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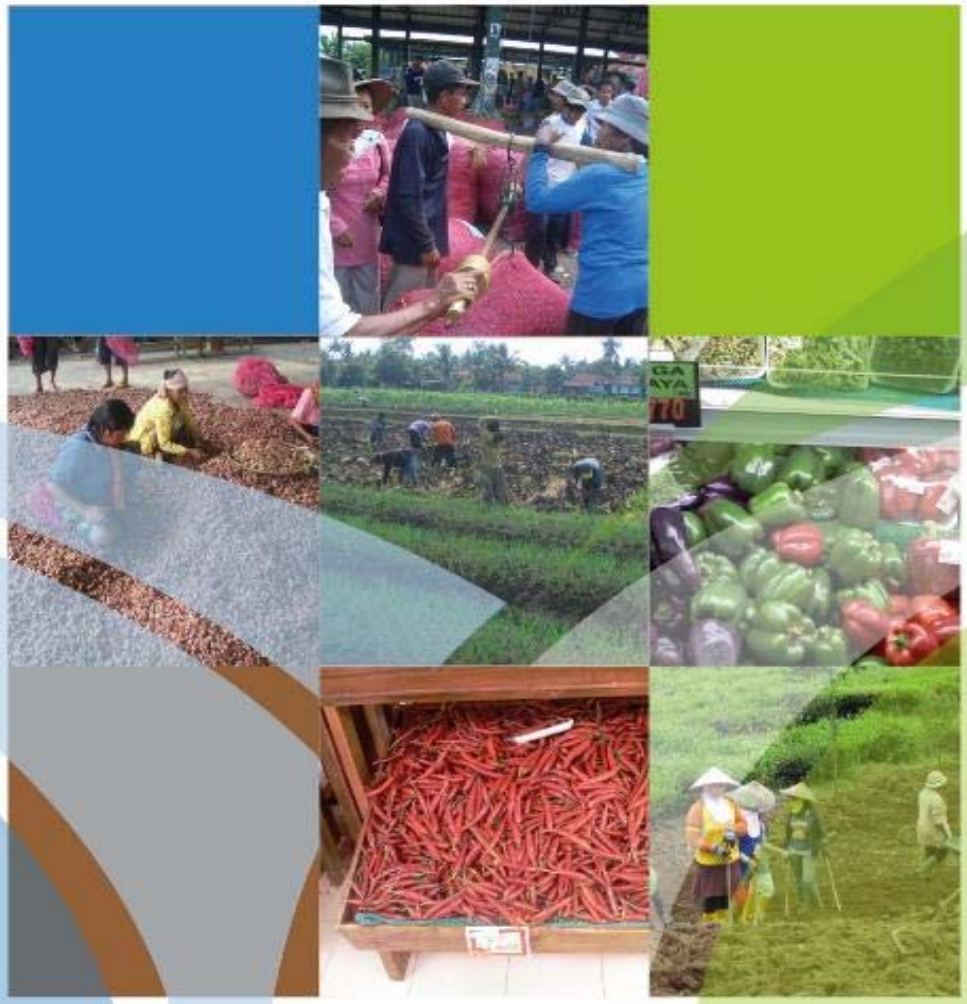

vegIMPACT

Improved Vegetable Production and Marketing for small farmers to Increase the Food Security status and to promote Private Sector Development in Indonesia

vegIMPACT is a program financed by The Netherlands' Government promoting improved vegetable production and marketing for small farmers in Indonesia, contributing to the food security status and private sector development in Indonesia. The program builds on the results of previous joint Indonesian-Dutch horticultural development cooperation projects and aligns with recent developments in the horticultural private sector and retail in Indonesia. The program activities (2012 – 2016) include the Development of Product Market Combinations, Strengthening the Potato Sector, Development of permanent Vegetable Production Systems, Knowledge Transfer and Occupational Health.

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Assessment of vegIMPACT potato trainings in Garut and Pangalengan

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Summary

In this report, we describe, assess and reflect on the intensive training intervention carried out from 2013 to 2015 within the work package Potato of the vegIMPACT program.

Indonesia is the largest potato producer in Southeast Asia ranking second after China. Furthermore, potato is one of the most important horticultural crops in Indonesia. The recently identified retarded development of area and production of potato relates to low seed quality and availability, high disease incidence with subsequent high pesticide inputs and reduced profits for farmers.
The overall vegIMPACT program objective was to contribute to an increased food security and private sector development in Indonesia. Within the work package Potato, this general objective was translated into the following measurable goals and indicators:

- increased potato (ware and processing) area,
- reduced pesticide and nitrogen use per unit of potatoes produced,
- reduced production costs per unit of potatoes produced, and
- reduce occupational health problems and risks.

The work package's Potato objectives were realised through knowledge transfer and subsequently behavioural change of potato farmers in two major potato growing regions Garut and Pangalengan, West Java, Indonesia, towards Good Agricultural Practices (GAP) through biweekly trainings during five consecutive potato growing seasons combined with onsite demonstrations and field visits. The Theory of Change was used as the framework to monitor and evaluate effects of trainings on behavioural changes using farm management registrations, farmer surveys, semi-structured interviews and focus group discussions.

The program was carried out by Wageningen University & Research (WUR) together with the Indonesian Vegetable Research Institute (IVEGRI) and national and international companies in potato production and marketing, and financed by the Dutch government.

With respect to the effects of trainings of farmers on their behavioural change, it is concluded that:

- The behavioural change of farmers towards good agricultural practices is strongly related to the trainings received and the supporting field demonstrations,
- The interaction between farmer's need/demand, identified in the farmer's surveys, and the adaption/modification of the trainings and field demonstrations, was highly appreciated and supported farmer's behavioural change.

Farmers were supportive critical and selective in behavioural change on trained topics when they were not convinced of the positive effects of the improved practice offered or that the improvements were too much work compared to the expected benefits.

From this study and with respect to the vegIMPACT project objectives, it is concluded that:

- The area (m^2) planted with (process) potato did not increase,
- The productivity (t ha^{-1}) increased by more than 10% for Granola (ware potato) and Atlantic (processing potato), and in the dry and rainy season,

- The pesticide use (kg A.I. t^{-1} product) decreased by more than 25% for Atlantic, both seasons, and for Granola in the dry season,
- The nitrogen use (kg N t^{-1} product) decreased for both varieties and in both seasons,
- The production costs (IND kg^{-1} product) decreased for Atlantic, in both seasons, and for Granola in the dry season. The decrease however, is less than the project target of 25%.

The participating farmers highly appreciated the repetitive character of the trainings during subsequent seasons and the practical aspects of the trainings. They indicated that they need to be continuously motivated to improve production practices and that training material, mainly the photos for recognizing a pest or disease, are still used.

1. Introduction

1.1. Potato production in Indonesia

Potato is one of the most important horticultural crops in Indonesia. Indonesia is the largest potato producer in Southeast Asia and has a second position after China in the International Potato Center-East, Southeast Asia and the Pacific region. However, the area and production hardly increased during the last decade (Table 1.1) despite a large increase of the import of potato (products). The causes of the retarded development of potato production have been identified during a joint Indonesian-Netherlands mission in May 2012 and include low seed quality and availability and high disease incidence (Van den Burg*, et al.* 2013), resulting in high pesticide input and reduced profits for farmers.

Table 1.1 The FAO statistics on potato production in Indonesia (http://faostat3.fao.org).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Area Harvested (ha)	65,923	65,420	61,557	59,748	62,375	62,650	71,238	66,531	59,882	65,989	70,187
Production (t)	1,009,979	1,072,040	1,009,619	1,011,911	1,003,730	1,044,492	1,176,304	1,060,805	955,488	1,094,232	1,124,282
Yield (kg/ha)	15,321	16,387	16,401	16,936	16,092	16,672	16,512	15,945	15,956	16,582	16,018

Potato has been a priority crop in the strategic plan of research and development program of the Indonesian Agency for Agricultural Research and Development (IAARD) / Indonesian Center for Horticulture Research and Development (ICHORD) during the past 30 years. This position is strongly related to its potential as a food crop and its potential for export to, for example, Malaysia and Singapore.

The German-bred Granola variety is the major potato variety in Indonesia since the 1980's. Granola has moderate resistances to potato virus Y (PVY) and potato leaf roll virus (PLRV) and has a slow degeneration rate, which has made it a successful variety in Indonesia. However, Granola is only suitable for fresh consumption as its dry matter content is too low and its reducing sugar content is too high for processing into modern potato products.
The USA-bred variety Atlantic is the only variety grown for processing into chips (or: crisps). Atlantic was introduced in Indonesia around 1980 (similar to Granola) and has been dominating the raw material supply to the potato processing industry since. Most Atlantic seeds are imported as insufficient seed is produced within Indonesia. Annual seed imports vary between 1,500 and 3,000 tons per year (Figure 1.1).
Both Atlantic and Granola are very susceptible to late blight and substitution with modern varieties is therefore actual and needed. These new varieties (fresh/ware and processing) should have higher levels of resistance to late blight (caused by *Phytophthora infestans*) which is the major fungal pathogen in the Indonesian potato crops (McPharlin*, et al.* 2011) and have appropriate properties for fresh consumption and for processing.

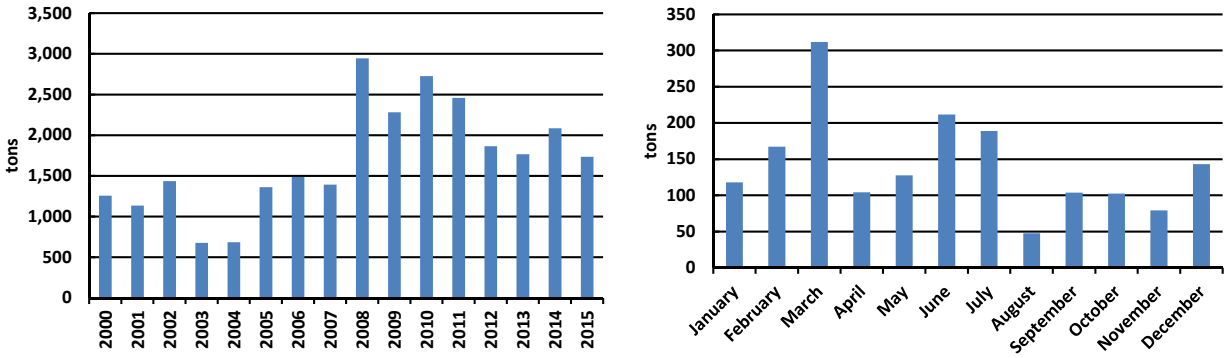

Figure 1.1 The total annual seed potato import (left) and the average seed import between 2000 – 2015 per month (source: www.bps.go.id)

1.2. The vegIMPACT program

The joint Indonesian-Netherlands mission in May 2012 initiated by the Dutch Embassy in Jakarta was intended to prepare a program within the Long Term Strategic Plan (2012-2015) for Food Security and Private Sector Development for collaboration on vegetable production in Indonesia. Currently, Indonesia is still considered a moderate hungry country (cdn.wfp.org/hungermap). Although Indonesia has made great progress in reducing poverty, from 14% of the population or 32 million people in 2009 to 11% in 2014, the number of undernourished people showed a slower decrease. Indonesia has achieved the Millennium Development Goal (MDG) to 'Eradicate extreme poverty and hunger' by reducing the proportion of undernourished people to 8.7% (FAO*, et al.* 2014). However, the decrease of undernutrition is less promising as the prevalence of stunting in children under five years of age was still 36.4% in 2013 implying inadequate access to diverse foods.

It is within the framework of the Long Strategic Plan that the vegIMPACT Program short for 'vegetable production and marketing with impact', was founded, financed by the Dutch government and carried out by Wageningen University & Research (WUR) together with local partners and national and international companies in vegetable production and marketing. The program builds on results of preciously joint Indonesian-Dutch horticultural development cooperation projects and aligns with the recent developments in the horticultural private sector and retail in Indonesia.

The six work packages (WP's) of the vegIMPACT program have comparable but partly different objectives (Table 1.2) which at the end all contribute to the objectives at the program level, i.e. to increase food security and private sector development in Indonesia. Potatoes is one of the horticultural crops to mitigate undernutrition as they contribute to food diversification and have relatively high concentrations of nutrients compared to other staple crops (ndb.nal.usda.gov/ndb/search/list).

At the start of vegIMPACT, the WP Potato was divided into activities focussing at the facilitation of the import of seed potatoes from the Netherlands and activities focussing at improving potato production in Indonesia. Activities related to the facilitation of the import of Dutch seed potatoes were rapidly phased out because of the restrictive import policy for seeds set by the Government of Indonesia. The seed law of Indonesia forbids seed imports two year after registration of a variety. One of the major Dutch seed potato companies changed its import strategy and started to collaborate with a local seed company to produce locally potato seeds. Therefore, activities of the WP Potato focussed at increasing production during a large part of the vegIMPACT program.

Table 1.2 The vegIMPACT program objectives for each Work Package (Hengsdijk 2017).

