval or ellipsoidal green greyish spots on the leave above the water or soil surface. Infections are on leaves and plumes and cause empty grains, which leads to lower production. Sheath blight is prevalent from the tillering to the ripening stage of the rice crop. In general rice seeds are treated with fungicides, and in serious cases the fields are sprayed with fungicides.

Common weeds in rice in Surinam (based on a scale of low [1] to high occurrence [5]), in descending order of economic loss, are:

- Red rice *(Oryza spp*) [5]: Harmful stages: Entire growth duration. Usually farmers first plough the rice field and let whatever seeds there are in the field grow and kill them when they reach 15-20 cm by spraying with Gramaxone or Glyphosate. This method is done before sowing rice seeds in the field.  Another method to destroy red rice is to sow rice seeds under water.
- 'Djhoesa' (*Frimbristyllis miliacea)* [5]: This weed is known to cause damage during the entire rice growth period. Damage to the rice plant results in weak tillering and small plums. This weed is usually controlled with chemical herbicides. Sowing in water is also recommended.
- Banyard grasses (*Echinochloa spp.)* (4): This genus within the grass family comprises a range of different species (including millets), but when not grown on purpose they can turn into very notorious weeds. Early banyard grass (*Echinochloa oryzoides*), *for example,* looks in appearance in the young stage very much like the rice plant and is therefore difficult to distinguish. Shama grass (*Echinochloa Colonum*) can infect the rice fields very rapidly. *Echinochloa spp* are known as one of the most obstinately weeds in the world. This weed is known to get more than 80 % of N out of the soil, and is also a host for many virus diseases. Usually, under water sowing (10-15 cm) is recommended to suppress this weed. Chemical control with Bispiribac Sodium is also effective.

- 'Moraina' *(Ischaemum rugosum)* [2]: 'Moraina" is known to cause damage during the entire rice growth period. Damage to the rice plant results in weak stooling and small plums. This weed is usually controlled with chemical herbicides. Sowing in water is also recommended.
- 'Padiegras' (*Luziola spruceana)* [2]: 'Padiegras' is known to cause damage during the entire rice growth period. Damage to the rice plant results in weak stooling and small plums. Chemical control is usually done to destroy this weed.
- 'Pindagras' (*Sphenoclea zeylanica)* (2): This weed is known to cause damage during the entire rice growth period. Damage to the rice plant results in weak stooling and small plums. This weed is usually controlled with chemicals. Sowing in water is also recommended.

Common pests in rice in Suriname (based on a scale of low [1] to high occurrence [5]), in descending order of economic loss, are:

- Snails *(Pomacea dolioides)* [5]: Snails feed on young and emerging rice plants and can completely destroy a crop during crop establishment. Feeding results in missing seedlings, with cut leaves sometimes floating. Chemical control is recommended.
- Whorl maggots *(Hydrellia deonieri)* [5]: A very important pest in Suriname. Larvae cause damage by making a tunnel into the leaves and feed between the two leaf surfaces, feeding on cell juice. Often the entire leaf tip will wilt and die. Reduced tillering and stunted growth may result, and in badly affected rice production, delayed panicle initiation may occur. Damage is usually caused from week 1-4 after sowing. Chemical control is used in case of serious field situations.
- Stem borers *(Rupella albinella)* [5]: The rice borer also known as stem borer is a larvae of the white rice moth (*Rupella abinella*) and the brown rice moth (*Diatracea saccharalis)*. The larvae are very damaging in the stooling stage as well as in the bloom and the ripening stage of the rice plants. Damage in the stooling stage is called "dead heart" Damage in this stage result in a decreased number of stems. Damage in both the bloom and ripening phase is called 'white head' and is characterized by plumes with empty grains. Late sowing usually results in higher damage rates of the borer. Damage occurs from week 4-15 after sowing. In general, chemical control is used.
- Caterpillars (*Spodoptera frugiperda)* [4]: Larvae from the caterpillar (*Spodoptera frugiperda*) are known to cause damage by completely cutting of leaf tips. However, the greatest damage occurs on seedling rice, where plants are too young to flood. Control measures include deep ploughing to expose pupae to predators. Infested fields could be flooded for 24-48 hours in order to drown caterpillars. Spraying wit contact insecticides is recommended.
- Worms (*Lissorhoptrus foveolatus)* [4]: Damage by these worms results in bitten seedlings and roots. Damage occurs in 1-2 weeks after sowing. Chemical control with insecticides is recommended. Also, soil reclamation is recommended as a cultural measure.
- Seedbugs *(Oebalus poecilus)* [4]: Damage caused by the seed wants starts at the bloom and is usually controlled with pesticides. Nymphs and adults feed on the endosperm at milk and dough stages. Adults inject an enzyme to predigest sugars and in the process contaminate the grain with fungus that causes grain discoloration. Adults attack panicles which results in empty grains, malformation and discoloration of grains. As a result, lower yields are achieved, reduced

quality and brittleness, which result in increased breakage on milling. Chemical control is utilized.

- Grasshoppers (*Conocephalus cinerus)* [3]: Grasshoppers feed on leaves and grains in the milk stages. When feeding on the grain, they nibble on the husk and drink its milky contents. Grasshopper damage is clearly shown by white, empty grains with a panicle, often several close together. Damage occurs between 4-15 weeks after sowing. Chemical control is used and usually short sowing period is recommended.
- Plant hoppers (*Sogata oryzicola***)** [3]: Damage of these sucking insects results in a yellow orange discoloration of the plants. Usually these insects appear 4-10 weeks after sowing. Usually chemical control is utilized.
- Thrips (*Stenchaetothrips biformes)* [3]: Thrips damage results first in yellowing followed by red orange discoloration of the plants. In general, thrips are causing damage between 1-4 weeks after sowing. Usually chemical control is used (insecticides). Cultural measures such as putting rice plants for 2-3 days under water is also recommended.

Table 3 provides an overview of the various pesticides used by rice farmers. About 64% of the pesticides used by rice farmers are insecticides, 23% herbicides, and 15% are fungicides. Rather disturbing is the fact that farmers are using higher dosages of pesticides than recommended on the label – they seldom use the recommended dosage. Farmers use different types of pesticides and have, according to themselves, not perceived much toxicity (Kesharie 2016).

