Strengthening of Open-Field Vegetable Production

Abstract

There are some 3,000 to 4,000 vegetable producers in Surinam. Most of them are part-time farmers producing on small plots (i.e., 1600-3200 m2 on average) that are not always appropriate for vegetable production (i.e., insufficient drainage). Except for land preparation, mechanization of vegetable production is minimal. Pesticides, however, are applied widely, but not always appropriately. Lack of effective control on the use of pesticides impedes access of Surinamese vegetables to most export markets and/or forces exporters to have each consignment tested.

Yields of several local vegetable varieties will be improved by replacing the current, deteriorated seed stock by seed that has been cleaned by LVV's seed unit. At the same time farmers will be trained in how to save good quality seeds in order to slow down future deterioration (output 1).

Improved production practices based on ICM and IPM will be developed and validated (output 2) and new production manuals for seven selected vegetables will be developed and released (output 3). The transfer of knowledge regarding ICM and IPM in vegetable production is further strengthened by training, on-farm demonstrations and YouTube instruction videos (output 4). This should also help vegetable growers to comply with food safety standards, which are expected to be enforced more rigorously in Suriname in the near future.

Introduction

Total vegetable production[1] in Surinam reached 24,569 tons in 2014, with a total value of approximately US$ 30.3 million. Area under production constituted 1436 ha in 2014. Between 2009 and 2014, the reported area under production and volume produced about doubled. Since the value of vegetable exports (mainly to the Netherlands) remained during this period stagnant at about US$ 1.5 million per annum (or about 5% of the total vegetable production in terms of value in 2014), the additional production must have ended up mainly in the local market. There is frequent mention of informal export of fruits and vegetables, in particular to French Guyana, but there are no hard data on this. [2]

Despite the rapid growth in local vegetable production, the import of vegetables (both fresh and processed) continued to increase from US$ 12.5 million in 2009 to US$ 16.4 million in 2014.[3] Apparently the consumption of vegetables received a major boost during the period 2009-2014.

Despite rapid growth in recent years, the vegetable sector has not been able to increase its export (an important policy objective) or substitute for vegetable imports. The latter is possible only to some extent as some of the vegetables imported (such as potatoes and onions) are not well suited to be grown in a tropical climate. Export markets are difficult to reach for various reasons, but most importantly:

a. Surinam does not have its 'house in order' in terms of operating proper food safety standards. Food safety legislation is not complete yet, agricultural inspection is absent, and the laboratory capacity to test (e.g., the residue laboratory) not yet operational. For many countries this is a reason to ban all vegetable import from Surinam or place it under very tight scrutiny. The Netherlands, for example, tests all vegetable consignments from Surinam and not without reason – 15% of all consignments tested over the past two years (2014-2015) were rejected because of MRL violations[4];
b. Inadequate cooling of the products during transport (in particular at the airport), which very much affects their quality;
c. High transportation costs (Surinam has only a limited number of direct connections to other countries); [5] and
d. Relatively high production costs. Vegetable export to the Netherlands targets mainly the large Surinamese community living there (about half a million), which has a weak spot for typical Surinamese products. Outside that market segment, competition on price and quality is a lot tougher.

Not having a proper food safety standards system in place is in the first place a major threat to the well-being of the local population. Farmers tend to use pesticides freely and widely, but not always appropriately. With no inspection system in place, the chances of being caught when making shortcuts on good agricultural practices are minimal. Moreover, LVV's principal publication on

[1] Definitions of what constitutes vegetable production differ between (statistical) publications. In some instances roots and tubers are included under vegetables (e.g., onions and potatoes), while in other instances they are not. In this project document we have labelled 'sweet potato' a vegetable.
[2] LVV. 2016. Agricultural Production Statistics. Paramaribo: LVV.
[3] Import data downloaded (spring 2016) from the International Trade Statistics Database (UN Comtrade). These vegetable import statistics also include potatoes and onions, which make up a substantial part of the reported vegetable import.
[4] A study by Tulane University reported a 20% rejection by the Dutch authorities because of MRL violation for the years 2011-2013. The 2014-2015 data suggest that things have slightly improved.
[5] LVV. 2011. Beleidswitboek Agribusiness. Paramaribo: LVV.

vegetable production[6] focuses mainly on chemical solutions to control pests and diseases. For example, it frequently recommends the use of malathion, an insecticide which has been banned by the European Union since 2007. Moreover, this publication does not mention the use of compost whatsoever. An update of these recommendations is very much needed; offering farmers more environmentally friendly solutions based on Integrated Pest Management (IPM) and Integrated Crop Management (ICM) strategies. For example, most farmers do not use compost to improve the physical and chemical composition of their soil. They are unfamiliar with the practice, are not convinced, or consider it as too much work. Still a lot of promotion of the practice needs to be done. Similarly, a great deal of promotion needs to be done to make sure that farmers only use pesticides that are allowed and use them properly and follow Good Agricultural Practices (GAP).