Objectives	Work Packages					
	Permanent Vegetable Systems	Potato	Knowledge Transfer	Occupational Health	Product Marked Combinations	Monitoring and Evaluation
1. Increase vegetable area (%)	■		■			
2. Increase vegetable productivity (%)			■		■	
3. Increase (process) potato area (%)		■	■			
4. Increase (process) potato productivity (%)		■	■			
5. Reduce pesticide use per unit of product (%)	■	■	■	■	■	
6. Reduce nitrogen use per unit of product (%)	■	■	■		■	
7. Reduce production costs per unit of product (%)	■	■	■		■	
8. Increase financial margins for farmers (%)					■	
9. Reduce occupational health problems and risks	■	■	■	■	■	
10. Increase employment (%)	■		■			
11. Increase female employment (%)	■		■			
12. Improve R&D and extension services	■	■	■	■		
13. Increase availability of private sector products & services	■	■	■		■	
14. Monitoring progress of project activities						■
15. Evaluation of effects of activities on project objectives, especially of trainings						■

The overall objective of the WP Potato was to contribute to food security and diversification though improved availability of affordable potatoes to people in Indonesia through a behavioural change of the participating potato farmers. This objective was further downgraded into measurable and evaluable objectives (Table 1.2).
The objectives were realized through a package of activities carried out over several years. The progress of activities was monitored and effects of activities on the objectives were evaluated by performance indicators following the impact pathway of the conceptual framework of the Theory of Change (ToC).

1.3. Reading guide

This report describes, assesses and reflects on the effects of the package of activities carried out from 2013 to 2016 to initiate behavioural change of the participating farmers. The progress is monitored and described, and the effects of the activities on the behavioural change of trained farmers are evaluated and reported. Chapter 2 describes the conceptual framework of the ToC and how the ToC is applied in the vegIMPACT program. Chapter 3 describes project activities to transfer knowledge and initiate behavioural change and to monitor and evaluate expected effects. Results are presented in Chapter 4. Results are discussed and some general conclusions with respect to the project activities are drawn in Chapter 5. Finally, recommendations for similar types of projects in the future are presented in Chapter 6.

2. Theoretical framework

2.1. Theory of Change (ToC)

The Theory of Change (ToC) provides a conceptual framework for planning, participation and evaluation to promote social/behavioural change. The framework consists of a problem analysis phase followed by an impact pathway phase (Figure 2.1).

2.2. The problem analysis phase

The problem analysis phase provides a framework to identify the problem(s) in a given area that will be addressed and subsequently mitigated by social/behavioural change. An inventory of the causes of the problem(s) is made and the underlying knowledge-related causes are identified. This analysis leads in general to objectives that are more specific. From this analysis the research questions and action plans/interventions, are derived to initiate and substantiate the social/behavioural change. The problem analysis phase provides a context analysis with the research questions and research design as well as activities to initiate behavioural change and thus mitigate the identified problem(s).

2.3. The impact pathway phase

The impact pathway phase describes the results presented as a sequence of events, the so called result chain(s) which shows the linkages between the sequence of steps in getting to impact (Douthwaite*, et al.* 2007). Carrying out the project activities results in outputs, being an immediate effect(s) of the interventions applied. These outputs are not immediately reflected in the project objectives, but result in the so-called outcomes that is the achieved short-term and medium-term effects of the activities done. Several levels of outcomes (immediate, intermediate, ultimate) are distinguished, in reaching the final impact. The higher up in the result chain (higher result level), the less influence or scope of control of the project activities is found. This means that the evaluation of measurable effects becomes increasingly more difficult when moving upwards in the result chain and are most often very low and not significant at the impact level.

The success of project activities and interventions in particular, depends on i) the logic of the ToC as such and within the context, and ii) to the way the activities are implemented and the skills and capacity of implementers. To understand behavioural change, the ToC demands to make explicit how the intervention activities are expected to lead to the desired results:

1. the pathway (or results chain) from intervention activities to outputs to a sequence of outcomes to impacts, and
2. why the various links in this pathway are expected to work.

The impact pathway assumptions and conditions behind the links in the pathways need to be explicitly described, that is, what has to happen for the causal linkages to be realized (Blamey and Mackenzie 2007; Rogers 2008; Weiss 1995). The general conceptual framework of a ToC is presented

in Figure 2.1.

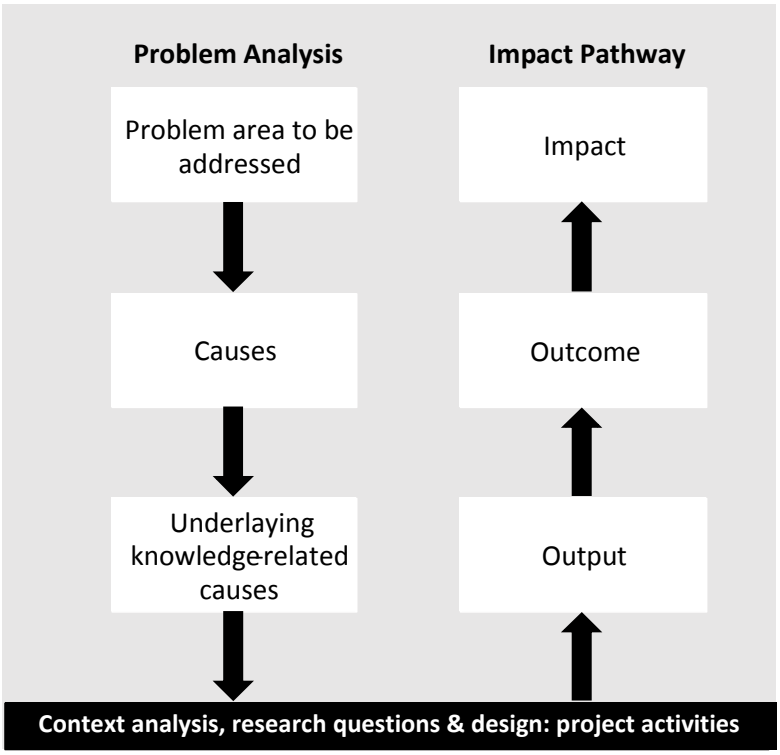

Figure 2.1 The conceptual framework of the Theory of Change.

2.4. The ToC and VegIMPACT program

2.4.1. The problem analysis phase

The vegIMPACT team leader and the Dutch Embassy in Jakarta within the Long Term Strategic Plan (2012-2015) performed the problem analysis during a mission in 2012 for Food Security and Private Sector Development. The analysis identified area's to be improved to increase food security and promote private sector development in Indonesia. These areas include the improvement of vegetable production and marketing of smallholder farmers in Indonesia. Research questions and designs were translated to project activities (Everaarts and Van Koesveld 2013). The major activity to initiate behavioural change of smallholder farmers was chosen to be training of trainers (ToT) and training of farmers (ToF). The training activities are therefore referred to as the intervention.

2.4.2. The impact pathway phase: from input to impact

The project activities include the development of training materials, designing and setting up field demonstrations for training purposes, and training of trainers and smallholder farmers. The training materials and the field demonstrations are inputs used for the trainings of smallholder farmers.
The behavioural change of trained farmers is not expected to happen at once but gradually over time through increased awareness and enhanced knowledge of farmers on agronomy and production techniques. Therefore, effects of activities are divided into different levels of result: immediate outcomes, intermediate outcomes, ultimate outcomes and impact as the final result (see Figure 2.2

and also section 3.7). The progress on performance indicators of potato farmers is monitored and evaluated at these different result levels. The performance indicators are the (process) potato area planted, productivity, pesticide use per unit product, fertiliser use per unit product and costs per unit product (Table 1.2).

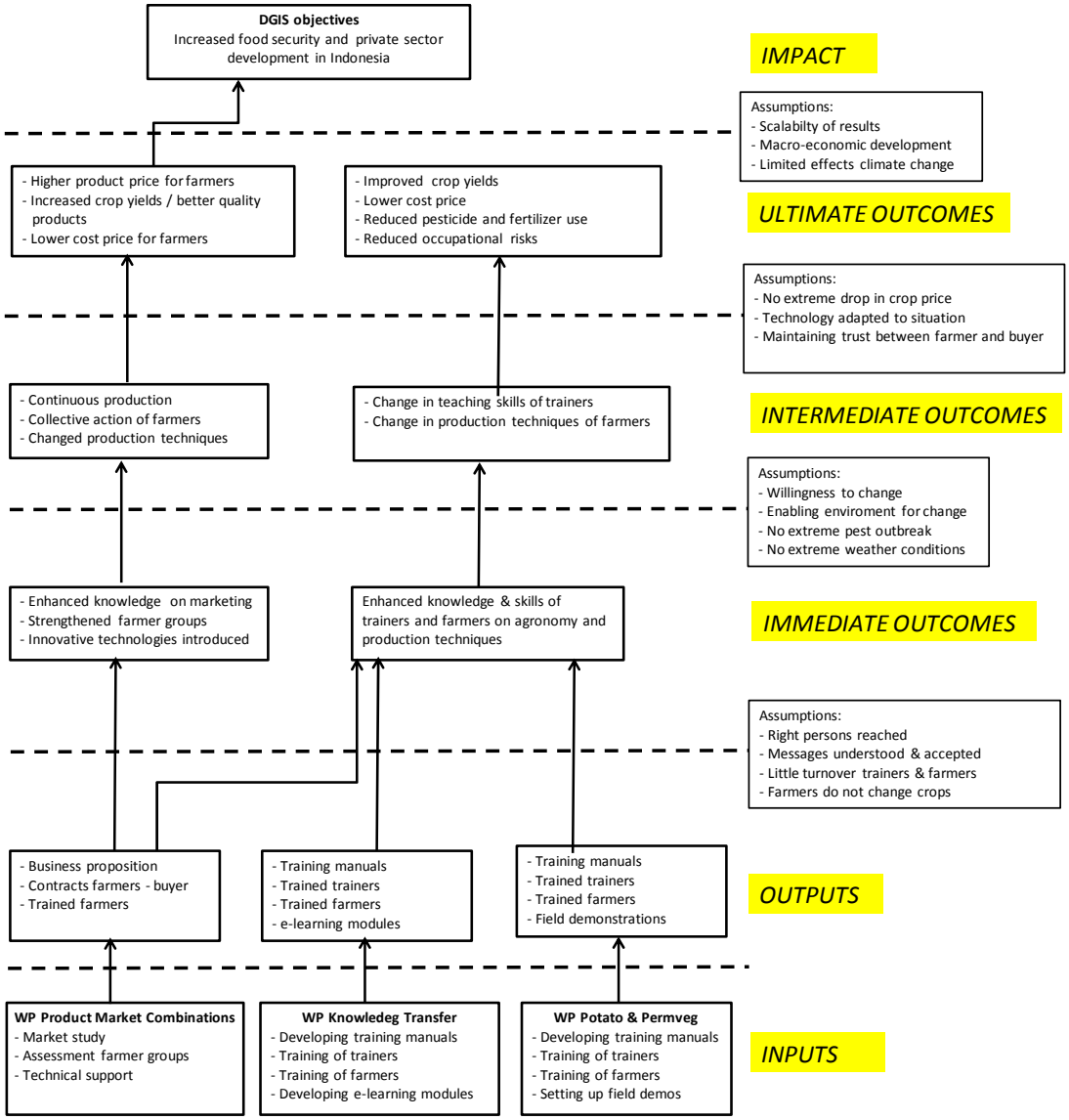

Figure 2.2 *The impact pathway following the Theory of Change of vegIMPACT at program level including the result chain of the Potato training interventions and underlying assumptions.*

In the vegIMPACT program, the ToC is used to perform activities, monitor and evaluate performance of activities as well as monitor and evaluate effects of activities on behavioural change through improved performance indicators. It is most interesting to understand the underlying process of *how* activities are expected to lead to the desired results, that is the social/ behavioural change, this is only sideways addressed as the number of farmers participating was limited and a reference group (no interventions) was not included due to limited finances. The vegIMPACT program therefore

mainly evaluates changes with subsequent effects on performance indicators. Interesting findings though, on how project activities did lead to behavioural changes, are discussed in the Discussion (section 5.1).

Monitoring and evaluation of activities of the vegIMPACT program were planned before, during and after the training sessions. Within the ToC, this is formulated as a result level: an intervention cycle is finished, what are the findings and how to improve the next cycle to maximize contribution to the project objectives. Such an intervention cycle is monitored by signing off attendance sheets of participating farmers. Quantitative findings of such a cycle are collected through farm management registrations on a daily basis and qualitative findings are collected through farmer surveys, presented as outcomes at different result levels, being results of the midterm 1, midterm 2 and end-line surveys compared to the baseline survey. Qualitative data support insights on the interpretation of quantitative results, on the linkages between result levels and can support insights on the underlying mechanisms. Additionally, qualitative data provide insights into the prevailing contextual factors and the implementation of the activities affecting project results.

2.4.3. Assumptions

The vegIMPACT result chain includes various assumptions about preconditions, the external environment and institutions (Figure 2.2). At each result level, the indicated assumptions became clear during the definition of the ToC. As a process, the ToC is continuously subject to change by new insights, learnings and a changing context. Overall, it is assumed that the vegIMPACT interventions and components will lead to an increase in production area, an increase in productivity, reduced costs and a reduction of pesticide use and fertiliser use (performance indicators, Table 1.2).