**Table 3: Reported pesticides used by rice farmers in Nickerie**

| | Insecticides | Herbicides | Fungicides |
|---|---|---|---|
| Before sowing | • Best- Act<br>• Brestan<br>• Karate<br>• Pannaly | • 2-4D Amine<br>• Glyphosate<br>• Gramaxone<br>• Nomina<br>• Roundup | |
| After sowing | • Admajor<br>• Best- Act<br>• Brestan<br>• Cyperkill<br>• Diazinon<br>• Fastac<br>• Hyperkill<br>• Karate<br>• Malathion<br>• Murella delta<br>• Pannaly<br>• Prontax<br>• Prontinex | • 2-4 D Amine<br>• Nomina | • Fuzi one<br>• Mancozeb<br>• Nativo |

Source: Kesharie (2016)

With regard to safety aspects, most of the farmers surveyed in Nickerie do not use pesticides safely. Only 31 out of 200 respondents reported to have received training in pesticide use. Farmers often rely on their own experiences when it comes to pesticide use. They often find the recommended dosage insufficient and apply more than recommended. They often also mix different types of pesticides into 'cocktails'. The investigation revealed that rice farmers consider pesticide use very dangerous and toxic for the environment, but not directly toxic for their own health.  Most respondents (83%) stated that they have never heard of Integrated Pest Management (IPM). At the same time, farmers stated that that they have sufficient experience and knowledge on the safety aspects of pesticides and how to use them properly. They also claim that they not have experienced any danger to their health. However, in the qualitative study, the majority of farmers (70%) indicated that they have experienced health effects such as burning sensation on their skin and their eyes, spots on the skin, and sneezing as a result of pesticide application. In general, it can be concluded that farmers have limited knowledge and awareness on health and environmental risks, particularly on the long term effects of chemicals and safe use of pesticides due to their low level of education.

Average costs of pesticide use per hectare rice are in the order of SRD 600-1000 for small farmer (Farmer's survey, July 2016).  Some farmers during the consultation indicated that they sprayed preventive regardless whether there was a problem. They mentioned pesticides costs of SRD 1000/ha and up. Other farmers, who spend more time in their fields, reported pesticide costs as low as SRD 400/ha.

## Project justification

According to IRRI, on average some 30-40% of the attainable rice yield is being lost every year due to weeds, pests and diseases.[7] This happens despite the fact that rice farmers do take the necessary measures to contain such losses, usually in the form of chemical interventions. The adoption of better agronomic practices, in particular integrated pest management, could reduce weed, pest and disease losses with a conservatively estimated 5 % (which is equivalent to a yield increase of 2.7%), while reducing the use of chemical pesticides with 10%.

In order to achieve this, a renewed effort will be made to make rice farmers aware of and trained in such better agronomic practices, while at the same time conduct research on improved IPM strategies for 'vogelzaad' weed (*Echinochloa spp.),* seedbugs *(Oebalus poecilus*), and leaf and neck blast disease as well as on less pesticide use during storage.

Rice breeding and soil fertility are two other factors that very much determine the productivity of rice production. ADRON will be receiving assistance from MARDI on these two factors in the coming years and hence the choice of this project to focus on weeds, pests and diseases.

Beneficiaries of this project will be rice farmers as well as a large group of people employed in the rice sector in various capacities.

## Interventions to date

Since 1997, ADRON has started with a research program in crop protection and Integrated Pest Management (IPM).  A start was made with conducting an inventory on the total rice production losses due to diseases, pests and weeds. In addition to this, the key pests were identified and described.

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[7] Sparks, A., A. Nelson, and N. Castill. 2012. 'Where rice pests and diseases do the most damage.' *Rice Today*, Vol. 11, No. 4. We assume that this range based on Asian data is also representative for Surinam, which was confirmed by ADRON's plant health specialist as a reasonable assumption.

However, no detail studies were conducted on key pests with regard to damage percentages, economic thresholds, pesticides investigations, etc.[8]

In 2007, ADRON started, in collaboration with FAO, a Farmer's Field School (FFS) which ran for several years. The purpose was to properly train farmers in various aspects of IPM. Emphasis was placed on how to show farmers that with a combination of optimum water management and biological control, the damage from pests and diseases can be kept under the economic threshold. During the FFS, the farmers observe their fields at least once a week and monitor their rice fields. They also received training in how to cut costs down but increase production. In 2012, the FFS was conducted by ADRON in the Van Drimmelen Polder in Nickerie. [9] Due to staff shortages, FFS has been discontinued in more recent years.

In 2009, ADRON conducted a diagnostic study on rice blast disease, and developed a factsheet on the development, identification and control measures.[10]

In 2011, ADRON, in collaboration with the Agricultural Production Department of ADEKUS conducted an investigation on post-harvest insects. Four insects were identified. The most frequent post- harvest insect was *Tribolium castaneum*. Some lab experiments were conducted to study the insecticidal properties of two natural products. The plants, *Tephrosia sinapou* and *Lantana camara* were dried and grinded, and then applied to the rice insects. However, results did not show significant insecticidal properties. It was recommended that more research on post-harvest insects is needed.[11]

In 2012, ADRON conducted research on weed management. From this study it was concluded that *Echinochloa spp.* ('vogelzaad') a common weed in the rice fields can cause a lot of damage because aside from the fact that they compete with rice plants for nutrition, they are also a host for fungi that are causing diseases. Adequate management of weed is therefore important, because in this manner fungi spores that can affect rice plants are then destroyed.[12]

In 2015, the Plant Health division of ADRON focused on the rice borer (*Rupela albinella*). This insect is known to cause a lot of damage in the rice stooling phase as well during the flower and in the ripening stadium of the rice plants. Based on the research results, measures to control the rice borer were described, including cultural measures including burning of all straw and stubbles, maintenance of all dams and canals, and seeding according to plant schedule.

## Project objectives

Main objective (i.e., goal): Strengthening of the rice sector in Suriname

Intermediate objectives (i.e., outcome):

- Enhanced productivity due to lower weed, pest and disease losses; and
- Use of chemical pesticides reduced.

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[8] Halteren, P. 1997. Reisverslag.Consultancy, ADRON, Anne van Dijk Onderzoekscentrum, Nickerie, Suriname
[9] Aleisi tori (2012).
[10] Aleisi tori (2009).
[11] Aleisi tori (2011).
[12] Aleisi tori (2011).

## Project outputs and activities

Project activities and outputs are summarized in table 4. Four types of losses are being addressed, namely: field losses due to weeds, field losses due to diseases, field losses due to pests, and post-harvest losses due to pests. Outputs 1-4 aim at producing IPM strategies for these four types of losses, output 5 aims to validate the recommended IPM strategies on-farm, output 6 aims at promoting IPM among farmers, output 7 aims at providing farmers tailor-made advice on plant health issues, and output 8 focuses on the monitoring of weeds, pests and diseases. Output 9 deals with capacity building of staff involved with the implementation of the project.