The expectation is that a proper functioning food safety system will be implemented in the coming years (see the Food Safety Component under the Loan), requiring vegetable growers to adjust their production practices in order to comply. They can achieve that by adopting more full-heartedly concepts such ICM, IPM, and GAP. If not, they will run the risk of their produce being rejected not only in export markets, but also in local markets.

Under the project, specific attention will be given to the following vegetable crops: eggplant (locally known as boulanger), bitter gourd (locally known as sopropo), okra (locally known as oker), yard long beans (locally known as kouseband), chili peppers, tomatoes, and sweet potatoes. These crops have been selected because: (a) they are the more important ones in terms of area grown; and (b) they have some export or import-substitution potential.

The aim of this project is to raise the productivity of open-field vegetable production and at the same time secure greater compliance with food safety and GAP standards.

Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. (FAO definition)

Integrated Crop Management (ICM) is a system of crop production which conserves and enhances natural resources while producing food on an economically viable and sustainable foundation. It is based on a good understanding of the interactions between biology, environment and land management systems

Background

The main vegetable production areas targeting the market are concentrated in the districts: Saramacca, Wanica, Para, and Commewijne. According to the Agricultural Census of 2008, there are 10,188 family farms of which 4,189 are in the above mentioned districts. Most of them are part-time farmers active in the horticulture sector. On average, they have some 1600-3200 m2 in production for vegetables. They typically focus on monoculture of a specific vegetable crop during several growing seasons. Most of the labour input is coming from family members or day labourers. Except for land preparation, hardly any mechanization is being used. The education level of most of the

[6] ODLOAV-LVV. 2005. Land- en Tuinbouwgewassen: Deel II Groente- en peulgewassen. Paramaribo: LVV.

farmers is low and production activities are funded with mainly own capital. Produce is usually sold to traders. Risks in vegetable production are relatively high – crops are relatively sensitive to weather conditions, pests and diseases. Nevertheless, vegetable production is attractive because of its relatively short production cycle and high value of output per square meter.

Ranked according to the area harvested, the most important vegetable crops grown in 2014 were: *yard-long beans (176 ha)*, *okra (137 ha)*, *chili pepper (127 ha)*, pumpkin (116 ha), *tomatoes (102 ha)*, *eggplant (96 ha)*, *bitter gourd (93 ha)*, Chinese cabbage (73 ha), cucumber (70 ha), tannia leaves (70 ha), *eggplant bitter (62 ha)*, cabbage (57 ha), and French beans (29 ha). The crops in italics will covered by this project. A long list of other vegetables covers another 204 ha. Sweet potato is grown on 51 ha. The seven selected vegetables crops represent 59% of the total area under vegetable production. It is expected, however, that a great deal of the good practices promoted by the project will also spill over to the other vegetable crops.

Table 1 reports for the selected open-field vegetable crops the type of seed being used, the average yield reported, and how this yield compares with the reported highest yield in the region. For most of the vegetable crops, farmers use their own farmer-saved seed or purchase such seed from other farmers. According to Everaarts, et al (2012)[7], production volumes of vegetables in Surinam are too small to sustain specialized seed companies. In as far as commercial seed is being traded, these are all imported seeds produced by foreign seed companies.

Table 1: Vegetable crop characteristics

Crop	**Type of seed/planting material used**	**Average yield**	**Benchmark**	
Yard long beans (*Vigna sesquipedalis*)	Own or locally purchased seed of rather poor quality.	14.0 ton	10.9 ton	Jamaica
Okra (*Abelmoschus esculentus*)	Local seed or imported variety	14.1 ton	23.9 ton	Bahamas
Chili pepper (*Capsicum chinense*)	Own or locally purchased seed of rather poor quality.	22.2 ton	27.0 ton	CARDI
Tomatoes (*Lycopersicon esculentum*)	Mostly imported seeds, but also some own seeds of impure lines	11.7 ton	123.5 ton[8]	Chile
Eggplant (*Solanum melongena*)	Own or locally purchased seed of rather poor quality.	28.5 ton	76.4 ton	Mexico
Bitter gourd (*Momordica charantia*)	Own or locally purchased seed of rather poor quality.	16.3 ton	25.3 ton	Peru
Sweet potato (*Ipomoea batatas*)	Farmers reproduce planting material of local varieties by cuttings and tubers. Five new varieties have recently been imported from Cuba.	9.8 ton	20.5 ton	Barbados

Trade of local seed is mainly between farmers. Unfortunately, however, the quality of farmer saved seeds tends to be poor because of poor seed saving practices. They are often not genetically pure, infected with pathogens, and seedlings are not uniform. Replacement of the current deteriorated genepool with healthy, pure seed or planting material is necessary for all seven crops, except tomatoes. The first option is to look for foreign varieties for which good-quality seeds can be obtained from research institutes or seed companies abroad and that could replace the current

[7] Everaarts, A.P., E. Doelahasori, R. Kromokardi, and M. Dipotaroeno. 2012. Groentenzaad voorziening in Suriname. Wageningen, The Netherlands: DLO-PPO and LVV-ODLOAV.