Not explicitly mentioned in Figure 2.2 is the underlying assumption that increased potato production contributes to food security. The importance of potato for maintaining food security and stability has increased over the past years particular in agricultural regions of developing countries (DeFauw*, et al.* 2012; He*, et al.* 2012; Hijmans and Spooner 2001). Section 1.1 shows that potato production is indeed selected by the Indonesian Government to contribute to increased food security and the project's assumption is a general accepted justified one.

The second underlying assumption is that increased potato production contributes to private sector development. From a Dutch perspective and being one of the largest seed potato exporters of the world, private sector development in this field is quite substantial. However, activities related to the facilitation of the import of Dutch seed potatoes were rapidly phased out because of the restrictive import policy for seeds set by the Government of Indonesia. This assumption is therefore not justified.

It is also assumed that smallholder farmers are interested to increase potato production. The vegIMPACT project builds on results of preciously joint Indonesian-Dutch horticultural development cooperation projects, which confirm that smallholder potato farmers are indeed interested to increase production. This assumption is therefore justified. Last but not least, the project assumed that farmers are in need for knowledge to increase, are willing to learn and to change production practices and that the project partners are capable of providing the information and thus be able to bridge the knowledge gap of smallholder farmers to increase production. This assumption is justified

in the sense that the farmers trained indicated to be in need of knowledge and that they were very eager to learn. The assumed willingness to change was less obvious.

2.4.4. External influences

External influences at the start of the intervention but not explicitly mentioned in Figure 2.2 are events, actors or institutions as well as conditions not directly related to the intervention. External influences may have positive and/or negative effects on the intended results. For example, a reduction of the price of potatoes could also explain an increase in potato consumption that is unrelated to the project activities. A negative external influence could be a strong and influential PR strategy of a pesticide company or a new government policy, which may have a contradictive effect to program objectives. The most severe external influence was the ban on the import of Dutch seed potatoes by the Government regulations of Indonesia. As a result, the vegIMPACT project goal on the use of high quality seed potatoes as effective means to improve production (both yields and area) was unachievable and project activities were adapted to overcome the lack of availability of high quality seeds.

2.4.5. Unintended and unanticipated effects

Unintended effects, positive or negative and unanticipated effects are effects that occur as a result of the intervention's activities and subsequent results need to be addressed and revealed when occurred. For example, better-trained farmers may increase area to be planted with potatoes and subsequently increase the demand for seed potatoes. Seed potatoes are only limited available, and an increased demand may increase prices, which results in increased production costs and that counteracts with project objective no. 7 of Table 1.2. A positive unintended effect can be that the farmers apply the good agricultural practices learned also to produce other crops.

2.4.6. Scope of control: Result levels

As indicated, the ambition of activities in vegIMPACT program is to contribute to the improved food security. However, to show statistical significant effects on these areas is outside the scope of control of this program and the available resources. The effects of interventions on improved socio-economic status and food and nutrition security are hard to control[1] and therefore definitely difficult to measure, especially in a small sample of beneficiaries per region and in the absence of a reference group which has not been targeted by the intervention[2].

[1] Improved income does not automatically lead to increased household expenditures on (healthy) food consumption.
[2] Because of limited resources.

3. Methods

The project was designed to develop training materials, to train trainers and smallholder farmers and to perform field demonstrations (Table 3.1). These activities are the inputs of Figure 2.2. Subsequently, the finished products of these activities are the outputs in the result chain.
The training of farmers, activity 2, also called “the intervention”, is the major activity to be monitored and evaluated by WP M&E.
Within the WP Potato, participating farmers were asked to register all activities of the potato production, activity 6. These registrations are referred to as the self-recordings of the participating farmers (section 3.1) and used to monitor and evaluate effects of the intervention on the project objectives of Table 1.2.

Table 3.1 Project, monitoring and evaluation activities to meet the project goals for potatoes

No	Activity	Amount	Topic
	Knowledge tests	10	Knowledge levels participating farmers
1	Training materials	15	Good Agricultural Practices
2	Training of farmers	40 farmers, 5 seasons	Good Agricultural Practices
3	Field demonstrations on late blight control	5	Demonstration on optimal late blight control
4	Field demonstrations on fertiliser use	4	Identification of optimal nitrogen and phosphate fertiliser application levels
5	Field demonstration on positive seed selection	1	Two season demonstration of effects of positive seed potato selection in the first season on yield and quality of the second season
6	Farm management registrations	40 farmers, 5 seasons	Self-recording of activities of potato production
7	Evaluation training of farmers	2	Evaluation of trainings during last training session
8	Farmer surveys	31 farmers, 4 times	Before (baseline), after training on dry and rainy production information (midterm 1 and 2) and after last production (end line)
9	Interviews of trainers	1	After training interview on the course of the trainings
10	Focus group discussions	2	After completion of training activities

Different parties were involved as ‘data collector’. Collection and quality check of farm records was done by WP Potato implementers, the surveys, interviews and focus group discussions were done by the WP M&E. The staff of WP M&E was not involved in the interventions to guarantee neutrality and prevent from self-assessment. It is also expected that the participant would speak out more freely when data was collected by an independent and neutral party. Timing and time horizon of information collection differed considerably. The knowledge tests were taken directly at the first and last training sessions, while the farmer surveys roughly cover a period of four years. Overall, data was collected over a period of four years, covering the periods 1.5 years before, during and 1.5 years after the trainings. Therefore, not all data from all sources can be compared, but the use of different perspectives and methodologies enables us to complement, triangulate and validate findings.

3.1. Knowledge tests

Knowledge tests were performed for two purposes. First, the tests were used to identify the weak knowledge areas and trainings needs of farmers to design the subsequent interventions (section 3.1.1). Second, the tests were used to evaluate whether farmers’ knowledge changed over time (section 3.1.2).

3.1.1. Knowledge test to design the intervention

At the start of the project, the knowledge level of the participating farmers was evaluated through a knowledge test (pre-test). The pre-test identified knowledge gaps and was done in the beginning of the first training season (rainy season 2013/2014). The main topics of the training and/or the demo plots were selected based on the pre-test results and on discussions with farmers when we presented the results of the farm recordings of the dry season 2013, the baseline results (De Putter*, et al.* 2014). The two main topics selected and agreed upon by farmers were "Controlling late blight in potato" and "Fertilizer management in potato". Therefore, the trainings and demo plots in the rainy seasons focused on late blight control and the trainings and demo plots in the dry seasons focused on fertilizer management (section 3.6). In addition, the training materials were developed (section 3.2) on these two main topics. During the project and as became clear that good quality seed could not become available, a third major topic was included: a demo plot on the positive selection method for farm saved seeds (section 3.6).

3.1.2. Knowledge test to evaluate changes in farmers' knowledge levels

The knowledge tests to evaluate changes in farmers' knowledge levels were done at the start of the project (pre-test), repeated mid-term to determine progress in knowledge levels and done immediately after the final training (post-tests). Results of the post-tests were compared to the pre-test to evaluate improvements in knowledge among participants.

3.2. Training materials

The training materials on Good Agricultural Practices (GAP) were developed by IVEGRI in collaboration with WUR (Figure 3) and had an emphasis on the identified weak areas of knowledge and the learning needs of the participants (from the pre-knowledge test section 3.1). The topics of the training material included:

1. Integrated Pest Management (IPM): which pesticide product(s) when to use,
2. Fertiliser management: calculate the needed doses of fertilisers products per field, when and how to apply,
3. Late blight control and spraying techniques: use of preventive and curative fungicides, spraying volume, spraying equipment,
4. Planning of crop production,
5. Positive seed selection of farm-saved seed to obtain good quality seed for the next planting.

General, the focus of the bi-weekly trainings was on late blight control in the rainy season and on fertilizer management in the dry season. There were no special training modules used, as the topics in each training were selected based on discussions with farmers. Trainings were periodically joined by WUR staff, who then presented results of the farm management registrations and field demonstrations.

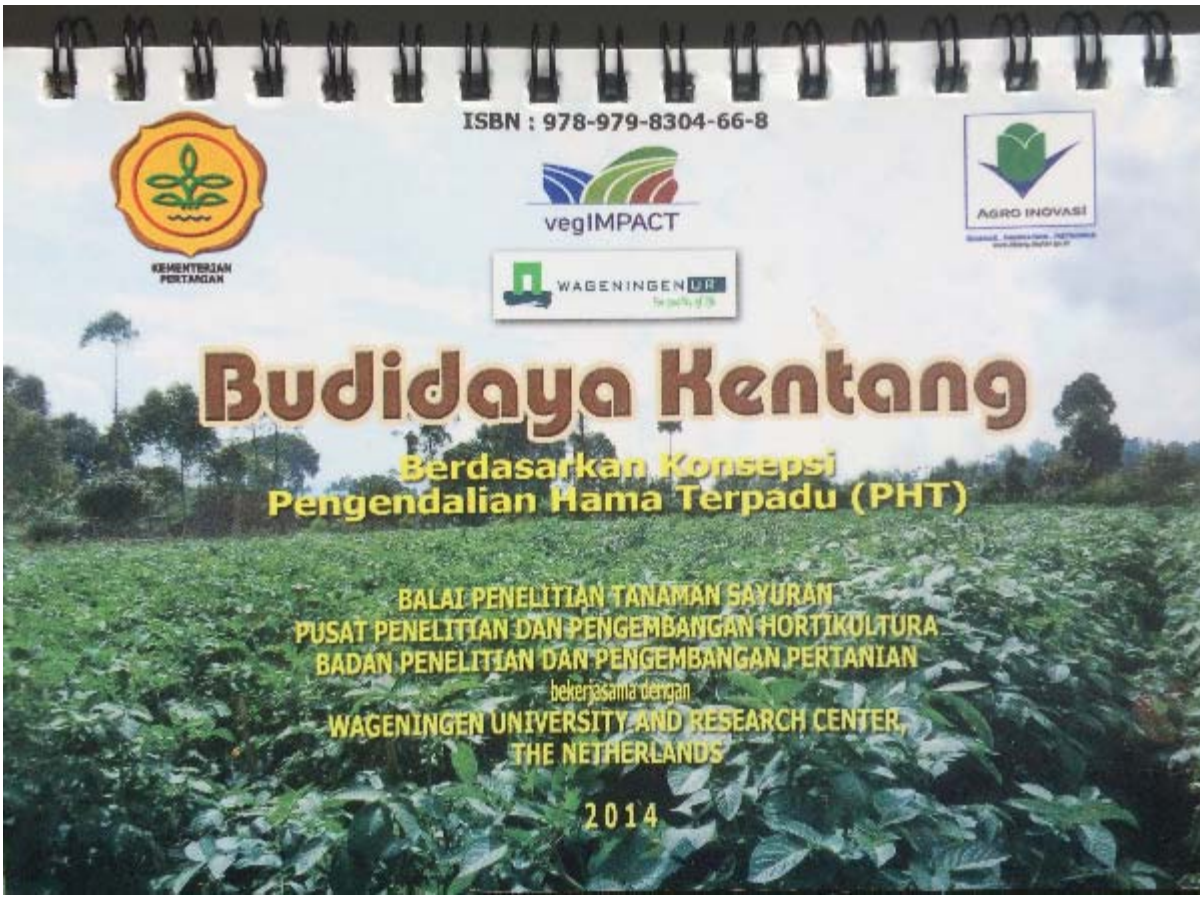

Figure 3 Example of the training materials developed by IVEGRI and WUR in the vegIMPACT program

3.3. Training of trainers

The training of trainers on all aspects of the potato production was performed on 8 and 9 October 2013. The training was attended by 24 participants (including the lecturers), of which the majority from IVEGRI, 2 from PT Indofood and 2 from PT East West Indonesia (Ewindo). The training was hosted by IVEGRI and organised by Dr Nikardi Gunadi. It was characterised by intensive and interesting exchange of ideas with a keen learning audience. The interaction between lectures and trainers revealed several conclusions on the potato production:

- A preliminary analysis of the farmers' survey showed that a large proportion of farmers, especially those in Garut, were unable to make a profit by growing potatoes. This was a very shocking conclusion. The data were verified during a visit by a team of researchers to the area during the following days.
- Possible reasons for the above mentioned conclusion were:
    - low quality and quantity of seed potatoes available,
    - stimulating and or forcing farmers to cut seeds,
    - resulting in poor crop development and subsequently poor yield.
- Possibly ineffective foliar fertilisation and excessive spraying increase input costs unnecessarily.

- The major disease is Late Blight (LB), *Phytophthora infestans*. In the country no varieties are available with good resistance to LB, nor are there many available in the world. The optimum control strategy for LB in Indonesia needs to be established.
- Nutrient management needs to be based on knowledge of the nutrient status of the fields: labs should offer routine testing facilities with fertilisation advices.
- The nutrient content or a range of nutrient content of organic manure used in Indonesia needs to be established. A range may be needed as manure of different sources is likely to have a different composition.
- The optimum fertilisation for potato and seed potato crops is not yet known and must be established.
- The extensive losses of quality of seed potatoes. Unfavourable storage conditions and unfavourable growing conditions of seed crops are major factors reducing the quality of the seed and hence the income of the farmer.
- The losses in quality of potatoes for processing during storage for longer periods are excessive and unacceptable.
- Advice given to facilitate farmers in GAP needs to be based on specific Indonesian conditions and data. Such advices cannot be applied one to one from foreign countries such as the Netherlands, but need to be validated on site in Indonesia.