**Table 4: Project activities**

| **Output** | **Activities** |
|---|---|
| 1. IPM strategies developed for weeds in rice, with a specific emphasis on banyard grasses (*Echinocloa species*) | 1.1 Characterization of weeds in rice fields |
| | 1.2 Literature review on weed-control mechanisms in rice |
| | 1.3 International consultation of weed control experts |
| | 1.4 Formulation of IPM strategies for the most common weeds in rice |
| | 1.5 On-station testing of possible control strategies for 'vogelzaad' |
| | 1.6 Technical as well as economic analysis of test results and formulation recommendations |
| | 1.7 Development of an IPM training module for controlling weeds in rice |
| 2. IPM strategies developed for diseases in rice, with a specific emphasis on leaf and neck blast | 2.1 Literature review on control of diseases in rice |
| | 2.2 Development of a system for evaluating fungal infestations, including rating scales and counting methods |
| | 2.3 Formulation of IPM strategies for the most common diseases in rice |
| | 2.4 On-station testing of possible control strategies for neck and leaf blast in rice |
| | 2.5 Technical as well as economic analysis of test results and formulation recommendations |
| | 2.6 Development of an IPM training module for controlling diseases in rice |
| 3. IPM strategies developed for pests in rice, with a specific emphasis on seed bugs | 3.1 Literature review on control of pests in rice |
| | 3.2 Development of a system for evaluating pest infestations, including rating scales and counting methods |
| | 3.3 Formulation of IPM strategies for the most common pests in rice |
| | 3.4 On-station testing of possible control strategies for seed bugs in rice |
| | 3.5 Technical as well as economic analysis of test results and formulation recommendations |
| | 3.6 Development of an IPM training module for controlling pests in rice |
| 4. IPM strategy developed to reduce pesticide use during storage | 4.1 Literature review on pests during rice storage |
| | 4.2 Evaluation of the damage of primary and secondary post-harvest insects |
| | 4.3 Investigation of the efficacy of bio-pesticides on post-harvest insects |

| Output | Activities |
|---|---|
| | 4.4 Development of bio-control measures for storage insects |
| | 4.5 Development of an IPM training module for controlling postharvest in rice |
| 5. IPM strategies validated in farmer fields | 5.1 Conduct a survey in years 1, 3 and 5 to monitor the adoption and impact of IPM (see outcome indicators) |
| | 5.2 Conduct two on-farm trials per year to test IPM recommendations |
| | 5.3 Review, analyze and interpret collected trial data and publish results and recommendations |
| 6. Known as well as newly tested/validated IPM strategies promoted | 6.1 Publicity campaign using modern media |
| | 6.2 Production and distribution of an IPM guide for farmers |
| | 6.3 Organization of 2 on-farm demonstrations of IPM measures per year |
| | 6.4 Organization of 1 Farmer Field School per year |
| | 6.5 Organization of training courses for farmers on IPM strategies |
| 7. Farmer advisory service regarding pests and diseases implemented | 7.1 Joint ADRON-LVV plant health extension program for rice |
| | 7.2 Operation of diagnostic service for weeds, pests and diseases |
| 8. Weeds, diseases and pests in rice growing areas monitored | 8.1 Set up of a monitoring system for weeds, diseases and pests in rice |
| | 8.2 Seasonal data collection and database update |
| | 8.3 Analysis and evaluation of the collected data, which may lead to specific recommendations for the next season and/or adjustments of IPM strategies |
| 9. Capacity building | 9.1 On-the-job training of 3 research technicians working for the plant health division of ADRON |
| | 9.2 Training of 5 senior extension officers of LVV in rice plant health and IPM strategies |
| | 9.3 Training of research and extension staff in spraying technics for (bio-)pesticides |
| | 9.4 Training of research and extension staff in data collection based on GPS Technology |
| | 9.5 Upgrade staff members |
| 10. General project costs | 10.1 Project management |
| | 10.2 Vehicles |
| | 10.3 Plant health laboratory |
| | 10.4 ICT equipment |
| | 10.5 Stationary |

## Project results

See results matrix below.