[8] This yield most likely reflects a great deal of production in greenhouses. Unfortunately, international statistics do not make a differentiation in the technology used to produce agricultural products.

genepool. In the case of chili peppers, for example, CARDI produces seeds of the 'scotch bonnet' variety (one of the popular varieties in Suriname) as well as several other chili pepper varieties. Also for the other vegetables there are similar options of importing high-quality seeds possible, but they are often not accepted in the market as consumers (both in Suriname and the Netherlands) have a strong preference for the traditional varieties known in Suriname. In that instance there is no other solution than to make an effort in cleaning up the available seed stock of that crop and distribute disease-free seed of high purity to farmers. At the same time, farmers should be trained how to save and manage seed properly in order to slow down the deterioration of the seed stock. This intervention should help to boost yields significantly.

The soil type of the important vegetable districts is mostly sand and clay. Poor drainage of fields can be very problematic during the rainy season due to poor design of the fields and poor maintenance or limited capacity of the primary waterway infrastructure, while during the dry season water shortages can have a negative impact on production and quality. Fertilizers are applied rather crudely, without much understanding of the chemical composition of the soil type. In addition, the use of compost has not been adopted widely, despite various demonstration and awareness campaigns.

Vegetable production in Suriname is also much affected by various pests and diseases (see table 2). Chemical pesticides to control pests and diseases are quite popular and widely used, but also misused (i.e., higher and more frequent doses than recommended, mixing pesticides, and using forbidden pesticides). This misuse of pesticides endangers consumers' health as well as access to export markets and can also lead to resistance built by pest and diseases for the pesticides used. Other control measures, based on IPM, such as preventive practices, bio-control measures and bio-pesticides are still being used very sparsely.

All of the open-field vegetables selected for this project are grown primarily for the local market and in a few instances also for export to the Netherlands – i.e., yard long beans, okra, bitter gourd and sweet potato (the 'blau kop' variety). Export of eggplant to the Netherlands has declined in recent years because of competition by other suppliers. Even for a very traditional Surinamese crop such as yard long beans, other suppliers than Suriname are finding their way to the consumer in the Netherlands. Looking at the export figures, vegetable export by Suriname has been rather stagnant for the past decade. The strategy of the vegetable exporters to focus only on a small niche market (i.e., the population in the Netherlands of Surinamese descent) has no real future as the next generation of Dutch of Surinamese descent will be less attached to the taste of typical Surinamese products. Opening up of vegetable export to other markets (in particular in the Caribbean) has been very difficult to date as: (a) no quality guarantees can be provided in the absence of a functioning food safety system; (b) flight connections are limited and transport is expensive; and (c) limited competitiveness in demanding markets.

In order to overcome the transport bottleneck to some extent, it could make sense to aim at exporting (semi-)processed vegetable products. For example, chili peppers can be dried or turned into pulp or chili sauces. However, this is only an option for a few vegetables.

Table 2: List of pest and diseases in the selected vegetables

Crop	Insects	Fungus/bacteria	Nematodes	Other
Yard long beans	Trigona bees Mites White flies Aphids Beetles Mole cricket	Leaf spot/diseases: Mildew, *Rhizoctonia* sp., *Cercospora* sp, *Corynospora* sp, etc. Fruit spot: *Colletotrichum* sp. Soil borne diseases: *Sclerotium rolfsii*	Root knot: *Meloidogyne* spp. Lesion: *Pratylenchus* spp., *Helicotylenchus* spp. and *Radopholus similis*	Virus
Eggplant	White flies Fruit borer Thrips Mites Aphids Beetles Caterpillar Gall midge Stinkbugs	Leaf spot/ diseases: *Fusarium* sp., *Corynospora* sp, etc. Fruit spot: *Phytopthora* sp., *Phomopsis* sp., Soil borne diseases: *Sclerotium rolfsii*, *Ralstonia* sp. , *Fusarium* sp.	Root knot: *Meloidogyne* spp. Lesion: *Pratylenchus* spp., *Helicotylenchus* spp. and *Radopholus similis*	Disorder of plant and fruit (boeboe siki)
Okra	Aphids Ants Beetles Mealy bugs Whiteflies Mole cricket Stinkbugs	"Roetdauw"	Root knot: *Meloidogyne* spp. Lesion: Pratylenchus spp., *Helicotylenchus* spp. and *Radopholus similis*	
Chilli pepper	White flies Thrips Caterpillar Mites Aphids Cutting ants	Leaf spot/ diseases: *Cercospora* sp, *Corynospora* sp, etc.. Soil borne diseases: *Sclerotium rolfsii*, *Ralstonia* sp. and *Fusarium* sp.	Root knot: *Meloidogyne* spp. Lesion: *Pratylenchus* spp., *Helicotylenchus* spp. and *Radopholus similis*	Anthracnose Unidentified leafrot
Bittergourd	Stinkbugs Thrips Mites Aphids Gall midges	Leaf spot/ diseases: *Cercospora* sp, *Corynospora* sp, etc. Fruit spot: *Colletotrichum* sp. Soil borne diseases: *Sclerotium rolfsii*, *Fusarium* sp.	Root knot: *Meloidogyne* spp. Lesion: *Pratylenchus* spp., *Helicotylenchus* spp. and *Radopholus similis*	Kalium deficiency
Tomato	White flies Fruitborer Thrips	Leaf spot/ diseases: *Cercospora* sp, *Corynospora* sp, etc. Fruit spot: *Erwinia* sp., Soil borne diseases: *Sclerotium rolfsii*, *Fusarium* sp., *Ralstonia* sp., Damping off	Root knot: *Meloidogyne* spp. Lesion: *Pratylenchus* spp., *Helicotylenchus* spp. and *Radopholus similis*	Anthracnose Catface Blossom End Rot Cracking
Sweet potato	Mole cricket White flies Beetles Tuber borer Catterpillars	Soil borne disease: *S. rolfsii*	Root knot: *Meloidogyne* spp.	