Most subjects raised were subsequently included in the trainings of smallholder farmers (section 3.4).

3.4. Training of smallholder farmers

Based on available resources and on the maximum number of smallholder farmers that can effectively be trained in a group, twenty farmers were selected in Garut and twenty farmers in Pangalengan. Half of the farmers at one location produced the ware potato variety Granola and the other half the processing potato variety Atlantic. All farmers were trained during five potato cultivations (± 2.5 years), starting in the rainy season 2013 and ending in the dry season of 2015. See section 3.4.2 for selection criteria for participating farmers.

3.4.1. Training program

The training program consisted of 7 to 8 bi-weekly trainings during the potato production season. In total farmers were trained during five potato production seasons. Farmers received snacks, drinks and lunch, and travel allowance when attending the training sessions. At the trainings, farmers received manuals on production practices to use during and after the trainings. The training sessions included a field visit of either the demonstration field or of a participating farmer, and a knowledge transfer part in a class room setting on findings of the field visit and/or cultivation practices such as integrated pest management (IPM), fertiliser management, late blight control and spraying techniques, planning of crop production, seed potato production and plant selection to obtain good quality potato seed for the following season.

The implementation of the training was done by IVEGRI with supplementary presentations of Wageningen Plant Research employees on findings of the field demonstrations and farm management registrations (section 3.1).

Figure 4 *Farmers in Indonesia have many pesticide products to choose from (top), organic products (bottom left) and chemical fertiliser products (bottom right)*

3.4.2. Selection of farmers

Farmers to be trained were carefully selected by predefined selection criteria. The criteria to participate were:

- Farmers are from one of the two sub-districts bordering the training sites,
- Farmers are literate (able to read and write),
- Farmers live close to the training site,
- Farmer's age is between 25 and 50 years,
- Farmers have at least five years' experience with the potato production and
- Farmers are committed to attend bi-weekly training sessions during five subsequent potato seasons.

The general characteristics of the selected and participating farmers of each region are presented in Table 3.2. There are substantial differences in available land for cultivation between farmers who grow Granola or Atlantic (Table 3.2) and the available land differed each year (data not shown). The average available land of farmers growing Granola was 8,429 m^2 or ≈ 2 acres with the smallest farmer of 700 m^2 (0.2 acres) and the largest farmer with 50,000 m^2 (12 acres). The Atlantic farmers have more land available for agriculture: on average 16,463 m^2 (4 acres) varying between 800 m^2 and 80,000 m^2. The available land reported varies from the land sizes, which are actually cultivated with potatoes as farmers grow more crops than only potatoes. Farmers also indicated to only partly own the land and rent land for a maximum of one year. The available land for production was stable during the project period that is between the baseline and the evaluation survey (data not shown).

Table 3.2 General characteristics of the participating farmers.

	Atlantic	Granola
Respondents male	17	14
Respondents female	0	2
Age (years; min – max)	41 (26-49)	42 years (29-52)
Education		
None	0%	7%
Elementary	12%	29%
Middle School	35%	29%
Senior School	47%	14%
Diploma 1	0%	7%
University	6%	14%
Head of the household	13	13 male farmers
Average family size (# persons)	4.6	4.6
Village		
Cikajang-Garut	47%	43%
Pangalengan	53%	57%
Mean available land (m^2, min-max)	16,463 (800-80,000)	8,429 (700-50,000)

3.4.3. Attendance sheets of participants of trainings

All farmers had to sign attendance sheets at each training session to monitor and evaluate if farmers were trained.

On average, the attendance rate of farmers was 75% and approximately 3 crop specialists per training were present (Table 3.3). The average attendance for the first three training seasons was 80% in Garut and slightly more than 70% in Pangalengan. Sometimes a participant could not be present due to personal circumstances. There was one drop-out in 2014 and another farmer replaced him. Farmers received at the end of each training season a certificate and did the knowledge test (section 3.1).

Table 3.3 Attendance of farmers, IVEGRI and crop specialists such as pest observers or extension agents attending the potato trainings

Region	Year	Season	# farmers	# crop specialists	# IVEGRI	% farmers
Garut	13/14	Rainy	16.8	3.5	4.5	83.8
	14	Dry	14.8	2.8	6.3	74.2
	14/15	Rainy	16.2	4.2	6.2	80.8
	15	Dry	-[1]	-	-	-
	15/16	Rainy	-	-	-	-
		Mean	16.7	3.4	5.6	80.0
Pangalengan	13/14	Rainy	13.1	2.7	5.4	65.7
	14	Dry	15.7	2.5	6.8	78.3
	14/15	Rainy	14.5	3.2	6.0	72.5
	15	Dry	-	-	-	-
	15/16	Rainy	-	-	-	-
		Mean	14.4	2.8	6.1	71.8
Mean			15.2	3.1	5.8	76.0

[1] Attendance sheets signed but not available for evaluation due to moving of local parties.

Figure 5 Farmers at the bi- weekly training session, visiting a farmers field (left) and the meeting in a classroom setting (right)

3.4.4. Evaluation of trainings of smallholder farmers by trainer

The final evaluation of the all training activities (trainings, field demonstrations, farm management registrations, farmer surveys) during the period of June 2013 until September 2016 was carried out in Garut and Pangalengan on 2 November and 31 October 2016, respectively. In each region, 19 trained potato farmers (Atlantic and Granola producing farmers), extension workers and pest observers involved in the project activities, attended the final evaluation during which 11 questions were asked in a classroom setting (Annex 3). The objective of the final evaluation was to assess all activities on suitability and/or in parallel with farmers' need. This evaluation also intended to provide a feedback from the participants to improve activities/project programs for further, new or similar projects. The evaluation of the trainings of the farmers was done during the final training session in Garut and in Pangalengan and conducted by the WP Potato implementers themselves. This division is therefore different from the presentation of the results of the farmers' surveys.

Table 3.4 Results of the evaluation of the training of smallholder farmers in a classroom setting.

Question		**Pangalengan**	**Garut**
The overall program in the Potato WP (%):			
	Not appropriate	10.5	0
	Appropriate	89.5	100
The implementation of bi-weekly training (%):			
	Not appropriate	0	0
	Appropriate	100	100
The overall demoplot / training implementation (%):			
	Not appropriate	31.6	57.9
	Appropriate	68.4	42.1
Reasons for not appropriate:			
		Observation must be conducted at least once a week so pest & diseases are well monitored	Demoplot late blight & fertiliser should both be carried out in dry rainy season, respectively
		Missing use/application of power sprayer to reduce pesticide application	
		Soil analysis should be included in training to implement fertiliser recommendations	
Is the program of demoplot/ training in the dry season or in the rainy season, reached the farmers' target (%):			
	Target not reached	100	57.9
	Target reached	0	42.1

Reasons for not reached the target:			
		Demoplot late blight & fertiliser should both be carried out in dry & rainy season	Demoplot late blight & fertiliser should both be carried out indry & rainy season
The usefulness of the training/ demoplot (%):			
	Useful	100	100
	Not useful	0	0
If training / demoplot appropriate, has results of demoplots/ training affected your farm activities (%)?			
	Affected	100	100
	Not affected	0	0
Example of activities that have changed thanks to the training (%):			
		Use of nitrate acid & selection of pesticide based on the mode of action	Application of animal manure reduced by 20-30% (by 73,7% of farmers)
			Application of pesticide reduced by 20% (by 73,7% of farmers)
			Some farmers still practice farm record keeping
			Some farmers reduced pH of spray solution
			Single application of pesticide
When did you decide to adopt the technology demonstrated in the training (%)?			
	Directly	42.1	21
	After 1 planting	10.5	79
	More than 1 planting	47.4	0
Is the information from the vegIMPACT program also spread to other potato farmers (%)?			
	Yes	100	100
	No	0	0
Shortcomings in the trainings of WP Potato?			
		Control of late blight was not fully successful	Seed potato production should get more attention
		Observation of pest & diseases should be carried out more intensively	Seed potatos to be used in demoplots should be from IVEGRI to reduce uncertainty of seed quality issues
		Training on application of power sprayer	Post harvest should be included in training
What kind of other activities would you like to propose in future training programs?			
		Product-market combination (product marketing)	Training on other vegetable crops (tomato, hot pepper, carrot)
		Post harvest	Product marketing for carrot & potato
		Training on farm management	Post harvest for tomato & hot pepper
		Tissue culture for potato seed production	Marketing for other vegetable crops
		Program for other vegetables (e.g. hot pepper, tomato)	
		Control of bacterial wilt diseases	
		Good Agricultural Practices (GAP)	
Overall point for Potato training program (scale 1-10):			
		8	8

3.5. Farm management registrations

Participating farmers were requested to keep a logbook of the management of the potato production, in total 200 farm management registrations (5 periods, 40 farmers per period). Farmers received instructions on the recording of daily management activities and information. The total number of farmers providing a farm management registration changed over time (Table 3.5). Farmers cultivating Atlantic decreased overtime from 20 in 2013 to 7 in 2015 as Atlantic seed was hardly available. The number of farmers cultivating Granola increased from 20 in 2013 to a maximum of 28 in 2014 as farmers shifted from Atlantic to Granola. The number of farmers planting potatoes in 2015 dry season also decreased as the weather was not good. One farmer left the program due to unknown reasons and one farmer was replaced. In total 180 farm management registrations were

collected. Detailed information on the farm management registrations are provided by (Van den Brink*, et al.* 2015b) and (Pronk*, et al.* 2017).

The registered data were processed in GENSTAT Eighteens Edition, Version 18.1.0.17005 (64 bits). The data of the three dry seasons were tested for linear regressing with time at the factor with an unbalanced design where the two rainy seasons were analysed for differences only, also using an unbalanced design. Potato area, potato productivity, pesticide use and production costs were log transformed to ensure a normal distribution of the residuals.

Table 3.5 The total number of farm registrations (#).

	Dry season			Rainy season		
Variety	2013	2014	2015	2013/14	2014/15	Total
Atlantic	20	9	7	13	9	58
Granola	20	28	20	26	28	122
Total	40	37	27	39	37	180

Figure 6 Farmers measuring yield (left) and exporting potatoes from the field (right)

3.6. Field demonstrations

Field demonstrations were designed and performed on late blight control, fertilisation practices and positive seed selection. The demonstrations on late blight control were performed in the rainy season of 2013-14 (Schepers*, et al.* 2014), the rainy season of 2014-15 in both Garut and Pangalengan (Schepers*, et al.* 2015) and in the rainy season of 2015-16 in Pangalengan (Schepers*, et al.* 2016). Results are reported and not discussed in this report. Demonstrations on fertilisation practices were designed and performed in Garut and Pangalengan in the rainy season of 2013-14, the rainy season of 2014-15 and the dry season of 2015 (Van den Brink*, et al.* 2015a). In the rainy season of 2013-14 different nitrogen (N) application levels were compared with farmers' practices of varieties Granola and Atlantic. In the rainy season 2014-15, the demonstration identified the optimal N application level for the potato production of the variety Granola. In the dry season of 2015, the interactive effects of N and phosphate (P_2O_5) fertilisation on potato production of the varieties Granola and Atlantic were evaluated in both Garut and Pangalengan, and the optimal P_2O_5 application level was identified for the potato variety Granola. Results are reported and not discussed in this report. Demonstrations on positive selection of seed was initiated in Garut in rainy

season of 2015-2016 where the positive selection was practiced in the varieties Granola and Atlantic (Gunadi*, et al.* 2017). The effects of the positive selection practiced were evaluated in Garut and Pangalengan of both varieties involved in the dry season of 2016 and not discussed in this report.

Figure 7 *Farmers visiting a demonstration on phosphate fertiliser use (top left) and positive seed selection (bottom left), evaluating a potato (top right), harvesting of a demonstration on late blight control (bottom right)*

3.7. Farmer surveys

Farmer surveys are often used to evaluate effects of trainings on farmers' behaviour and, when found necessary, to adapt trainings to the results found. The findings are collected through farmer surveys conducted before the trainings started, the baseline survey, during the project (midterm 1, midterm 2 surveys) and after the project, the end-line survey. The different measures allow for a comparison in time and can reveal changes in good agricultural practices before and after the trainings.

3.7.1. Baseline, mid-term 1 and 2, and end-line survey

Farmer surveys consisted of interviewing trained farmers to:

- establish their knowledge level,
- collect information on production practices and performances, and
- collect information on training appreciation (only in the midterm and end-line survey)

The farmer surveys were all structured surveys including open questions for the "why" and the "how", based on a 'before' (baseline), 'after' (mid-term 1 and 2) and 'evaluation' (end-line) survey on the changes of verifiable outcome indicators and on causes of change of the verifiable outcome indicators. A local enumerator performed the surveys. For the surveys the recall (or recollection) approach is used, meaning that farmers were asked about the past production season. As timing of data collection in relation to the trainings is crucial, too shortly afterwards practises may not be implemented and too long afterwards farmers may not be able to recall farm management and marketing details, approximately one year between each survey was chosen (Table 3.6). The recall method is highly complementary to the quantitative information collected through the farm management registrations (section 3.1) and may result in conflicting findings (Dijkxhoorn*, et al.* 2014) discussed in Chapter 5 Discussion and Conclusions.
Questionnaires for each survey were translated into Bahasa, pretested on a small sample of farmers and improved before use. An example of the baseline survey is provided in Annex 1. Farmers were asked for the past dry as well as the rainy production season in one survey round to keep the threshold level for participation as low as possible. Results presented therefore often depend on a different number of observation (n) which is included in the tables. Other reasons contribute to a smaller number of observations than interviewed farmers as well: The moment that the surveys were conducted was a compromise between the dry and rainy production season, which moves in time depending on weather conditions, and thus some interviews were conducted when potatoes were not yet harvested. Unfortunately, to revisit farmers after harvest was too costly. However, the major reason farmers data were missing was that farmers did not plant the intended variety at all, in both seasons. This made a comparison between the two potato varieties not possible. Table 3.6 shows that from the 17 farmers selected to grow the variety Atlantic 11 produced Atlantic in the dry season and 14 in the rainy season prior to the trainings.