**Table 5: Results matrix**

| **Project objective** | To strengthen the rice sector | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Outcome indicators** | **Base** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Target** | **Means of verification** |
| *Enhanced productivity due to lower weed, pest and disease losses* | | | | | | | | |
| Indicator 1: Reduction in pest and disease losses | Estimated at 1900-2900 kg/ha | 0% | 1% | 2% | 3% | 4% | 5% (=95-180 kg/ha) | 1. Survey<br>Comment: A reduction in losses translates itself in higher yields, but not all increase in yields can be attributed to a reduction in pest and disease losses. |
| *Use of chemical pesticides reduced* | | | | | | | | |
| Indicator 1: Expenditures on pesticides reduced | Estimated at SRD 600-1000 per ha | 0% | 2% | 4% | 5% | 8% | 10% | 1. Survey<br>Comment: Make sure expenditure data are corrected for inflation. |
| **Output indicators** | **Base** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Target** | **Means of verification** |
| *1. IPM strategies developed for weeds in rice, with a specific emphasis on 'vogelzaad'* | | | | | | | | |
| 1.1 IPM strategies for weeds in rice formulated | 0 | | 1 | | | | 1 | 1. IPM report on weeds in rice |
| 1.2 IPM strategy for 'vogelzaad' tested | 0 | | 1 | | | | 1 | 1. Test report |
| 1.3 Economic and technical analysis of IPM 'vogelzaad' strategy | 0 | | | 1 | | | 1 | 1. Research report |
| 1.4 IPM training module for weeds in rice developed | 0 | | | 1 | | | 1 | 1. Training module |
| *2. IPM strategies developed for diseases in rice, with a specific emphasis on leaf and neck blast* | | | | | | | | |
| 2.1 Fungal infestation measurement protocol/system developed | 0 | | 1 | | | | 1 | 1. Fungi measurement protocol document |
| 2.2 IPM strategies for diseases in rice formulated | 0 | | 1 | | | | 1 | 1. IPM report on diseases in rice |
| 2.3 IPM strategy for blast in rice tested | 0 | | 1 | | | | 1 | 1. Test report |
| 2.4 Economic and technical analysis of IPM strategy for blast in rice | 0 | | | 1 | | | 1 | 1. Research report |
| 2.5 IPM training module for diseases in rice developed | 0 | | | 1 | | | 1 | 1. Training module |
| *3. IPM strategies developed for pests in rice, with a specific emphasis on seed bugs* | | | | | | | | |
| 3.1 Pest infestation measurement protocol/system developed | 0 | | 1 | | | | 1 | 1. Pest measurement protocol document |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3.2 IPM strategies for diseases formulated | 0 | | 1 | | | | 1 | 1. IPM report on pests in rice |
| 3.3 IPM strategy for seed bugs tested | 0 | | 1 | | | | 1 | 1.Test report |
| 3.4 Economic and technical analysis of IPM strategy for blast in rice | 0 | | | 1 | | | 1 | 1. Research report |
| 3.5 IPM training module for pests in rice developed | 0 | | | 1 | | | 1 | 1. Training module |
| *4. IPM strategy developed to reduce pesticide use during storage* | | | | | | | | |
| 4.1 Evaluation of post-harvest losses in rice due to pests | 0 | | 1 | | | | 1 | 1.Evaluation report |
| 4.2 Efficacy of bio-pesticides on controlling post-harvest pests tested | 0 | | 1 | | | | 1 | 1. Test report |
| 4.3 Bio-control measures for post-harvest pests developed | 0 | | 1 | | | | 1 | 1. Research report |
| 4.4 IPM training module for pests in rice storage developed | 0 | | | 1 | | | 1 | 1. Training module |
| *5. IPM strategies validated in farmer fields* | | | | | | | | |
| 5.1 Surveys conducted to monitor adoption IPM | 0 | 1 | | 1 | | 1 | 1 | 1. Survey report |
| 5.2 Two on-farm trials per year to test IPM recommendations executed. | 0 | | | 2 | 2 | 2 | 6 | 1. Trial reports |
| 5.3 Farm trial results analysed | 0 | | | | | 1 | 1 | 1. Research report |
| *6. Known as well as newly tested/validated IPM strategies promoted* | | | | | | | | |
| 6.1 Number of YouTube videos released | 0 | | 2 | 2 | 3 | 3 | 10 | 1. YouTube videos uploaded |
| 6.2 IPM farmer guide produced and distributed | 0 | | | 500 | 400 | 300 | 1500 | 1. Publication<br>2. Stock figures |
| 6.3 Number of farmers that have visited an on-farm IPM demonstration | 0 | | | 200 | 200 | 200 | 600 | 1. List of visitors |
| 6.4 Number of farmers that have attended the farmer field school program | 0 | | | 15 | 15 | 15 | 45 | 1. List of participants per FFS<br>2. Evaluation of FFS by participants<br>Comment: Each year an FFS will be organized with a new group of participants. |
| 6.5 Number of farmers that have been trained in IPM strategies | 0 | | | 200 | 200 | | 400 | 1. List of participants per FFS<br>2. Evaluation reports of training events |
| *7. Farmer advisory service regarding weeds, pests and diseases implemented* | | | | | | | | |
| 7.1 Number of rice farmers contacted per | 0 | 100 | 200 | 300 | 400 | 500 | 500 | 1. Annual progress report |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| year | | | | | | | | |
| 7.2 Number of advisory reports produced | 0 | | 60 | 80 | 100 | 100 | 100 | 1. Annual progress report |
| *8. Weeds, diseases and pests in rice growing areas monitored* | | | | | | | | |
| 8.1 Monitoring system designed and functioning | 0 | | | 1 | | | 1 | 1. Inspection report |
| 8.1 Data collection | 0 | | | 2 | 2 | 2 | 6 | 1. Seasonal survey reports |
| 8.2 Collected data analysed | 0 | | | 2 | 2 | 2 | 6 | 1. Analysis reports |
| *9. Capacity building* | | | | | | | | |
| 9.1 Three plant health research technicians at ADRON trained on the job | 0 | 3 | | | | | 3 | 1. Evaluation report, including staff test before and after training |
| 9.2 Five senior extension staff of LVV trained in IPM | 0 | 5 | | | | | 5 | 1. List of staff trained<br>2. Evaluation of training by participants |
| 9.3 Research and extension staff trained in the use of GPS equipment to collect data | 0 | 9 | | | | | 9 | 1. List of staff trained<br>2. Evaluation of training by participants |
| 9.4 Educational upgrade of ADRON staff members (3 from MBO to HBO and 1 from BSc to MSc) | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 1. Annual study progress report<br>2. Copy of diploma obtained<br>Comment: Part-time study takes five years to complete. |
| *10.Overall project expenditures/activities* | | | | | | | | |
| 10.1 Vehicles for transport available | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 1. Vehicles in place |
| 10.2 Plant health laboratory built, equipped and staffed | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1. Inspection report |
| 10.3 Staff equipped with ICT equipment | 0 | 1 | 1 | 1 | 1 | 1 | 1 | All ICT requirements in place |
| 10.5 Project management | 0 | 1 | 1 | 1 | 1 | 1 | 5 | Project budget in control |

## Project implementation

ADRON will be the principal executor of the project, although there will also be a substantial contribution from LVV's extension service in the Western Region. The IPM specialist, who will be contracted full-time for the duration of the project, will also be the project manager (one day a week has been budgeted for this particular task). The project manager will be responsible for the implementation of the project and will report to a project oversight committee, which will consist of two representatives of ADRON (the director and a board member), a representative of LVV's extension service (the director of the Region West), and the Coordinator of the Agricultural Innovation Component, representing the Program Execution Unit (PEU) of the Loan. The latter entity handles the contribution of the IDB loan to the project (see figure 1). The PEU reports to both LVV and IDB.

The project oversight committee will meet at least twice a year, but more frequently if needed, and provide guidance to the project manager. The project manager will submit every six months a progress report to the project oversight committee and a projection of activities for the next 12 months.

Staff members of ADRON and LVV will be assigned to the project for a certain number of days per year (the red link). For the time they spend on project activities they report to the project manager. If there are issues that cannot be resolved within the project, the project leader can take this up with the oversight committee. Also staff specifically hired for the project by the PEU, will report to the project manager.