Project justification

The three big challenges the vegetable sector in Surinam is facing are:

a. How to increase its productivity in a sustainable way in order to compete in local as well as international markets and to generate more income. The recent economic and financial crisis forces vegetable growers to reconsider the use of increasingly expensive, imported inputs such as pesticides and fertilizer. Hence alternative strategies based on ICM and IPM concepts to raise productivity are very much needed;
b. How to secure compliance with food safety and GAP standards. Vegetable farmers are insufficiently aware of what this entails and how they have to alter their production techniques and practices in order to comply with given standards. Attempts of introducing GAP in the past have largely failed because there was no proper follow up; and
c. How to develop and strengthen value chains and markets for its produce locally as well as internationally.

This innovation project will focus in particular on the first two challenges[9] and proposes the following measures:

1. Improve/maintain the quality of vegetable seeds produced by farmers. Production volumes of vegetables in Surinam are too small to warrant the establishment of local seed companies (Everaarts, et al 2012). Farmers rely either on purchasing imported seeds, on producing their own seed, or on purchasing farmer-produced seed from neighbouring farmers. In the case of farmer-produced seed, the quality of the seed depends strongly on the skill of the farmer to do so. In the case of the local varieties of eggplant, yard long beans, okra, and bitter gourd, the quality of the farmer-produced seed has eroded so much that the production of properly cleaned seed by professionals (i.e., the seed unit of ODLOAV) is needed. For sweet potato, something similar applies to the planting material used by farmers;
2. Validation of new production recommendations for open-field vegetables, based on ICM and IPM concepts;
3. The development of new production manuals for eggplant, bitter gourd, okra, yard-long beans, chili peppers, tomato and sweet potato, integrating the latest insights of ICM and IPM approaches. These manuals should also inform farmers about how to comply with food safety and GAP standards as well as with organic production standards if they want to target that market; and
4. Promotion of specific production practices in the form of training and demonstrations.

Beneficiaries of the project will be: (a) small- to medium-sized vegetable producers as they will be able to grow more and safer vegetables; and (b) consumers as they will be able to buy 'safer' vegetables.

Interventions to date

LVV activities with a strong ICM/IPM element in recent years are:

1. "Practical training on Composting", where 60 extension officers and technicians of the experimental gardens were trained.

[9] The third challenge will most likely be addressed by a competitive fund that will be setup by the EU.

2. “On-farm research and training” in the crops bitter gourd, eggplant and okra, where totally 30 farmers (exporters, out growers) were involved. These activities were carried out at 3 different export farms. The main objective was to develop sustainable cropping systems, mainstreaming Global GAP practices in above mentioned crops.
3. Training of farmers and extension officers to do early diagnosis in outbreaks of the Black Sigatoka Disease and Moko disease in banana through on- the -job training and stakeholder meetings.
4. Practicing ICM/IPM in the fruit fly program of LVV focusing on male annihilation technique, bait traps and fruit destruction.
5. Research of new biological pesticides and implementing the use of baking soda against mildew, neem leaf extract against leaf footed bugs, neem-oil against aphids, garlic extract and Bromorex (biopesticide) against white flies.
6. *Crotalaria striata* on root knot nematodes as rotation crop and as soil treatment.
7. Testing varieties of sweet potato on production under local circumstances and on susceptibility for root knot nematodes since 2014
8. Training on “safe use of pesticides” and “recycling of pesticide bottles”, where 300 farmers and 80 personnel of the ministry of Regional development were involved.