Table 3.6 Total number of interviewed farmers (outliers removed) producing potatoes in the dry and/or rainy season in the baseline, mid-term 1 and 2, and end-line survey.

Variety	Interviewed on	Baseline[1]	Midterm 1	Midterm 2	End-line
Atlantic	Dry season	11	9	6	6
	Rainy season	14	12	6	8
	Total[2]	17	17	17	17
	Dry season	13	9	13	14
	Rainy season	14	14	13	11
Granola	Total[2]	14	14	14	14

[1] Baseline survey conducted in July 2013; Midterm 1 in March to August 2014; Midterm 2 in June 2015, End-line in November 2015 to May 2016

[2] Total is not the sum of dry and rainy as most farmers grow potatoes in both seasons

3.7.2. Survey questions to establish the knowledge level

The knowledge level and subsequent changes were measured by two questions. The first question was on disease identification and effective pest management. The second question was on nutrient deficiency identification and effective fertiliser management. Figure 3.8A and B show the two

important potato disorders which occur in Indonesia and that were used in the survey. The questions were asked in each survey, so in total four times.

A B

Figure 3.8 Two important potato diseases in Indonesia used to evaluate change in knowledge of farmers of the survey; A= late blight; B = nutrient deficiency (Delleman, et al. 2005)

3.7.3. Survey questions to collect information on production practices and performances

The questions in the survey to collect information on production practices and performances were grouped into different categories:

- Personal and household characteristics,
- Production and productivity (including input use, i.e. volumes, type, frequency, costs)
- Current agricultural practices,
- Occupational health,
- Training exposure and sources of information.

3.7.4. Survey questions to establish training appreciation

The questions in the survey on training appreciation address whether the farmer would recommend the training to a neighbouring farmer and whether the farmer did share obtained knowledge to colleague potato farmers who did not participate in the trainings. Recommendation and sharing of knowledge is often used as a proxy to measure appreciation of the training and usefulness of the learnings.

3.7.5. Data processing

In total, 35 farmers were interviewed with the surveys, 18 farmers producing the variety Granola and 17 farmer producing the variety Atlantic. Before data analysis, outliers were removed (four farmers producing Granola). A web tool was used to enter and extract survey data. All data were further analysed with the statistical software package STATA (www.STATA.com). The focus as impact measurement tool is on differences between results of the baseline survey and the end-line survey where the midterm surveys mainly serve as monitoring instrument for progress. Data results are analysed with an unbalanced Anova and statistical significant differences indicated at the 10%, 5% and 1% or smaller by *, **, ***.

The trained group initially consisted of 20 Atlantic and 20 Granola farmers of which 10 were located

in the region Garut and 10 in Pangalengan (section 3.2). Farmers in each region were trained together. Because of the low number of observations, differences in indicators collected in the surveys cannot be statistically tested for significance. For the same reasons, causality assumptions cannot be tested with regression models. It is therefore not the objective of the surveys to claim significance and to generalize results. The small number of farmers offers the possibility to present individual behavioural characteristics of each participant. The advantage of a small number of observations is to analyse every observation in detail and to treat each individual behaviour as relevant and valuable. The farmer survey results need to be interpreted in a modest but valid way as they provide in-depth insights and understanding of individual farmers when combined with other data sources.

3.8. Interview of trainer and focus group discussions

Interviewing the trainer and organising a focus group discussion (FGD) is a qualitative methodology to in general establish the training appreciation. The results were used to:

I. Facilitate interpretation and support results of quantitative data;
II. Reveal the perceptions of the target group on the intervention and its' effects;
III. Trace the process of the interventions to draw conclusions on the contribution of the training towards the program objectives of vegIMPACT and;
IV. Identify underlying constraints in the case of non-achievement.

The trainer of IVEGRI was interviewed on August 19, 2017 and approximately 10 trained potato farmers participated in the FGD in Garut and a comparable number of farmers in Pangalengan on November 2015 and August 2016, respectively.

Data was collected and analysed based on the analytical framework in Annex 3 and conducted alongside the following assessment elements: *relevance* (how relevant is the intervention according to participants considering program goals and the actual situation of the participants); *effectiveness* (how effective is the intervention in achieving the program targets); *impact* what are the positive and negative changes produced by a development intervention, directly or indirectly, intended or unintended); and *sustainability* (what is the long term perspective of the intervention and can and will it last after withdrawal of the intervention (OECD 1991). The program objectives and the assessment elements were translated into semi-structural interview guidelines covering the topics presented in Annex 3.
During FGD, farmers were asked about what they remembered from the training and which aspects of the trainings they applied. While the survey lists the questions and topics, the FGD was not structured as such and farmers were invited to react spontaneously to what they remember and apply.

4. Results

This Chapter presents the results on the project activities combining those of the farm management registrations and farmer surveys according to the subject evaluated. In addition, the results on training appreciation collected through the farmer surveys, the semi-structured interview of the trainer and the FGD's are combined. Some results are presented elsewhere, such as those of the field demonstrations and some results are included with the methods. Some background information on the farm management registrations and farmer surveys is presented below and needs to be kept in mind when reading the results.

Farmers were requested to register farm management activities and purchases immediately, on a daily basis, but that this was seldom practiced. At the bi-weekly collection of the notebook, the collector sat down with the farmer for approximately one hour to verify the past two weeks' activities. Farmers appeared to have little knowledge on absolute units; most purchases were noted in units like bags and or bottles. For fertilisers this was less of a problem than for pesticides, as most fertilisers come in standardised sized bags. Pesticides however, come in different size bottle or bags.

In some years no Atlantic seed was available for farmers (section 3.5), but because they did want to plant potatoes they planted Granola. In the farmer surveys, these farmers indicated not to have planted Atlantic, but Granola. As they were however, selected to participate for the Atlantic cultivar they were registered as missing data. Despite not planting the appropriate variety or not planting at all, the majority of the farmers attended all training sessions.

4.1. Knowledge levels

Atlantic farmers	Figure	Granola farmers
All farmers recognized late blight, both in the baseline and subsequent surveys. However, recommended treatments of all farmers changed in the subsequent surveys. While in the baseline all farmers treated with just 'pesticides', in the subsequent surveys they recommend to spray with fungicides. This is more appropriate than spraying with pesticides.	 *A. Late blight*	Figure A shows the typical effects of late blight. About 94% of the farmers identified the figure A as late blight in the baseline and about 93% recommended spraying with pesticides. After the training, 88% of the farmers identified figure A as late blight meaning that less farmers gave the correct answer. However, most farmers recommended spraying with fungicides, which is more appropriate than spraying with pesticides.
While in the baseline the majority of farmers gave the correct answer when confronted with figure B (deficiency), in the subsequent surveys they seemed quite confused as they gave various answers from a virus to dry rot to lack of Potassium. Fifty eight % of the farmers would treat the crop with fungicides according to the subsequent surveys up against 0% in the baseline.	 *B. Deficiency*	Thirty three % of the farmers identified figure B as a deficiency problem. The majority of farmers suggested spraying and only a few suggested adding fertilisers. During the end-line survey, only 22% identified figure B correctly as a deficiency problem. After the training, the number of farmers decreased that recognized the deficiency correctly. They suggested a variety of different treatments, from irrigation to using a different seed variety, spraying pesticides or to use fertilisers.

The survey yielded practical examples of the correct frequency and timing of spraying, the direction of spraying, the importance of mixing less types of fungicide products and that mixing should depend

on specific active ingredients, the importance of application of basic fertilisers before planting, how to measure soil pH and water pH, how to calculate the correct doses of fertilisers, the identification of various diseases and subsequent decide on the right treatment.

4.2. (Process) potato area (%)

Results from farm management registrations

The area cultivated with potatoes in the dry season varied between 2,047 m^2 in 2014 for Granola to 4,415 m^2 for Atlantic in 2013 and in the rainy season between 2,174 m^2 for Granola in 2013/14 to 4,648 m^2 for Atlantic in 2013/14 (Table 4.1).

The area cultivated with potatoes decreased in the dry season over time to 58% for Atlantic and to 77% for Granola (Table 4.1). The decrease of 18.8% per year was significantly smaller than 0 and the same for both varieties. The model chosen was highly significant and explained 50% of the variation.

The area cultivated in the rainy season with the variety Atlantic decreased to 66% where the area cultivated with Granola increased to 106%. The area cultivated differed between varieties, for Atlantic being larger than for Granola indicated by the letter in the last column of Table 4.1, but no differences were found between the two seasons.

Additionally to not planting at all, as seeds were not available, farmers also planted a smaller area when planting. Both results show that the potato production is under pressure and suffers from a severe lack of sufficiently available good quality seeds.

Table 4.1 The (process) potato area (m^2) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season		
Variety	Unit	2013	2014	2015	Slope[1]	2013/14	2014/15	Means
Atlantic	m^2	4,415	3,928	2,577		4,648	3,079	4,006 a
	%	100	89	58		100	66	
Granola	m^2	2,705	2,047	2,086		2,174	2,297	2,238 b
	%	100	76	77		100	106	
Total	m^2	3,560	2,988	2,332		3,411	2,688	
	%	100	84	65	-18.8	100	79	

[1] Regression fit for the model was 50%.

Results from farmer surveys

The majority of the interviewed farmers produce potatoes both in the dry and rainy season (*Table* 4.2), although some farmers did not plant potatoes due to various reasons. It also appears that farmers producing Atlantic had also fields with Granola, 26% in the dry season and 21% in the rainy season, whereas only two farmers produced Atlantic alongside Granola in the dry season only.

The average area of potato decreased between the baseline survey and end-line survey from 9,327 m^2 to 4,330 m^2 for Atlantic in the dry season, a reduction to 46% of the initial area planted with Atlantic (*Table* 4.2). The decrease for Granola was less profound in the dry season, a reduction to 69% of the initial area planted Granola. In the rainy season, for both Atlantic and Granola the decrease in area was in the similar order of magnitude, 53% and 38% of the initial area planted with Atlantic and Granola respectively.

Table 4.2 Farmer surveys: the (process) potato area (m^2), the number of farmers (n) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season			
Variety	Unit	Baseline	Midterm 1	Midterm 2	End-line	Baseline	Midterm 1	Midterm 2	End-line
Atlantic	m^2	9,327	4,983	5,533	4,330	8,880	6,613	2,513	4,700
	n	11	9	6	6	14	12	6	8
	%	100	53	59	46	100	74	28	53
Granola	m^2	3,847	3,922	1,889	2,648	5,481	4,833	3,396	2,068
	n	13	9	13	13	8	14	13	11
	%	100	102	49	69	100	88	62	38
Total	m^2	5,069	4,453	3,040	3,179	8,897	5,654	3,117	3,287
	n	24	18	19	19	22	26	19	19
	%	100	88	60	63	100	64	35	37

4.3. Potato productivity (%)

Results from farm management registrations

The potato productivity (t ha^{-1}) in the dry season varied between 16.5 t ha^{-1} in 2014 for Granola to 22.9 t ha^{-1} in 2015 and in the rainy season between 15.7 t ha^{-1} in 2013/14 for Atlantic to 21.4 t ha^{-1} in 2014/15 for Granola (Table 4.3).

The productivity increased in the dry season over time to 115% for Atlantic and to 132% for Granola (Table 4.3). The increase of 2.2% per year for Atlantic was significantly larger than 0 but smaller than that for Granola of 10% per year. The model chosen was significant and explained 38.5% of the variation.

The productivity in the rainy season of the variety Atlantic increased to 116% where the productivity for Granola increased to 104%. The productivity differed between varieties, for Atlantic being smaller than for Granola indicated by the letter in the last column of Table 4.3, but no differences were found between the two seasons.

Table 4.3 Farm management registrations: the (process) potato productivity (t ha^{-1}) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season		
Variety	Unit	2013	2014	2015	Slope[1]	2013/14	2014/15	Means
Atlantic	t ha^{-1}	16.9	20.0	19.4		15.7	18.1	16.7 b
	%	100	119	115	2.2	100	116	
Granola	t ha^{-1}	17.7	16.5	22.9		20.5	21.4	21.0 a
	%	100	95	132	10.1	100	104	
Total	t ha^{-1}	17.3	18.3	21.2		18.1	19.8	
	%	100	107	123		100	109	

[1] Regression fit for the model was 38.5%.