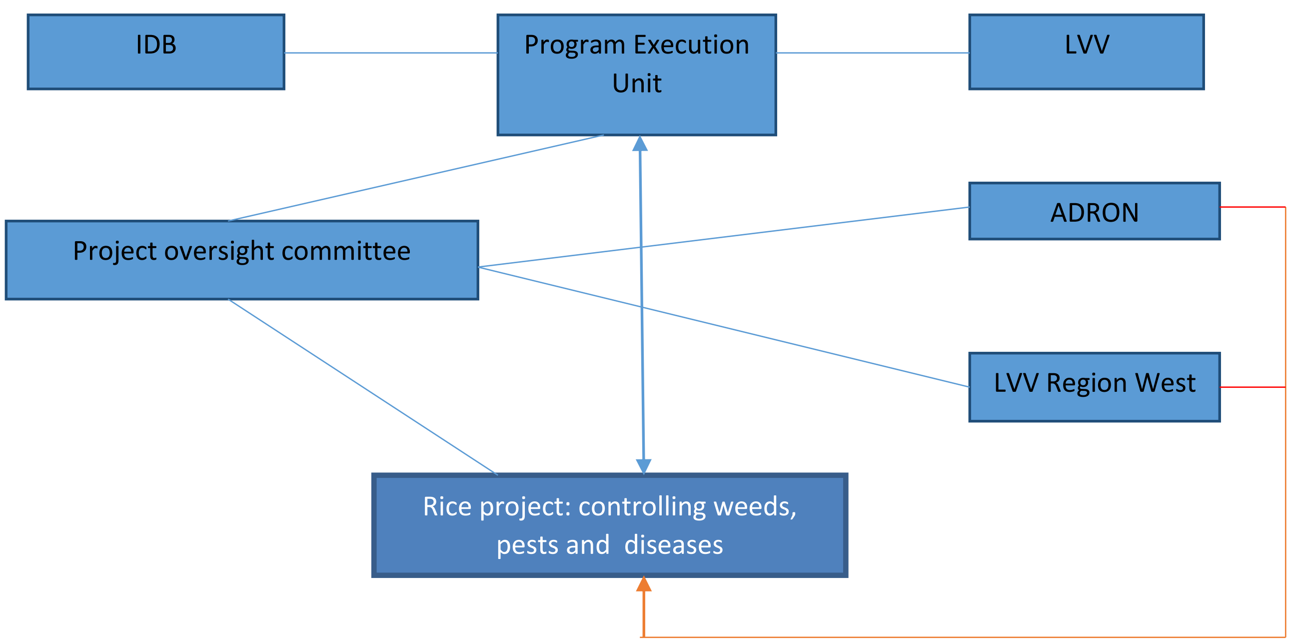


**Fig 1: Organigram project governance**

A key responsibility of the project manager will be to make sure that the various budgeted inputs needed for the implementation of the project activities are made available on time by the Program Execution Unit.

All project activities should be carried out within a period of five years. Table 6 summarize the project time table.

**Table 6: Project time table**

| | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1-i** | **1-ii** | **1-iii** | **1-iv** | **2-i** | **2-ii** | **2-iii** | **2-iv** | **3** | **4** | **5** |
| **1. IPM strategies developed for weeds in rice, with a specific emphasis on 'vogelzaad'** | | | | | | | | | | | |
| 1.1 Characterization of weeds in rice fields | ■ | ■ | ■ | ■ | | | | | | | |
| 1.2 Literature review on weed-control mechanisms in rice | ■ | ■ | | | | | | | | | |
| 1.3 International consultation of weed control experts | ■ | ■ | | | | | | | | | |
| 1.4 Formulation of IPM strategies for the most common weeds in rice | | | ■ | ■ | | | | | | | |
| 1.5 On-station and field testing of possible control strategies for 'vogelzaad' | | | | | ■ | ■ | ■ | ■ | | | |
| 1.6 Conduct technical as well as economic analysis of results and formulate recommendations | | | | | | | | ■ | | | |
| 1.7 Development of an IPM training manual for controlling weeds in rice | | | | | | | | | ■ | | |
| **2. IPM strategies developed for diseases in rice, with a specific emphasis on leaf and neck blast** | | | | | | | | | | | |
| 2.1 Literature review on control of leave and neck blast | ■ | ■ | | | | | | | | | |
| 2.2 Development of a system for evaluating fungal infestations, including rating scales and counting methods | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 2.3 Formulation of IPM strategies for the most common diseases in rice | | | | | ■ | ■ | ■ | ■ | | | |
| 2.4 On-station testing of possible control strategies for neck and leaf blast in rice | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 2.5 Technical as well as economic analysis of test results and formulation of recommendations | | | | | | | | | ■ | | |
| 2.6 Development of an IPM training manual for controlling diseases in rice | | | | | | | | | ■ | | |
| **3. IPM strategies developed for pests in rice, with a specific emphasis on seed bugs** | | | | | | | | | | | |
| 3.1 Literature review on control of seed bugs in rice | ■ | ■ | | | | | | | | | |
| 3.2 Development of a system for evaluating pest infestations, including rating scales and counting methods | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 3.3 Formulation of IPM strategies for the most common pests in rice | | | | | ■ | ■ | ■ | ■ | | | |
| 3.4 On-station testing of possible control strategies for seed bugs in rice | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 3.5 Technical as well as economic analysis of test results and formulation of recommendations | | | | | | | | | ■ | | |
| 3.6 Development of an IPM training manual for controlling pests in rice | | | | | | | | | ■ | | |
| **4. IPM strategy developed to reduce pesticide use during storage** | | | | | | | | | | | |
| 4.1 Literature review on pests during rice storage | ■ | ■ | | | | | | | | | |
| 4.2 Evaluation of the damage of insects during on-farm and off- | | | | | ■ | ■ | ■ | ■ | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| farm storage of rice | | | | | | | | | | | |
| 4.3 Investigation of the efficacy of bio-pesticides on post-harvest insects | | | | | | | | | | | |
| 4.4 Development of bio-control measures for storage insects | | | | | | | | | | | |
| 4.5 Development of an IPM training manual for controlling pests in rice storage | | | | | | | | | | | |
| **5. IPM strategies validated in farmer field** | | | | | | | | | | | |
| 5.1 IPM farm trials implemented | | | | | | | | | | | |
| 5.2 Conduct two on-farm trials per year | | | | | | | | | | | |
| 5.3 Review, analyze and interpret collected trial data and publish results and recommendations | | | | | | | | | | | |
| **6. Promotion of known as well as newly tested/validated IPM strategies** | | | | | | | | | | | |
| 6.1 Conduct a publicity campaign using modern media | | | | | | | | | | | |
| 6.2 Production and distribution of an IPM guide for farmers | | | | | | | | | | | |
| 6.3 Organization of 2 on-farm demonstrations of IPM measures per year | | | | | | | | | | | |
| 6.4 Organization of 1 Farmer's Field School per year | | | | | | | | | | | |
| 6.5 Organization of training courses for farmers on IPM strategies | | | | | | | | | | | |
| **7. Farmer advisory service regarding pests and diseases implemented** | | | | | | | | | | | |
| 7.1 Joint ADRON-LVV plant health extension program for rice | | | | | | | | | | | |
| 7.2 Operation of a diagnostic service for weeds, pests and diseases | | | | | | | | | | | |
| **8. Weeds, diseases and pests in rice growing areas monitored** | | | | | | | | | | | |
| 8.1 Design and set up of a monitoring system for weeds, diseases and pests in rice | | | | | | | | | | | |
| 8.2 Seasonal data collection and data base update | | | | | | | | | | | |
| 8.3 Analysis and evaluation of the collected data, which may lead to specific recommendations for the next season and/or adjustments of IPM strategies | | | | | | | | | | | |
| **9. Capacity building** | | | | | | | | | | | |
| 9.1 On-the-job training of 3 research technicians working for the plant health division of ADRON | | | | | | | | | | | |
| 9.2 Training of 5 senior extension officers of LVV in rice plant health and IPM strategies | | | | | | | | | | | |
| 9.4 Training of research and extension staff in data collection based on GPS Technology | | | | | | | | | | | |
| 9.4 Upgrade staff members | | | | | | | | | | | |
| **10. Overall project activities** | | | | | | | | | | | |
| 10.1 Project management | | | | | | | | | | | |
| 10.2 Vehicles | | | | | | | | | | | |
| 10.3 Plant health laboratory | | | | | | | | | | | |
| 10.4 ICT equipment | | | | | | | | | | | |
| 10.5 Stationary | | | | | | | | | | | |
| 10.6 Baseline and end-of-project surveys | | | | | | | | | | | |

## Project partners

This project intends to conduct more on-farm research in order to test IPM strategies under real farm conditions, involve rice farmers more closely in the development and adaptation of such strategies, and accelerate the uptake of IPM knowledge and technologies. This requires closer collaboration between all partners involved – farmers, researchers, and extension officers. A revival of the farmer field schools (FFS) could be a good starting point for also jointly identifying possible other themes for on-farm research. Eventually farmer field schools could evolve into farmer research groups that participate actively in ADRON's research.