All the above mentioned activities are also already included in brochures, booklets and posters which are used by the Extension Department, on agricultural fairs and for training activities.

Project objectives

Main objective (i.e., goal): Strengthening of the vegetable sector in Surinam

Intermediate objectives (i.e., outcome):

1. Enhanced productivity of the vegetable crops targeted; and
2. Improved compliance with food safety and GAP standards.

Project outputs and activities

Project outputs and activities are summarized in table 3. For all seven vegetable crops (chili pepper, tomatoes, eggplant, yard long beans, okra, bitter gourd, and sweet potato) the project aims at three interventions: (1) Provide farmers access to good quality seed; (2) Validate new production recommendations; and (3) Promote better production practices, including organic solutions.

Table 3: Projects outputs and activities

Outputs	Activities
1. Better quality vegetable seeds (or tubers in the case of sweet potato) made available to farmers	1.1 Refer farmers to good quality, imported varieties in the case of chili pepper, tomatoes, and okra. CARDI sells chili pepper seeds. 1.2 Undertake the production of “clean” seed from the present seed stock for the local varieties of eggplant, yard long beans, okra, and bitter gourd. Produce in the case of sweet potato, clean tubers. 1.3 Training of farmers in how to retain good quality vegetable seed for eggplant, yard long beans, okra, bitter gourd and chili pepper, and tubers in the case of sweet potato. Eight one-day training events for 25 farmers each have been budgeted. 1.4 Production of five YouTube videos of how to produce good quality vegetable seed for eggplant, yard long beans, okra, bitter gourd, and tubers for sweet potato. 1.5 Setup of a gene bank for yard-long beans, eggplant, okra, chili pepper, bitter gourd, and sweet potato; and 1.6 Test the germination of bitter gourd seed.

2. Selected new production recommendations validated	2.1 Validation of fertilizer recommendations for all seven vegetable crops on two different soil types. 2.2 Validation of traditional composting technology versus the bocashi method. 2.3 Validation of different irrigation and drainage technologies. 2.4 Validation of the efficiency and effectiveness of different spraying techniques for (bio) pesticides. 2.5 Validation of crop rotation to keep the root knot nematode population under control. 2.6 Validation of the impact of the active ingredient in *Crotalaria striata* on root knot nematodes. 2.7 Validation of the use of (bio)pesticides against insect pests in the selected vegetables. 2.8 Validation of the use of (bio)pesticides against fungal and bacterial diseases in the selected vegetables.
3. New production manuals for open-field vegetables released and promoted	3.1 Literature review, with a specific emphasis on ICM, IPM and GAP. 3.2 Consultation with international experts on: ICM, compost for organic production, improvement of seed quality, identification of economic pests and diseases, economic threshold of pests and diseases 3.3 Consultation with local experts on statistical analysis and development of crop manuals 3.4 Drafting of the production manuals 3.5 Testing of the manuals with farmer panels 3.6 Production of the manuals (text, layout, etc.) both in printed form as well as electronically 3.7 Promotion campaign around the production manuals among vegetable growers
4. Vegetables growers informed of and trained in best production practices	4.1 Four different training courses will be offered to the vegetable growers in the main production areas during years 1-4. In the first year, two training sessions per district are planned each targeting 20 farmers. In years 2-4, one training session per district is planned each targeting 30 farmers; 4.2 On-station or on-farm demonstrations of three best practices (i.e., composting, spraying pesticides, and water management) in four different locations (one per district), preferably in collaboration with vegetable growers' associations. 4.3 Production of 14 YouTube instruction videos highlighting specific good practices 4.4 Use of social media and text messaging to reach out to farmers
5. Key data collected for the production manual, the result matrix and the impact study	5.1 Survey of the seven selected vegetables, covering: (a) current production practices and problems; (b) production costs and yields; (c) pesticide use; and (d) adoption of good practices and new technologies. This survey will be conducted at the beginning as well as at the end of the project in the four targeted districts as well as in the Nickerie district, which will function as the control group for the impact evaluation.[10]

Project results

See results matrix below.

[10] In order to create a clear distinction between the targeted districts and the control group, no distribution of improved seeds should take place in the Nickerie district until after the completion of the project. The same applies to training events and on-farm demonstrations.