Results from farmer surveys

An overview of the potato productivity and percentage of change over time are presented in Table 4.4. The productivity of Atlantic did not change between baseline and end-line survey in the dry season but increased to 236% in the rainy season whereas the productivity of Granola increased to 129% and 238% in the dry and rainy season, respectively. The number of observations (n) was substantially lower than the number of farmers interviewed (17 producing Atlantic; 14 Granola), for both varieties. In the baseline survey, six and three farmers indicated not to plant Atlantic in the dry and rainy season, respectively, five farmers indicated that the crop was lost in the rainy season and two had not yet harvested in the rainy season. Only one farmer had not planted Granola in the dry seasons, baseline survey, and six farmers had not planted in the rainy season and three reported that the crop was lost. These results are understandable as the baseline took place before the trainings in two major potato-producing regions Garut, the region where Atlantic traditionally is produced and Pangalengan, the region where Granola traditionally is produced. As both groups are presented in the results along the varieties, farmers in Garut in general do not plant Granola and farmers in Pangalengan in general do not plant Atlantic.

The discrepancy between the number of interviewed farmers and observations however, continued over time and increased at the end-line survey for Atlantic in the dry and rainy season. Granola was in general produced most. This discrepancy was no longer due to yield failures, which supports the conclusion that farmers had better skills for potato production after the trainings.

Table 4.4 Farmer surveys: Potato productivity (t ha^{-1}), the number of farmers (n) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season			
Variety	Unit	Baseline	Midterm 1	Midterm 2	End-line	Baseline	Midterm 1	Midterm 2	End-line
Atlantic	t ha^{-1}	14.1	15.8	20.4	14.1	8.5	17.1	17.9	20.1
	n	11	8	6	6	6	12	6	8
	%	100	113	145	100	100	201	210	236
Granola	t ha^{-1}	17.4	14.6	14.5	23.3	10.7	13.4	16.6	24.6
	n	13	9	13	13	5	14	13	11
	%	100	84	83	134	100	125	154	229
Total	t ha^{-1}	15.8	15.2	16.3	20.4	9.5	15.1	17.0	22.7
	n	24	17	19	19	11	26	19	19
	%	100	96	103	129	100	159	178	238

4.4. Pesticide use per unit of product (%)

Results from farm management registrations

The pesticide use (kg active ingredients (A.I.) per ton potato produced) in the dry season varied between 1.1 kg t^{-1} in 2015 for Granola to 5.1 kg t^{-1} for Atlantic in 2013 and in the rainy season between 1.8 kg t^{-1} for Granola in 2014/15 to 4.1 kg t^{-1} for Atlantic in 2013/14 (Table 4.5).

The use of active ingredients per ton potatoes decreased in the dry season over time to 37% in Atlantic and to 45% for Granola (Table 4.5). The decrease of 58% per year for Atlantic was significantly smaller than 0 and larger than that for Granola of 34%. The model chosen was highly significant and explained 50% of the variation.

The pesticide use in the rainy season for the variety Atlantic decreased to 60% where the pesticide use for Granola decreased to 87%. In the rainy season, pesticide use differed between varieties, for Atlantic being higher than for Granola, indicated by the letter in the last column of Table 4.5, but no differences were found between the two seasons.

Table 4.5 Farm management registrations: the pesticide use (kg active ingredient (A.I.) t^{-1} product) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season		
Variety	Unit	2013	2014	2015	Slope[1]	2013/14	2014/15	Means
Atlantic	Kg A.I. t^{-1}	5.1	2.4	1.9		3.9	2.3	3.2 a
	%	100.0	48	37	-58	100	60	
Granola	Kg A.I. t^{-1}	2.1	1.9	1.1		2.1	1.8	2.0 b
	%	100.0	92	45	-34	100	87	
Total	Kg A.I. t^{-1}	3.6	2.2	1.5		2.7	1.9	
	%	100.0	61	42		100	72	

[1] Regression fit for the model was 50.2%.

In the dry season, this decrease was associate with fewer applications per week (Table 4.6) for Atlantic and Granola. No differences were found in the rainy season.

Table 4.6 Farm management registrations: the number of pesticide applications (#) per week during the dry and rainy season and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry			Rainy	
Variety	Unit	2013	2014	2015	2013	2014
Atlantic	#/week	1.7	1.6	1.2	1.8	1.8
	%	100	95	72	100	99
Granola	#/week	1.5	1.4	1.1	1.6	1.6
	%	100	91	70	100	100
Total	#/week	1.6	1.5	1.2	1.7	1.7
	%	100	93	71	100	98

Farmers used fungicide products with preventive and curative active ingredients (Table 4.7). The use shows comparable decrease over time as the total pesticide use of Table 4.5. Both types of active ingredients were used in 2013, dry and rainy season.

Table 4.7 Farm management registrations: the use of preventive and curative active ingredients per ton potatoes during the dry and rainy season and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry						Rainy			
		Preventive			Curative			Preventive		Curative	
Variety	unit	2013	2014	2015	2013	2014	2015	2013	2014	2013	2014
Atlantic	Kg t^{-1}	4.8	2.4	1.7	0.33	0.09	0.22	3.7	2.2	0.18	0.12
	%	100	50	35	100	27	66	100	59	100	70
Granola	Kg t^{-1}	2.0	1.8	1.1	0.14	0.11	0.05	1.9	1.7	0.17	0.16
	%	100	93	54	100	76	37	100	86	100	93
Total	Kg t^{-1}	3.4	2.1	1.4	0.24	0.11	0.10	2.5	1.8	0.17	0.15
	%	100	62	40	100	44	40	100	71	100	87

Results from farmer surveys

The use of pesticides ranges from 1.4 kg A.I. t^{-1} in the end-line survey in the dry and rainy season for Granola to 5.6 kg A.I. t^{-1} in the baseline survey for Atlantic in the dry season (Table 4.8). The pesticide use decreased over time for Atlantic to 36% in the dry and 66% in the rainy season. The decrease for Granola in the dry was to 47% and the rainy season to only 19% of the use in the baseline survey.

Table 4.8 Farmer surveys: the pesticide use (kg active ingredient (kg A.I. t^{-1} potatoes), the number of farmers (n) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season			
Variety	Unit	Baseline	Midterm 1	Midterm 2	End-line	Baseline	Midterm 1	Midterm 2	End-line
Atlantic	Kg t^{-1}	5.6	2.3	2.8	2.0	4.7	3.9	3.0	3.1
	N	11	8	5	6	7	12	6	8
	%	100	41	50	36	100	82	64	66
Granola	Kg t^{-1}	2.9	3.5	2.1	1.4	4.9	2.6	1.4	1.9
	N	13	9	13	14	8	14	13	11
	%	100	119	72	47	100	53	29	39
Total	Kg t^{-1}	4.2	2.9	2.3	1.6	4.8	3.2	1.9	2.4
	N	24	17	18	20	15	26	19	19
	%	100	71	56	38	100	66	40	50

The number of pesticide applications per week depends on the prevalence of pests and diseases in a particular season. As indicated before, commonly, pest and diseases are more prevalent in the rainy season. Correspondingly, we observed a higher spraying frequency in the rainy season compared to the dry season (Table 4.9) irrespectively of variety. Some farmers sprayed on a daily base according to the Baseline survey but decreased the spraying frequency to four per week according to the end-line survey, in the rainy season. This decrease is significant. In general, farmers have reduced the number of pesticide applications significantly and none of the farmers sprayed daily in the end-line (Table 4.9).

Table 4.9 Farmer surveys: number of pesticide applications per week during the dry and rainy season in the baseline and end-line for Atlantic (n=17) and Granola (n=14).

		Dry season		Rainy season	
Variety		Baseline	End-line	Baseline	End-line
Atlantic	Mean	1.7	1.2	3.0	2.4
	Minimum	0.0	0.0	0.0	0.0
	Maximum	3.0	2.0	7.0	4.0
Granola	Mean	1.6	1.1	3.7	2.2
	Minimum	1.0	1.0	2.0	0.0
	Maximum	3.0	2.0	7.0	4.0

The majority of the farmers always used and continued to use a mixture of pesticides. Thirty three percent of the farmers producing Granola according to the in baseline survey and 27% according to the end-line survey used one single product at a spray application. Only 5.8% of the Atlantic farmers uses one single product at a spray application (both in baseline and end-line). There is a small increase (+17%) in the number of farmers who says to always use a mixture (compared to sometimes a mixture and sometimes a single product in the baseline).
Furthermore, the baseline survey showed that all farmers only used preventive fungicide products. A preventive fungicide should be applied before the disease infects the crop. However, the crop does not show any disease symptoms at that time. The common spraying strategy was to start spraying preventive fungicides when the disease is detected or when farmers think the infection may occur.

When the major potato disease late blight (*Phytophthora infestans*) is detected in the crop, preventive fungicides will not cure the crop and it will be lost. To cure the crop after infection curative fungicides need to be applied. The end-line survey indicated that the use of only preventive fungicides in both Atlantic and Granola reduced to approximately 40% of the farmers and that more than half (56% for Atlantic and 57% for Granola) of the farmers used curative fungicides. A small percentage of farmers indicated to adjust the fungicide type to the crop needs, one Atlantic and two Granola farmers. This change from preventive to curative fungicides at least prevents the crop being lost. However, the best strategy is to use timely preventive fungicides with different active ingredients to prevent infections and to use a curative fungicide only when infections are noticed. In this way, the disease will not develop resistance to single active ingredients.

The trainings promoted the use of single pesticide applications to improve the effectiveness of pesticides. Despite this advice, the majority of farmers maintained mixing practices after the trainings. The main reasons for farmers to mix pesticides are that they are not convinced of the improved effectiveness of using single pesticide applications and most importantly, applying single pesticides requires much more (costly) labour as the spray frequency increases considerably. In addition, the farmers have often hire labour for pesticides application. Farmers are not always in control of how the labourers apply the pesticides and what they exactly use. In addition, if farmers are able and willing to share the obtained knowledge and teach their labourers, they cannot control the actual practices and are not in the position to enforce their labourers to change.

Major changes in spraying practices were related to the spray nozzle and the spray angle. About one third of the farmers increased the spraying angle increasing the efficiency of spraying, and hardly any farmer (only three, both in the Atlantic and the Granola group) used nozzles with big drops after the training. In the dry season, farmers also changed the timing of spraying to the most effective spraying time, which depends on the type of pesticide and target. They indicated that in the rainy season it was difficult to spray at the most appropriate time due to heavy rains during the day. The section *production and productivity* elaborates more on the production costs aspect. Text box 1 below presents a quotation of one of the farmers on adoption of agricultural practices on pesticides application.

Text box 1: Potato Farmer Garut on adoption

"We sometimes follow the recommendations, sometimes not. Especially for the doses of pesticides, we are very afraid it is not enough if we spray less. In the dry season, we apply the majority of the lessons, but not in the rainy season. It is too risky for pest & diseases control. But, the issue in the dry season is watering which increases production costs compared with the rainy season."

4.5. Nitrogen use per unit of product (%)

Results from farm management registrations

The N use (kg N per ton potato produced) in the dry season varied between 7.9 kg t^{-1} in 2015 for Granola to more than 12.9 kg t^{-1} for Atlantic in 2014 and in the rainy season between 8.6 kg t^{-1} for Granola in 2013/14 to 15.1 kg t^{-1} for Atlantic in 2014/15 (Table 4.10).

The N use decreased in the dry season over time to 65% in Atlantic and to 61% for Granola (Table 4.10). This decrease however, was not significant over time, most likely due to the large standard deviation in the measurements. The model chosen was not significant and explained only 0.9% of the variation.

However, the unbalanced Anova showed that the N use was lower in 2015 than in the previous years at the 10% significant level, see the nitrogen use in the total observations in Table 4.10. No differences between varieties were found.

The N use in the rainy season for the variety Atlantic decreased to 96% where the N use for Granola decreased to 41%. The N use differed between varieties, for Atlantic being higher than for Granola, indicated by the letter in the last column of Table 4.10, but no differences were found between the two seasons.

Table 4.10 Farm management registrations: the nitrogen use (kg t^{-1} product, standard deviation between brackets) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season		
Variety	Unit	2013	2014	2015	Slope[1]	2013/14	2014/15	Means
Atlantic	Kg t^{-1}	12.6 (10.6)	12.9 (8.7)	8.2 (1.0)		12.4 (5.7)	15.1 (8.4)	13.5 a
	%	100	102	65	n.s.	100	122	
Granola	Kg t^{-1}	12.2 (5.5)	11.8 (8.2)	7.9 (3.9)		10.1 (4.8)	8.4 (4.5)	9.2 b
	%	100.0	96.9	61.3	n.s.	100	84	
Total	Kg t^{-1}	12.4 (8.3) a	12.3 (8.2) a	8.0 (3.4) b		10.8 (5.2)	10.0 (6.3)	
	%	100	100	65	n.s.	100	93	

[1] Regression fit for the model was 0.9%.

Results from farmer surveys

The nitrogen use (kg N t^{-1} potatoes produced) reduced to 50% for Atlantic in the dry season, end-line compared to baseline survey, and to 60% for Granola, same season and period (Table 4.11). The reductions in the rainy season were even higher, to 27% for Atlantic and to 33% for Granola. Farmers were trained on how to calculate the required dose for fertiliser products. The required dose was demonstrated through field demonstrations. Farmers indicated that they did not know how to calculate what is needed for the crop. They now know how to, but they also indicated that they do not calculate the required doses always as it is a lot of work compared to the expected benefits.