Collaboration of ADRON with the agricultural extension division of LVV (represented by the Western Region Office and the district offices) is currently minimal. Over the years ADRON has developed its own extension activities through its Communications program. This process took place without an official policy view formulated jointly by SNRI and LVV. New varieties, the release of new information leaflets and disseminating information through TV, radio and other channels is undertaken unilaterally without specific feedback from the LVV Western Region office, district offices, and other stakeholders. This project aims to establish tighter collaboration between ADRON and the Western Region Office of LVV (which is responsible for extension in the main rice producing area) and coordinate their joint activities on the topic of IPM in rice. To this end, five senior extension officers will be trained in IPM by ADRON and spend, for the duration of the project, 50% of their time on extension activities related to IPM in rice.

Within Suriname, ADRON collaborates with the Agricultural Production Department of ADEKUS on various research topics. Such research is usually undertaken by students as part of their thesis work and requires the necessary coordination between ADRON and ADEKUS in terms of research topic selection and the availability of research infrastructure and ADRON staff. This standing practice will also apply to the current project and where possible students will be welcomed to contribute to the project. In addition to coaching students, faculty staff gets occasionally involved in rice research projects themselves. Some of the specialists to be contracted for the implementation of the current project could be recruited from the university on a consultancy basis. Moreover, students from ADEKUS will be recruited to assist with the survey in years 1, 3 and 5 (see output 5).

Outside Suriname, ADRON will collaborate with international research institutes (such as IRRI and CIAT) and with national rice research programs in the Caribbean and South America and further away in Asia. In this regard, the Malaysian Agricultural Research and Development Institute (MARDI) will be an important partner for ADRON on rice plant breeding and soil fertility in the coming years as a project financed by the Islamic Development Bank will be implemented in the coming years.

Within the region it would make sense to intensify the collaboration with the rice research station in Guyana, which services a rice production system that is quite similar to that of Surinam, and struggles with similar staff capacity problems. Both countries could benefit from such collaboration, by planning their research agenda jointly and trying to minimize duplication of research effort. However, this form of collaboration should be backed by a serious commitment from the governments of Suriname and Guyana.

Since 1996, ADRON collaborates with the International Network for the Genetic Evaluation of Rice (INGER) of the International Rice Research Institute (IRRI) in the Philippines. This collaboration ensures that the breeding program of the ADRON actively participates in the network and annually receives seed collections for review under Surinamese conditions. Likewise, varieties from Surinam were tested in 2004 and 2008 in about 30 places in the world.

ADRON also aims to become a member of the 'Fondo Latinoamericano para Arroz de Riego' (FLAR), which is a regional alliance of organizations in support of irrigated rice production, dealing with research, technology adoption, institutional strengthening and knowledge management. Membership would provide ADRON access to the gene bank of FLAR. FLAR is based at CIAT in Colombia, which is one of its founding members.

## Project budget

In table 7, a summary of the budget is provided per output. The general project cost budget line includes project management costs, the establishment and operation of a plant health laboratory, vehicles and motors, equipment, and stationary.

The overall budget of the project is approximately US$ 1,570,000, of which roughly US$ 1,149,000 will be financed by the IDB loan and the remainder (mostly salaries of permanent staff) by ADRON (US$ 326,000) and LVV (US$ 96,000). Moreover, ADRON and LVV will each pick up the bill for electricity, water, telephone, office space, etc., which have not been accounted for in the current budget. Detailed budget tables are available in Excel form and will be made available as an annex.

**Table 7: Project budget**

| Outputs | Funding | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total |
|---|---|---|---|---|---|---|---|
| | | US$ | | | | | |
| 1. IPM strategies developed for weeds in rice, with a specific emphasis on 'vogelzaad' | IDB | 9,740 | 39,526 | 7,857 | 0 | 0 | 57,123 |
| | ADRON | 4,920 | 5,040 | 0 | 0 | 0 | 9,960 |
| 2. IPM strategies developed for diseases in rice, with a specific emphasis on leaf and neck blast | IDB | 21,240 | 14,811 | 21,786 | 0 | 0 | 57,837 |
| | ADRON | 20,760 | 20,160 | 0 | 0 | 0 | 40,920 |
| 3. IPM strategies developed for pests in rice, with a specific emphasis on seed bugs | IDB | 26,240 | 14,811 | 21,786 | 0 | 0 | 62,837 |
| | ADRON | 20,760 | 20,160 | 0 | 0 | 0 | 40,920 |
| 4. IPM strategy developed to reduce pesticide use during storage | IDB | 2,500 | 15,617 | 7,571 | 0 | 0 | 25,688 |
| | ADRON | 600 | 4,140 | 0 | 0 | 0 | 4,740 |
| 5. IPM strategies validated in farmer fields | IDB | 7,150 | 0 | 17,510 | 10,360 | 17,510 | 52,530 |
| | ADRON | 600 | 0 | 7,260 | 6,660 | 7,260 | 21,780 |
| 6. Known as well as newly tested/validated IPM strategies promoted | IDB | 0 | 0 | 78,999 | 50,499 | 21,785 | 151,284 |
| | ADRON | 0 | 0 | 7,920 | 7,920 | 7,920 | 23,760 |
| 7. Farmer advisory service regarding weeds, pests and diseases implemented | IDB | 21,000 | 11,300 | 11,400 | 11,500 | 11,500 | 66,700 |
| | ADRON | 3,120 | 12,480 | 12,480 | 12,480 | 12,480 | 53,040 |
| | LVV | 15,750 | 15,750 | 15,750 | 15,750 | 15,750 | 78,750 |
| 8. Weeds, diseases and pests in rice growing areas monitored | IDB | 0 | 0 | 8,090 | 5,590 | 5,590 | 19,270 |
| | ADRON | 0 | 0 | 18,120 | 16,920 | 16,920 | 51,960 |
| | LVV | 0 | 0 | 4,320 | 4,320 | 4,320 | 12,960 |
| 9. Staff capacity strengthened | IDB | 26,261 | 9,665 | 5,000 | 5,000 | 5,000 | 50,926 |
| | ADRON | 0 | 0 | 0 | 0 | 0 | 0 |
| 10. General project costs | IDB | 281,147 | 58,357 | 71,214 | 80,714 | 58,357 | 549,790 |
| | ADRON | 12,600 | 12,600 | 12,600 | 12,600 | 12,600 | 63,000 |
| **Subtotal** | **IDB** | **395,278** | **164,088** | **251,214** | **163,664** | **119,742** | **1,093,985** |
| | **ADRON** | **63,360** | **74,580** | **58,380** | **56,580** | **57,180** | **310,080** |
| | **LVV** | **15,750** | **15,750** | **20,070** | **20,070** | **20,070** | **91,710** |
| Contingency 5% | IDB | 19,764 | 8,204 | 12,561 | 8,183 | 5,987 | 54,699 |
| | ADRON | 3,168 | 3,729 | 2,919 | 2,829 | 2,859 | 15,504 |
| | LVV | 788 | 788 | 1,004 | 1,004 | 1,004 | 4,586 |
| **Total** | **IDB** | **415,042** | **172,292** | **263,774** | **171,847** | **125,729** | **1,148,684** |
| | **ADRON** | **66,528** | **78,309** | **61,299** | **59,409** | **60,039** | **325,584** |
| | **LVV** | **16,538** | **16,538** | **21,074** | **21,074** | **21,074** | **96,296** |
| | **All** | **498,108** | **267,139** | **346,147** | **252,329** | **206,842** | **1,570,564** |