Results matrix

Project objective	To strengthen the production of open-field vegetables							
Outcome indicators	**Base**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Target**	**Means of verification**
Increased productivity								
Indicator 1: Increased yield/ha yard long beans	14 ton/ha	0%	0%	5%	10%	15%	30%	1. Production statistics collected by LVV; 2. Follow-up survey of farmers trained.
Indicator 2: Increased yield/ha okra	14.1. ton/ha	0%	0%	3%	6%	9%	15%	1. Production statistics collected by LVV; 2. Follow-up survey of farmers trained. Comment: Production for export is shifting back to the traditional, land-race variety
Indicator 3: Increased yield/ha chili peppers	22.2 ton/ha	0%	0%	2%	2%	2%	10%	1. Production statistics collected by LVV; 2. Follow-up survey of farmers trained. Comment: Reported yield is already quite high compared to what is being reported by other countries
Indicator 4: Increased yield/ha tomatoes	11.7 ton/ha	0%	0%	5%	10%	15%	30%	1. Production statistics collected by LVV; 2. Follow-up survey of farmers trained.
Indicator 5: Increased yield/ha bitter gourd	16.3 ton/ha	0%	0%	4%	8%	12%	20%	1. Production statistics collected by LVV; 2. Follow-up survey of farmers trained.
Indicator 6: Increased yield/ha eggplant	28.5 ton/ha	0%	0%	4%	8%	12%	20%	1. Production statistics collected by LVV; 2. Follow-up survey of farmers trained.
Indicator 7: Increased yield/ha sweet potato	9.8 ton/ha	0%	0%	5%	10%	15%	30%	1. Production statistics collected by LVV; 2. Follow-up survey of farmers trained.
Increased compliance with food safety and GAP standards								
Indicator 1: Share (area under) vegetable production GAP certified	0%	0%	0%	5%	10%	15%	75%	1. Data provided by the local GAP certification agency (?) Comment: Local GAP standards are in the process of being developed by the Suriname Bureau of Standards. Not clear yet who will do the certification and how.
Indicator 2: Incidence of MRL violations in vegetable export to NL down	15%	12%	9%	6%	3%	1%	0.1%<	1. Statistics Dutch Food Safety Authority
Indicator 3: Incidence of MRL violations in vegetables in local markets	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Comments: Once the food safety inspection and the residue laboratory will be operational, the government should start compiling and publishing statistics on the frequency of MRL violations in local markets.
Output indicators	**Base**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Target**	**Means of verification**
1. Better quality vegetable seeds or tubers made available to farmers								
Indicator 1: "Clean" seeds or tubers produced and distributed	0	1			2	2	5	1. Clean planting material or seed available for farmers at LVV Comment: Clean sweet potato varieties will be available in year 1, yard long bean and okra in year 4, and bitter gourd and eggplant in year 5. For tomatoes and chili pepper the strategy is to rely on

								imported seed.
Indicator 2: Number of farmers trained in seed production and storage techniques	0	100	100				200	1. List of attendees 2. Training evaluation forms summary and analysis 3. Training materials used
Indicator 3: Number of times the four YouTube movies on how to save good quality seed viewed	0	400	800	800	800	800	3600	1. Website statistics Comment: There is standard software to record and analyse the number of website page visits and downloads
2. Selected new production recommendations validated								
Indicator 1: Number of production recommendations validated	0	1	0	0	7	0	8	1. Research reports
3. New production manuals for open-field vegetables released and promoted								
Indicator 1: Production manuals released	0	0	2	3	2	0	7	1. Manuals available both in printed form and electronically
Indicator 2: YouTube movies highlighting specific aspects of open-field vegetable production released	0	0	2	4	4	4	14	1. YouTube movies Comment: Per crop two YouTube movies covering the whole production cycle of the crop
4. Vegetables growers informed of and trained in good production practices								
Indicator 1: Number of printed manuals distributed	0	0	300	450	450	450	2100	1. Stock figures
Indicator 2: Number of views of YouTube movies	0	0	1500	2750	2250	500	7000	1. Website statistics
Indicator 3: Number of farmers trained in best practices	0	160	120	120	120		520	1. List of attendees; 2. Training evaluation forms summary and analysis; and 3. Training materials used Comment: Training courses will be offered in four different districts.
Indicator 4: On-farm demonstrations of best practices	0	2	1				3	1. Annual progress reports specifying activities undertaken and number of farmers reached.
5. Key data collected for the production manual, result matrix and impact study								
Indicator 1: Survey results	0	1				1	2	1. Statistical report

Project implementation

The head of the entomology division of ODLOAV will be the project leader and responsible for the implementation of the project. Staff from various divisions within ODLOAV (in particular the seed unit and the agro-hydrology division) will contribute to the project as well as staff of ODL – i.e., extension, modern media and statistics.

The survey at the beginning of the project will help to identify the crop- and location-specific problems encountered by farmers in the different districts, related to soil (physical and chemical), seeds, cultivation, pests and diseases, and the use of fertilizers and pesticides. Possible solutions for these problems preferably based on ICM and IPM, will be tested and evaluated.

The survey will be a joint effort of ODLOAV and ODL. The research results will be incorporated in the ICM manuals, which will also be used in awareness raising campaigns for stakeholders in the agricultural sector. The campaigns will be supported by modern communication methods such as Face book, text messages, a website dedicated to agricultural extension, and YouTube instruction videos.

Table 4 provides an overview of the implementation of the activities through time. A more detailed time table broken down by sub-activities and per quarter for the first two years will provided as an annex.