Table 4.11 Farmer surveys: the nitrogen use (kg N t^{-1} potatoes), the number of farmers (n) and percentage change over time (%) for variety Atlantic and Granola, and all farmers.

		Dry season				Rainy season			
Variety	Unit	Baseline	Midterm 1	Midterm 2	End-line	Baseline	Midterm 1	Midterm 2	End-line
Atlantic	Kg t^{-1}	23.2	9.3	10.9	11.6	32.0	13.2	9.4	8.6
	N	11	8	5	6	7	11	6	8
	%	100	40	47	50	100	41	29	27
Granola	Kg t^{-1}	11.4	8.7	9.4	9.4	17.1	11.2	7.8	7.5
	N	13	8	13	14	8	13	13	11
	%	100	76	82	82	100	66	46	44
Total	Kg t^{-1}	16.8	9.0	9.8	10.1	24.0	12.1	8.3	8.0
	N	24	16	18	20	15	24	19	19
	%	100	54	58	60	100	50	35	33

4.6. Production costs per unit of product (%)

Results from farm management registrations

The production costs (IDR per kg potato produced) varied between 2,340 IDR/kg in 2015 for Granola to more than 4,000 IDR/kg for Atlantic in 2013 (Table 4.12).

The costs decreased in the dry season over time to 65% in Atlantic and to 88% for Granola (Table 4.12). The decrease of 7.7% per year for Atlantic was significantly smaller than zero and larger than that for Granola of 5%. The model chosen was highly significant and explained 50% of the variation.

The production costs in the rainy season for the variety Atlantic decreased to 83% where the production costs for Granola slightly increased to 105%. The production costs differed between varieties, for Atlantic being higher than for Granola, indicated by the letter in the last column of Table 4.12, but no differences were found between the two seasons.

Table 4.12 Farm management registrations: the production costs (IDR kg^{-1} product, excluding labour) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season		
Variety	Unit	2013	2014	2015	Slope[1]	2013/14	2014/15	Means
Atlantic	IDR kg^{-1}	4,297	2,938	2,791		3,726	3,074	3,459 a
	%	100	68	65	-7.7	100	83	
Granola	IDR kg^{-1}	2,607	2,988	2,299		2,512	2,636	2,576 b
	%	100	115	88	-5.0	100	105	
Total	IDR kg^{-1}	3,452	2,963	2,545		2,916	2,742	
	%	100	86	74		100	94	

[1] Regression fit for the model was 50.0%.

Results from farmer surveys

The production costs ranged from 1,433 IDR kg^{-1} for Granola in the end-line survey of the rainy season to slightly more than 7,000 IDR/kg for Atlantic in the baseline survey, rainy season (Table 4.13). In general, the production costs decreased over time, sometimes to approximately 35% of the costs of the baseline survey. The smallest decrease was found for Atlantic in the dry season, 88%.

Table 4.13 Farmer surveys: the production costs (IDR kg^{-1} product, excluding labour), the number of farmers (n) and percentage change over time (%) for Atlantic, Granola and all farmers.

		Dry season				Rainy season			
Variety	Unit	Baseline	Midterm 1	Midterm 2	End-line	Baseline	Midterm 1	Midterm 2	End-line
Atlantic	IND kg^{-1}	4,158	2,338	2,363	3,641	7,090	2,937	2,377	2,325
	n	11	8	5	6	6	12	6	8
	%	100	56	57	88	100	41	34	33
Granola	IND kg^{-1}	2,221	2,124	2,041	1,617	3,079	2,835	1,893	1,433
	n	13	9	13	13	5	14	13	11
	%	100	96	92	73	100	92	61	47
Total	IND kg^{-1}	3,109	2,225	2,131	2,256	5,266	2,882	2,046	1,808
	n	24	17	18	19	11	26	19	19
	%	100	72	69	73	100	55	39	34

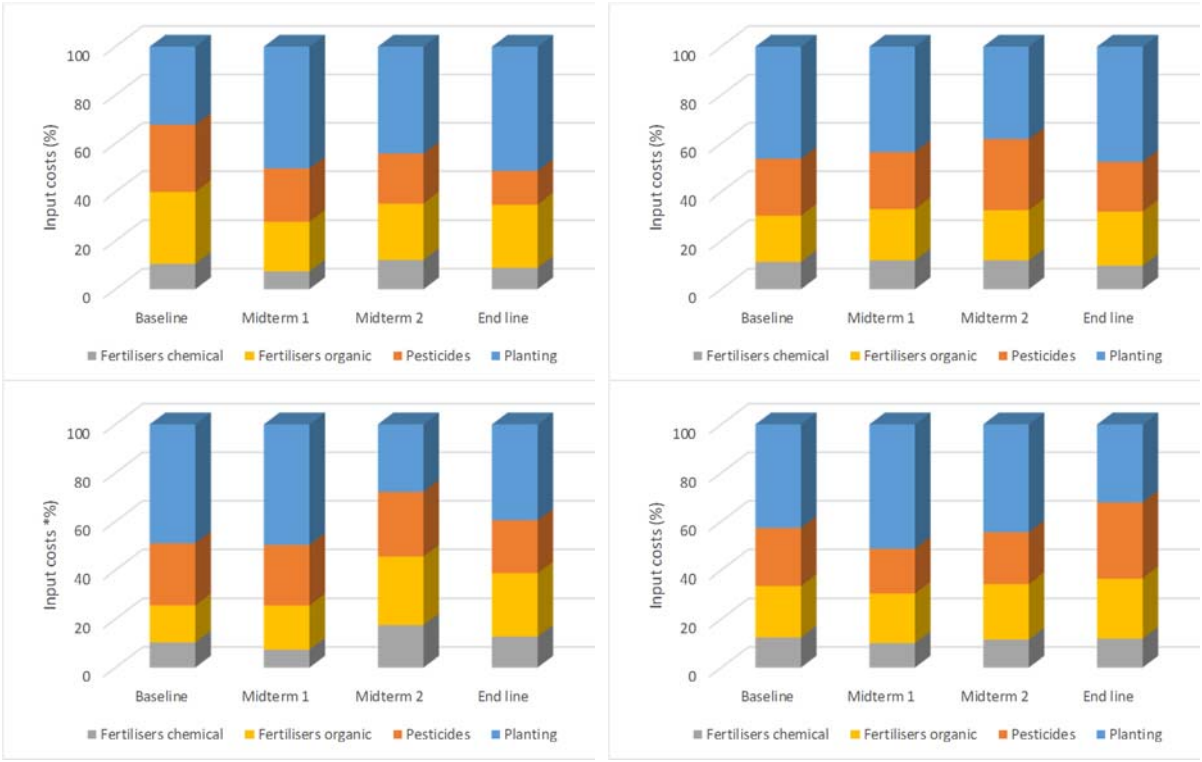

Figure 4.1 Composition of cost components of Atlantic (top) and Granola (bottom) in the dry (left) and rainy season (right) based on farmers surveys. Costs for labour are not included.

The different costs components changed slightly over time but show some variation depending on variety and season (Figure 4.1). In the dry season, costs for pesticides tend to reduce as percentage of the total cost price for both Atlantic and Granola where costs for organic fertilisers increase. In the rainy season costs for pesticides hardly changed.

4.7. Occupational health problems and risks (farmer surveys)

Use of Personal Protective Equipment

The end-line survey suggests that Granola farmers increased the use of Personal Protective Equipment (PPE) from 71% in the baseline to 100% in the end-line survey (Table 4.14). Also all farmers producing Atlantic use some kind of PPE after the trainings. Especially the overall, hat, boots and gloves are used by the majority of farmers. Farmers indicated to use these PPE products as it reduces the risk of skin contact with pesticides significantly. Masks are not very popular and often not used. These results are promising but should be interpreted with care as 56% of the Atlantic and 35% of the Granola farmers do not spray themselves, but contract external labour that in general does not use PPE and which were not targeted by the intervention. Often, the argument for not using PPE by labourers was "It is not comfortable while working in the field", which appeared to relate to practical issues. For example, almost all male labourers smoke and it's difficult to smoke with a mask, the use of PPE hampers the smooth work and the heat makes wearing of PPE very unpleasant under tropical conditions. In short, the trained farmers were aware of the dangers and the benefits of PPE but:

- they often do not spray themselves,
- they and their labourers have practical arguments for not using PPE.

Table 4.14 Farmer surveys: Percentage of farmers that use personal protective equipment (PPE) and specific PPE products in the baseline survey and the end-line survey for variety Atlantic and Granola.

Variety	PPE	Baseline	End-line
Atlantic (n=17)	Using any PPE	94	100
	Gloves	5.9	47.1
	Goggles	35.3	5.9
	Gumboots	88.2	94.1
	Hat	70.6	100.0
	Jacket/rain coat	23.5	5.9
	Mask	82.4	29.4
	Overall or long sleeves	29.4	100.0
Granola (n=14)	Using any PPE	71	100
	Gloves	35.7	57.1
	Goggles	71.4	14.3
	Gumboots	64.3	92.9
	Hat	14.3	100.0
	Jacket/rain coat	64.3	7.1
	Mask	7.1	14.3
	Overall or long sleeves	38.8	100.0

Period between spraying and working

Another positive change can be found in the period between spraying pesticides and working in the field. More farmers extended the period between spraying and working on the field: 27% of the farmers according to the baseline survey waited one day between spraying and working against 67% in the end-line survey. However, still 27% Granola and 41% Atlantic farmers in the end-line survey only wait one hour. There is a positive change among the Atlantic farmers as in the baseline survey, before the intervention, 18% never waited after spraying against 0% in the subsequent surveys.

Occurrence of incidents

The number of incidents in the end-line survey that required medical attention among farmers and workers decreased compared to the baseline survey. In the baseline survey, 12% of the farmers reported one accident and 88% no accident. In the end-line survey, 100% reported no accident of both Granola and Atlantic farmers. We are not able to conclude whether the training contributed to this difference but it is a positive finding. Maybe farmers are more aware of the dangers and risks of the field work, but the occurrence of an incident cannot always be controlled for.

4.8. Training appreciation (farmer surveys)

This sections combines results on the training appreciation according to the farmers' surveys, the semi-structured interview of the trainer and the FGD's (sections 3.7.4 and 4.8). The main outcomes of the qualitative data are grouped together in this section alongside the main evaluation criteria (see Annex 3), i.e. relevance, effectiveness, impact and sustainability. Additionally, all farmers were asked to mention spontaneously topics of the trainings, specific learnings, level of adoption and barriers in adoption (Table 4.15).

Relevance

In general, farmers showed a high level of appreciation. The farmer surveys indicated that farmers were quite satisfied with the intervention (training program) and rated on average an 8 and 8.5 (scale 1 – 10) for the Atlantic and Granola farmers, respectively. Farmers said that the intervention was relevant and addressed key bottlenecks among potato farmers producing Atlantic and Granola.
This positive attitude was furthermore confirmed as all (100%) Granola farmers and 94% Atlantic farmers would recommend the training to a neighbouring farmer and 67% Granola farmers shared some newly obtained knowledge with other, non-participating farmers. This percentage was a bit higher among the Atlantic farmers of whom 89% indicated to have shared knowledge. The information given in the FGD's was, however, different. In the FGD's farmers said to be very busy and only shared knowledge within their family.
The common opinion of farmers was that the trainings need to be simple, practical and repetitive to be effective (Text box 2). Farmers especially emphasised to appreciate the practical aspects of the trainings. In particular, the field demonstrations were a key asset of the intervention although farmers also criticised the implementation of the demonstrations. Several recommendations were suggested to improve them as a training instrument. Farmers said that yields of the demonstrations

on late blight control were not convincing and potatoes were heavily infested with late blight. Although they were enthusiastic about the training program offered, they were modest with respect to the expected results: they produce potato for ages and they are used to and convinced of their own practices. They expressed an open mind for innovations (changed practices) but it should really be beneficial. In case of late blight control, the demonstrations showed limited and insufficient benefits. However, photos to recognise a pest or disease were found beneficial and still used by some farmers.
Farmers furthermore highly appreciated the repetitive character of the trainings. Most training subjects were repeated during the five production seasons. Farmers indicated that they needed to be reminded to improve their practises towards GAP. They also indicated that they need a refresher course on a regular basis to keep them motivated to apply GAP.

Text box 2:

"It is possible to increase knowledge but to change an attitude is difficult. We found at the very start that learning is in repetition and that you have to train farmers several seasons, both dry and rainy, as both seasons are very specific in characteristics and agricultural practices. At first, they thought one training would be enough but farmers had many difficulties with the knowledge so they extended the training and demos."

An important proxy for relevance of the intervention is whether farmers are willing to contribute from their own resources. This question yielded a mixed response: some would and some would not be willing to contribute with own means to a similar training. A positive responder said: "Yes, I would be willing because I then build my own capacity".
The spontaneously mentioned topics of relevance are listed in Table 4.15 according to first mentioned being number one. Most relevant was the training on fertiliser application, followed by pesticide application. Farmers learned how to calculate the appropriate application dose and some still use the provided list to calculate the correct doses of fertilisers according to land size. However, for some others the calculation rules were too difficult to apply as the exact land size was unknown, too risky in the rainy season as the appropriate dose in practice means a lower dose, or they just were not motivated to apply the rules. Another lesson learned was on pesticide characteristics: the different classifications /ingredients of pesticides /herbicides /fungicides and application to a certain pest /disease and that not all pesticides can be and/or should be mixed. The majority of farmers indicated not to continue the farm management registrations.