## Human Resources

Table 8 summarizes the human resources that have been budgeted to implement the various activities. Several research specialists will be contracted by the project for a limited period of time and charged against the IDB loan. In the case of the IPM specialist (which is more-or-less a full-time position), it would be better to hire such a specialist on a permanent contract, but that is currently not feasible because of budget constraints. ADRON is expected to provide all the research support staff that is needed to implement the project. This may require some internal reassignment of staff or recruitment of new staff.

LVV is expected to provide for the duration of the project five senior extension officers that will work for 50% of their time on IPM issues in rice (output 7). In addition, a contribution of 144 days/year is expected from extension staff to monitor the incidence of weeds, pests and diseases once the monitoring system is in place (output 8).

**Table 8: Human resources involved in the implementation of the project**

| | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Total** | **Cost** | **Source funding** |
|---|---|---|---|---|---|---|---|---|
| **Staff** | ***Days*** | | | | | | ***US$*** | |
| IPM specialist (contract) | 214 | 218 | 238 | 153 | 138 | 961 | 240,250 | IDB |
| Agronomist (contract) | 34 | 55 | 100 | 20 | 0 | 209 | 41,800 | IDB |
| Economist (contract) | 12 | 50 | 100 | 20 | 0 | 182 | 36,400 | IDB |
| Post-harvest specialist (contract) | 10 | 25 | 10 | 0 | 0 | 45 | 9,000 | IDB |
| Other specialists (contract) | 5 | 10 | 0 | 0 | 0 | 15 | 2,750 | IDB |
| | | | | | | | | |
| ADRON staff time – HL | | 26 | 26 | 26 | 26 | 104 | 12,480 | ADRON |
| ADRON staff time – ML | 744 | 845 | 525 | 495 | 505 | 3,114 | 186,840 | ADRON |
| ADRON staff time – LL | 624 | 692 | 456 | 456 | 456 | 2,684 | 80,520 | ADRON |
| | | | | | | | | |
| LVV extension staff time – ML | 525 | 525 | 669 | 6 69 | 669 | 3,057 | 91,710 | LVV |
| | | | | | | | | |
| Farmers | | | 360 | 360 | 360 | 1,080 | 32,400 | ADRON |
| Students | 100 | | 100 | | 100 | 300 | 9,000 | IDB |

## Capital items

Table 9 summarizes the main capital items that will be purchased for the execution of the project. The establishment of a new plant health laboratory is by far the biggest investment (in total some US$ 171,000 in terms of capital expenditures) that will be undertaken by the project.

**Table 7: Capital items that will be acquired for the project**

| Activity | Capital item | Price/unit | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|---|---|
| Project | Pick up | 40,000 | 2 | | | | |
| Project | Motor | 2,000 | 5 | | | | |
| Project | Construction costs laboratory | 40,000 | 1 | | | | |
| Project | Lab furniture | 20,000 | 1 | | | | |
| Project | Lab equipment | 73,290 | 1 | | | | |
| Project | Other lab equipment | 7,500 | 1 | 1 | 1 | 1 | 1 |
| Project | Copy/printer machine | 2,500 | 1 | | | 1 | |
| Project | Projectors | 2,000 | 1 | | | 1 | |
| Project | Laptops | 1,000 | 2 | | | 2 | |
| Project | Desktop | 1,000 | 2 | | | 2 | |
| Project | Drives | 500 | 2 | | | 2 | |
| 1.1 | Equipment (GPS data collectors, etc.) | 2,500 | 1 | | | | |
| 2.2 | Equipment | 5,000 | 1 | | | | |
| 2.4 | Equipment | 5,000 | 1 | | | | |
| 3.2 | Equipment | 5,000 | 1 | | | | |
| 3.4 | Equipment | 5,000 | 1 | | | | |

## Service contracts

Table 8 summarizes the service contracts that will have to be contracted in order to implement the project. Indicative terms for consultants to be hired for the project are provided in Annex A.

**Table 8: Service contracts**

| | | | Year of acquisition | | | | |
|---|---|---|---|---|---|---|---|
| **Activity** | **Contract** | **Price/unit** | **1** | **2** | **3** | **4** | **5** |
| IPM specialist | Full-time contract | 50,000 | 1 | 1 | 1 | 1 | 1 |
| Agronomist | Contracts for limited periods | 200 | 34 | 55 | 100 | 20 | 0 |
| Economist | Contracts for limited periods | 200 | 12 | 50 | 100 | 20 | 0 |
| Post-harvest specialist | Contracts for limited periods | 200 | 10 | 25 | 10 | 0 | 0 |
| Other specialists | Contracts for limited periods | 200 | 5 | 10 | 0 | 0 | 0 |
| Activity 6.1: Promotion campaign | Contract production videos and promotion material | 5000 | | | 1 | 1 | 1 |
| Activity 6.2: Production IPM guide | Text writer | 150 | | | 50 | | |
| | Layout specialist | 100 | | | 20 | | |
| | Printing of guidelines | 18000 | | | 1 | | |

## Annex A: Indicative Terms for Consultants to be Hired by the Project

Overall project

Input needed from an Integrated Pest Management (IPM) specialist (internationally advertised) for the duration of the project (i.e., 5 years) on a full-time basis.

TOR

Working under the direct supervision of the director of ADRON, the IPM specialist will:

1. Lead the implementation of the project;
2. Interact with the procurement office of the Program Execution Unit in order to facilitate an on-time release of project inputs;
3. Supervise the activities of the various ADRON and LVV staff involved in the project;
4. Supervise the activities of the various consultants recruited on the behalf of the project;
5. Provide technical input into the various project activities as specified in the budget;
6. Report back to the Supervising Committee as well as Program Execution Unit; and
7. Conduct other ad hoc activities that may deemed necessary for the smooth implementation of the project.