Table 4: Project time table

	Year-Quarter										
Output/Activity	**1-I**	**1-II**	**1-III**	**1-IV**	**2-I**	**2-II**	**2-III**	**2-IV**	**3**	**4**	**5**
1. Quality of vegetable seeds planted by farmers improved											
1.1 Refer farmers to good quality, imported varieties in the case of tomatoes, chili peppers and okra											
1.2 Undertake the production of clean seed from the present seed stock for the traditional varieties of sweet potato, okra, eggplant, yard long beans, bitter gourd											
1.3 Training of farmers in how to retain good quality vegetable seed for eggplant, yard long beans, okra, bitter gourd and sweet potato.											
1.4 Production of five YouTube movies of how to retain good quality vegetable seed/planting material for eggplant, yard long beans, okra, bitter gourd and sweet potato.											
1.5 Setup of a gene bank for yard-long beans, eggplant, okra, bitter gourd, and sweet potato											
1.5 Test the germination of bitter gourd seed											
2. Selected new production recommendations validated											
2.1 Validation of soil recommendations for all seven vegetable crops on two different soil types											
2.2. Validation of traditional composting technology versus the bocashi method on station											
2.3 Validation of water management recommendations for all seven vegetable crops on two different soil types											
2.4 Validation of the efficiency and effectiveness of different spraying techniques for (bio) pesticides.											
2.5. Validation of crop rotation to keep the root knot nematode population under control.											

2.6. Validation of the use of (bio)pesticides against diseases and insect pests in the selected vegetables											
2.7. Validation of ICM recommendations for all seven vegetable crops on station											
2.8. Applied research *on farm* for all seven crops (after the validation on station)											
3. New production manuals for open-field vegetables released and promoted											
3.1 Literature review, with a specific emphasis on ICM, IPM and GAP.											
3.2 Consultation with international experts on: ICM, compost for organic production, improvement of seed quality, identification of economic pests and diseases, economic threshold of pests and diseases											
3.3 Consultation with local experts on statistical analysis and development of crop manuals											
3.4 Drafting of the production manuals											
3.5 Testing of the manuals with farmer panels											
3.6 Production of the manuals (text, layout, etc.) both in printed form as well as electronically											
3.7 Promotion campaign around the production manuals among vegetable growers											
4. Vegetables growers informed of and trained in best production practices											
4.1 Training courses for vegetable growers in main production areas;											
4.2 On-station or on-farm demonstration of best practices, preferably in collaboration with vegetable growers' associations.											
4.3 Production of 14 short YouTube movies to highlight specific good practices											
5. Key data collected for the production manual, result matrix and impact study											
5.1 Survey of current production practices, yields, pesticide use and technology adoption in the four targeted districts											
5.2 Survey of current production practices, yields, pesticide use and technology adoption in the control group district (Nickerie)											

Project partners

Potential local partners for the project are various producer association and cooperatives, such as Cooperatie Kwatta, Wi uma fu sranan, Cooperatie Koewarasan, and the Vegetable Exporters Association. There are also various women groups active in home gardening / vegetable production. The three main educational establishments that offer agricultural courses (NATIN, PTC and ADEKUS) frequently seek collaboration with LVV to organize research projects for their students. This project aims to offer some students this opportunity.

Active participation of the IICA office in Paramaribo will be sought in order to establish better international contacts.

Potential international partners nearby are EMBRAPA in Brazil and CARDI in Trinidad & Tobago. The latter has an active research program on chili peppers. Further away are potential partners such as the World Vegetable Center (holding the world's largest vegetable germplasm collection), but also Dutch connections could be helpful as the Netherlands is a major vegetable seed producer.

Project budget

A summary of the budget per output is provided in table 5. The general project cost budget line includes project management, stationary, equipment and vehicles that are not output specific.

Overall budget of the project is about US$ 884,000, of which roughly US$ 546,000 will be financed by the IDB loan and US$ 337,000 by LVV (mostly salaries). Moreover, LVV will 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 5: Project budget summary