Output 1: IPM strategies developed for weeds in rice, with a specific emphasis on ‘vogelzaad’

A. Input needed from a local agronomist for 40 working days (30 days in year 2 and 10 days in year 3).

TOR

Working under the direct supervision of the project leader, the agronomist will:

1. Assist with the formulation of IPM strategies for the most common weeds in rice;
2. Conduct, together with an economist, the analysis of the field trials testing possible strategies to control ‘vogelzaad’; and
3. Assist with the development of an IPM training module for controlling weeds in rice.

B. Input needed from a local economist for 40 working days (30 days in year 2 and 10 days in year 3).

TOR

Working under the direct supervision of the project leader, the economist will:

1. Assist with the formulation of IPM strategies for the most common weeds in rice;
2. Conduct, together with an agronomist, the analysis of the field trials testing possible strategies to control ‘vogelzaad’; and
3. Assist with the development of an IPM training module for controlling weeds in rice.

Output 2: IPM strategies developed for diseases in rice, with a specific emphasis on leaf and neck blast

A. Input needed from a local agronomist for 40 working days (10 days in year 2 and 30 days in year 3).

TOR

Working under the direct supervision of the project leader, the agronomist will:

1. Assist with the formulation of IPM strategies for the most common diseases in rice;
2. Conduct, together with an economist, the analysis of the field trials testing possible strategies to control leaf and neck blast; and
3. Assist with the development of an IPM training module for controlling diseases in rice.

B. Input needed from a local economist for 40 working days (10 days in year 2 and 30 days in year 3).

TOR

Working under the direct supervision of the project leader, the economist will:

1. Assist with the formulation of IPM strategies for the most common diseases in rice;
2. Conduct, together with an agronomist, the analysis of the field trials testing possible strategies to control leaf and neck blast; and
3. Assist with the development of an IPM training module for controlling diseases in rice.

Output 3: IPM strategies developed for pests in rice, with a specific emphasis on seed bugs

A. Input needed from a local agronomist for 40 working days (10 days in year 2 and 30 days in year 3).

TOR

Working under the direct supervision of the project leader, the agronomist will:

1. Assist with the formulation of IPM strategies for the most common pests in rice;
2. Conduct, together with an economist, the analysis of the field trials testing possible strategies to control seed bugs; and
3. Assist with the development of an IPM training module for controlling pests in rice.

B. Input needed from a local economist for 40 working days (10 days in year 2 and 30 days in year 3).

TOR

Working under the direct supervision of the project leader, the economist will:

1. Assist with the formulation of IPM strategies for the most common pests in rice;
2. Conduct, together with an agronomist, the analysis of the field trials testing possible strategies to control seed bugs; and
3. Assist with the development of an IPM training module for controlling pests in rice.

Output 4: IPM strategy developed to reduce pesticide use during storage

A. Input needed from a local post-harvest specialist for 45 working days (10 days in year 1, 25 days in year 2, and 10 days in year 3)

TOR

Working under the direct supervision of the project leader, the post-harvest specialist will:

1. Conduct a literature review on pests during rice storage;
2. Take the lead on evaluating the damage of insects during on-farm and off-farm storage of rice;
3. Take the lead on investigating the efficacy of bio-pesticides on post-harvest insects;
4. Develop a set of bio-control measures for storage insects; and
5. Develop an IPM training module for controlling post-harvest losses in rice together with an agronomist and an economist.

B. Input needed from an agronomist for 10 working days in year 3

TOR

Working under the direct supervision of the project leader, the agronomist will:

1. Assist with the development of an IPM training module for controlling post-harvest losses in rice together with a post-harvest specialist and an economist.

C. Input needed from an economist for 10 working days in year 3

TOR

Working under the direct supervision of the project leader, the economist will:

1. Assist with the development of an IPM training module for controlling post-harvest losses in rice together with a post-harvest specialist and an agronomist.

Activity 6.5: Organization of training courses for farmers on IPM strategies (three-day course, 40 farmers per course, 10 courses in total)

A. Input needed from a local agronomist for 40 days (20 days in year 3 and 20 days in year 4)

TOR

Working under the direct supervision of the project leader, the agronomist will:

1. Prepare, together with the IPM specialist and an economist, a three-day training course, based on the training modules developed under the outputs 1-4 (8 days);
2. Deliver the training course ten times across the main rice producing areas (30 days); and
3. Further fine tune the course based on feedback received from farmers (2 days).

B. Input needed from a local economist for 40 days (20 days in year 3 and 20 days in year 4)

TOR

Working under the direct supervision of the project leader, the economist will:

1. Prepare, together with the IPM specialist and an agronomist, a three-day training course, based on the training modules developed under the outputs 1-4 (8 days);
2. Deliver the training course ten times across the main rice producing areas (30 days); and
3. Further fine tune the course based on feedback received from farmers (2 days).

Output 9: Capacity building

A. Input needed from a local agronomist for 39 days (34 days in year 1 and 5 days in year 2)

TOR

Working under the direct supervision of the project leader, the agronomist will:

1. Assist with the development of a manual on weeds, diseases, and pests in rice production for research technicians and researchers (20 days);
2. Participate in the on-the-job training of ADRON staff in recognizing weeds, pests and diseases in rice (4 days);
3. Train ADRON staff in laboratory-based diagnostic technics for diseases, pests and weeds (5 days);
4. Participate in the on-the-job training of ADRON staff in statistical methods (5 days); and
5. Participate in the training of senior extension staff in rice plant health and IPM (5 days).

B. Input needed from a local economist for 12 days in year 1

TOR

Working under the direct supervision of the project leader, the economist will:

1. Assist with the development of a manual on weeds, diseases, and pests in rice production for research technicians and researchers (10 days); and
2. Participate in the on-the-job training of ADRON staff in recognizing weeds, pests and diseases in rice (2 days).

C. Input needed from a local statistical expert for 5 days in year 2.

TOR

Working under the direct supervision of the project leader, the statistical expert will:

1. Train, together with an agronomist, ADRON staff in statistical methods.

D. Input needed from a local extension specialist for 5 days in year 2.

TOR

Working under the direct supervision of the project leader, the extension specialist will:

1. Train ADRON staff in extension and communication skills.

E. Input needed from a local pesticide spraying specialist for 4 days in year 1.

TOR

Working under the direct supervision of the project leader, the pesticide spraying specialist will:

1. Train ADRON and LVV staff in pesticide spraying techniques.

F. Input needed from a local GPS/data collection specialist for 1 day in year 1.

TOR

Working under the direct supervision of the project leader, the GPS/data collection specialist will:

1. Train ADRON and LVV staff in data collection using GPS technology