Output	Fund	Year 1	Year 2	Year 3	Year 4	Year 5	Total
		(US$)					
Output 1	IDB	37,823	34,844	32,788	24,904	0	**130,359**
	LVV	24,331	27,418	20,829	16,190	0	**88,768**
Output 2	IDB	28,958	16,684	19,099	23,854	1,440	**91,035**
	LVV	27,269	33,043	28,963	28,963	4,870	**123,106**
Output 3	IDB	13,150	12,785	23,160	21,410	19,410	**89,915**
	LVV	19,186	25,909	18,273	1,225	1,025	**65,619**
Output 4	IDB	2,080	2,480	2,180	2,320	600	**9,660**
	LVV	2,290	4,420	8,395	9,070	6,750	**30,925**
Output 5	IDB	3,900	0	0	0	3,900	**7,800**
	LVV	4,666	0	0	0	4,666	**9,331**
General project costs	IDB	147,230	14,590	12,090	12,090	11,180	**199,030**
	LVV	2,600	2,600	2,600	2,600	2,600	**13,000**
Subtotal	**IDB**	**229,241**	**81,383**	**89,317**	**84,578**	**32,630**	**519,999**
	LVV	**75,676**	**93,390**	**79,060**	**58,048**	**15,245**	**321,418**
Contingency 5%	IDB	11,462	4,069	4,466	4,229	1,632	**26,000**
	LVV	3,784	4,669	3,953	2,902	762	**16,071**
Total	**IDB**	**240,703**	**85,452**	**93,783**	**88,807**	**34,262**	**545,999**
	LVV	**79,459**	**98,059**	**83,013**	**60,950**	**16,007**	**337,489**
	All	**320,162**	**183,512**	**176,795**	**149,757**	**50,269**	**883,488**

Human resources

The human resources that have been budgeted to implement the various activities have been summarized below (see table 6). Assuming 210 working days a year, this five-year project will require a total input of 20.6 FTE research staff with a higher level of education (i.e., an applied science (HBO) or science degree (BSc or MSc)) will be needed. In its peak year (year 2), 6.1 FTE higher-level research staff will be needed or half of ODLOAV's current capacity at that level. At the mid-level research staff level a similar problem has been reported. As a consequence, additional professional staff will have to be recruited in order to implement the project. In particular, the seed unit needs to be strengthened and for that reason 1,125 days of higher-level research staff and 1,500 days of mid-level research staff have been budgeted against the IDB loan. It is understood these newly recruited staff financed by the IDB loan will receive a permanent government employee contract once their 'project' contract expires.

Table 6: Human resources involved in the implementation of the project

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	(days)					
Research staff – HL	1,061	1,289	1,176	704	99	4,329
Research staff – ML	840	901	877	725	68	3,411
Research staff – LL	1,294	948	905	812	72	4,031
Extension staff – HL	4	0	0	0	4	8
Extension staff – ML	37	34	59	69	39	237
Extension staff – LL	137	72	72	72	125	478
Modern media staff – HL	18	82	68	67	65	300
Modern media staff – ML	5	30	20	20	20	95
Modern media staff - LL	5	30	20	20	20	95
Statistical staff - HL	4	0	0	0	4	8
Statistical staff - ML	4	0	0	0	4	9

Capital items

Table 7 summarizes the main capital items that will be purchased for the execution of the project. The single biggest investment is that into a tractor with harvest attributes (US$ 60,000). This investment should also be of use to the other projects.

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

			Date of acquisition				
Output	**Item**	**Cost**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Overall project	Pick up 4WD	40,000	1				
	Van	25,000	1				
	Tractor with harvest attributes	65,000	1				
	Laptop	1,000	1				
	Desktop	1,500	1				
	Copy machine	800	1				
Output 2	Shredder	1,500	1				
	Duro tank	400	1				
	Hoses	300	1				
	Waterpump	1,000	1				
	Waterfilter	400	1				
	USB microscope	100	10				
	Soil auger	150	1				
	Camera	500	2				
	Brushcutters	1,000	3				
	Insect collection cabinet with boxes	1,000	1				
	Stereo microscope	1,000	1				
	Sieve 350 µm	200	1				
	Counting dishes	100	1				
	Oostenbrink spoelapparaat	1,000	1				
	Light intensity meter	100	1				

Services

Table 8 summarizes the services that will have to be contracted on behalf of the project.

Table 8: Service contracts

			Date of acquisition				
Output	**Item**	**Cost**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1.2.1 Producing clean okra seed (8 cycli of 6 months)							
	Clearing and preparing land	400	1				
1.2.2 Producing clean eggplant seed (8 cycli of 6 months)							
	Clearing and preparing land	400	1				
1.2.3 Producing clean bitter gourd seed (cycli of 6 months)							
	Clearing and preparing land	400	1				
1.2.4 Producing clean long yard bean seed (cycli of 4 months)							
	Clearing and preparing land	400	1				
1.2.5 Producing clean sweet potato planting material							
	Clearing and preparing land	400	1				
2.3 Validation of water management recommendations for all seven vegetable crops on two different soil types							
	Installer hiring contract	1000	1				
2.5. Validation of crop rotation to keep the root knot nematode population under control.							
	Hiring tillage machinery	500	1	2	2	2	
2.6. Validation of the use of (bio)pesticides against diseases and insect pests in the selected vegetables							
	Hiring tillage machinery	500	2	4	4	4	
2.7. Validation of ICM recommendations for all seven vegetable crops on station							
	Hiring tillage machinery	500	1	2	2	2	
3.7 Production of the manuals (text, layout, etc.) both in printed form as well as electronically							
	Editing services	500		1	2	2	2
	Printing services	9000		1	2	2	2