Table 4.15 Topics mentioned by farmers[1], degrees of application and barriers for adoption

	Topics	*Lessons learned*	*Adoption*	*Barriers for application*
1	Fertiliser application	Calculate correct application rate depending on size of land: both for manure and chemical fertiliser	Mixed. Some do and use the provided list with figures but some do not.	It is difficult to calculate the right doses/size of land and some admit to be too lazy to do the calculations. There is also intercropping which makes it hard for farmers to calculate the right doses
		To apply basic fertiliser 1 or 2 weeks before planting	Mixed, some do	
2	Pesticide application	Calculate correct doses of pesticide application rate depending on size of land	Not in the rainy season Yes in the dry season	Too risky in the rainy season, high risk for pest & diseases. Sometimes they are lazy to calculate exact the correct amounts.
		Correct frequency and timing of spraying	Not in the rainy season Yes in the dry season	Difficult to apply at the right time in the rainy season (heavy rains and you cannot spray when it rains)
3	Spraying equipment	To replace nozzle every 6 months: Use smaller droplets	Yes Yes	
4	Pesticide characteristics	The different classifications /ingredients of pesticides /herbicides /fungicides and application to a certain pest /disease	Yes they are more cautious what to apply and when	If they are able to diagnose they use the right pesticides. A problem is that they do not always have the right information and updates on new pest & diseases
		That not all pesticides can be and/or should be mixed	Mixed, some still mix, some use a single doses	The farmers seem not convinced of single doses.
5	Chemical characteristics soil and irrigation water	To measure pH of soil and water and the correct treatment	pH water meter: yes	No pH soil meter available; they can send a sample of soil to IVEGRI but it takes 2 months for the results.
6	Cultivation practises	Correct distance of planting	Mixed, some do	
8	Potato seeds	Selection of good farm saved seed	Mixed. Some do, some do not. They prefer to cultivate a new variety. Some keep the smallest ones as seed, some sell the smallest ones	The recommendation that the seed should not fall on the ground during transport is difficult to follow. They load their motorbikes full and the road is not very good so during transport it sometimes falls
9	Disease control	Better control late blight	It is still a huge challenge, even the demo was infected.	
10	General obstacle		Farmers use contract labour, especially for spraying. They give the labourers instructions but it is not always followed. So labourers are not trained but do the actual work	Cost-benefit: majority of farmers is relatively doing well, the perceived benefits do not outweigh the costs/investment/changes.
11	Other positive elements mentioned		Exchange visits to other potato farmers	Mutual exchange and learning with other potato farmers
12	Farm management registration keeping		Not very motivated; not willing to continue	
13	Concrete benefits /effects		Lower production costs in general in the dry season due to less costs on pesticides and fertiliser	Some have higher yields in the dry season

[1] Topics are ordered according to moments of mentioning meaning that topic 1 was the first topic mentioned, 2 the second and so on.

Effectiveness

The results of the qualitative data show an increase in knowledge levels and farmers relate that increase directly to the trainings received. The effect further in the result chain is more diffuse. The behavioural change shows mixed results related to personal characteristics (e.g. more educated farmers are more willing and able to adopt the lessons) and contextual characteristics (e.g. the seasonal differences, farmers are very hesitant to change integrated pest management in the wet season as occurrence of pest and diseases and their effects on yields is high). The relatively easy and less risky practices changed to the better, i.e. the replacement of the nozzles of the spraying equipment number 3 of Table 4.15).

Specific contextual and cultural reasons mentioned by farmers, which negatively influenced the change in behaviour and thus hampered effectiveness, relate to:

- the presence of very active pesticide agents promoting their products and rewarding purchases (external factor),
- extension officers with low levels of expertise and knowledge of good agricultural practices, which farmers cannot consult for questions or when facing problems during implementation of acquired knowledge, and
- high temperatures and a country-wide habit of smoking which discourages the use of PPE.

Impact

It is early to have concrete and valid insights into the long-term impact of the WP Potato. The impact very much depends on how the farmers continue and if they are able and willing to capitalize on the lessons learnt.
The quote in the text box 3 illustrates the diversity among farmers.

Text box 3: Concluding remark farmer leader:

"Every famer has a different opinion. One is convinced of the lessons and material, another not (yet) and does not apply. It takes time to change. A farmer learns and applies step by step, one thing at the time. He will never change his practices completely all at once. So the training is good and we learnt things and we changed some things but not everything is changed. In addition to that, there are other influencing factors like the changing weather, so you have to adopt the knowledge and adapt your behaviour. Another dynamic is that new pests and diseases are occurring, this is a continuous process. And yes there are some benefits for the majority of farmers: more efficiency with doses of pesticides and fertilizer. Applying is not that difficult, the challenge and difficulty is to convince. That's the whole issue."

Sustainability

Farmers indicated that they need to be constantly motivated to practice GAP for sustainable changes and when not in place, the sustainability of the interventions may be questionable. Reminder meetings and courses were suggested. In addition, farmers reflected on the small number of farmers involved in the trainings, thus limiting the expectations on sustainable improvements of the entire Indonesian potato production on GAP.

5. Discussion and Conclusions

The discussion aims to reflect on the project goals for potato and whether the trainings have effectively contributed to the behavioural change of the participating potato farmers. This results in a number of conclusions and recommendations.

5.1. Discussion

5.1.1. Methodological issues

Training activities

The major objective of the vegIMPACT program was to improve the indicators of Table 1.2 through a behavioural change of those who were trained towards GAP. The change in management towards GAP is a prelude to the higher crop yields and improved resource use efficiencies. In the context of the Potato trainings this means, for example, that the promoted and adopted improved spraying techniques result in both less pesticide use and better crop health and associated higher yields.

Farm management registrations

The farm management registrations were a new method for farmers to collect information. In general, it was quite a difficult task for farmers and only a few still practice the farm registration. Prices of purchases were registered in local units, IDR. Due to deflation, this was sometimes a large number and mistakes with zeros were easily made. This became clear when during a meeting on production costs and benefits the costs calculated for pesticides for Granola were much too high in view of the participating farmers. Indeed, looking at the farm management registration, one product's price was mistakenly noted too high compared with the purchases of the same product at other times. This illustrates that, although not used to register farm management data, farmers had a good awareness of production costs by the end of the project. Additionally, they were not shy to express their opinion on the information offered.

Farmer surveys

The farmer surveys used the so-called recall method. The major risk in this method is that it can be difficult for farmers to remember the correct data on costs, specific inputs and revenues. The majority of farmers is not used to keep records or logbooks although it appeared that the majority keeps the receipts from their purchases at the input shops. Another issue challenging accurate yields is the common practice that farmers receive a bulk contract price for their harvest before actual harvesting. They are not aware of the actual yield and quality (different grades) of their harvest, the specific prices per kg / grade and the trader includes the transportation costs in the contract (bulk) price. Data was gathered as soon as possible after completion of harvest to limit recall inaccuracy and it was compared with the farm management registrations as a reference and benchmark to check for validation of data. The quantitative data collection is therefore in this project supported with qualitative data.

The great advantage of surveys is that farmers actively are asked for the “how” and the “why”. This information is particularity valuable and needed when answering questions on the (non) adoption of information offered (lessons) and its barriers, see Table 4.15. The information on the “how” and the “why” allowed the trainer(s) to modify the trainings to improve efficacy during the project period. Although this interactive process is not always clear and transparent, it is reflected in the farmers’ appreciation of the trainings and which were in general well received (section 4.8).

Assumptions

The assumption of the vegIMPACT program was that trainings (intervention) contribute to improve the identified indicators. From Table 5.1 it becomes clear that most indicators have improved between the first record collected and the last, whichever evaluation method was used. Are these changes related to the trainings and set up of the intervention, or are they caused by external influences?

First, the indicator that did not improve was the planted area with potatoes, especially processing potatoes. The external influences made the private sector development impossible and the lack of sufficient good quality seed potatoes was not addressed through involvement of the Dutch private sector. However, the need for better seed has become increasingly clear throughout the program, not at the least by the farmer data. The assumption that seed is a major bottleneck in potato production is confirmed. A small contribution in this field was done at the end of the vegIMPACT project through a demonstration on how to collect farm-saved seeds (Gunadi*, et al.* 2017) as response on the farmers’ demand for improved seed and quality.

The assumption that the project identified the right group to train is confirmed by the high training appreciation of the farmers. However, for the Atlantic potato farmers the urgency and relevance to change was very low as they have a fixed contract with a buyer and are relatively ensured of income. Furthermore, most farmers also indicated that they have contract workers or other employees to do part of the work. Especially the PPE’s improvements are therefore difficult to realise, as contract workers see no benefit in following the guidelines provided in the trainings. It may therefore be advisable to include selection criteria on participants, such as, the persons who are performing the actions need to be involved in the trainings. Farmers may then bring along their spraying personnel so they can benefit from the trainings. Farmers also mentioned that planting distance was new for them, which may then include the employees that actually do the planting to the trainings to optimize the improvement.

The selection method (section 3.4.2) contributed to the right group to train but had some additional effects. The selection yielded relatively rich and well developed farmers, that is, not the poorest farmers. Additionally, some Atlantic farmers had contracts with the processing factory. Both aspects may have affected the interest of farmers to apply in some of the learnings as the added value compared to the costs or efforts was considered to loo.

The assumption that farmers are willing to learn is a valid one but also a mixed one: learning has a “price” and when the price is too high the willingness is low. Too high may mean that there are financial costs involved of which the benefits are not immediately clear but more often farmers indicated that they were too lazy (Table 4.15) or too busy with other, non-agricultural related occupations.

External influences

Various external influences may have influenced the success of the intervention and profitability of trained farmers:

- High fluctuation of potato market prices, which is beyond the control of the farmers and the program implementers.
- Seed quality / variety policy and regulations: a major bottleneck in the potato production is the availability of sufficient quality potato seed, for both the processing variety Atlantic as well as for the table potato variety Granola. Although the vegIMPACT project initially addressed that as well, this was abandoned, as the institutional setting did not allow importing good quality seed potatoes. The participation and development of private partners was subsequently delayed and put on hold in search of other solutions.
- Role of pesticide shops and agents with strong promotion activities and rewards on purchase.
- No governmental (restrictive/protective) policy and regulation on distribution of pesticides,
- Government supports and favours other crops like rice and maize through input subsidies,
- Farmers rent land for short periods in the area and therefore might be less interested in GAP, which for example also takes into account short-term environmental effects of production and long-term effects of management and inputs on soil quality. In addition, the rental fees of quality soil at a good location (e.g. near to a water source) are very high and not affordable for the majority of farmers.
- Climate challenges: the majority of farmers hesitates to produce potatoes in the dry season with the risk of draught. In general, farmers prefer to produce potato in the rainy season but they hesitate to apply the lessons learnt as the risk for pest and disease occurrence is high. As a result, there is no year round production and marketing of potatoes and planting schedules are difficult to introduce.
- Recommended inputs are not always available at the input shops. Farmers buy their inputs for the whole season at the start of planting. They do not change during the season but use what they have in stock; even though they learned that they should use another input type.
- Low availability and access to information on market, prices, traders, diseases and pesticides. Information remains limited or is accessed to late (in case of a disease).
- Low incentive /market price: almost half of the farmers targeted had a market and a fixed contract with their potato buyer. They were not only used to produce potato and experienced farmers but also motivated to continue potato production as they had a guaranteed buyer. The downside is that there is no big urgency for improving the yield volumes and quality as the buyer does not request for improved quality and the contract defines well-defined (maximum) volumes. This situation gives an interesting point of discussion for future interventions: who to target, what kind of farmers and what kind of relation and value chain should be approached. What are the pros and contras and which model is suitable to what type of farmer and market situation.
- Distrust about the demonstrations: no confidence in the results and distrust about how the demonstrations were carried out. This does not stimulate trust in the training and trainers, and hampers adoption of new practices.

5.1.2. Knowledge transfer

The behavioural change, that is the adoption of practices, shows mixed results related to personal characteristics and contextual characteristics (section 4.8). There are various plausible explanations of the mixed results of the intervention on the project objectives (i.e. area expansion, yield, improved pesticide and fertiliser use and cost price). The first remark is in line with the intervention logic; knowledge, which has not been (sufficiently) transferred, cannot be practiced. Second, we have seen that - for various reasons - not all farmers apply and adopt the lessons learnt on GAP's. Significant and meaningful changes on productivity and reduced production costs can therefore not be expected. In the following paragraphs, we elaborate on the limitations of the Potato - ToC in the Indonesian context and point at plausible explanations why the results of trainings is limited.

Relevance

Not all training topics were well transferred and accepted. For example, the impact of the training on occupational health aspects was low, probably for two reasons. First, many PPE's are not very practical for sprayers and, second, not all farmers spray themselves but hire contract labour for pesticide spraying. It seems that farmers have limited control over how contract labourers perform their work.

Effectiveness

The adoption of GAP is commonly understood as an investment decision that requires capital and labour resources and access to knowledge, information and training. These investment decisions are mainly guided by perceived risk (Barham*, et al.* 2014; Feder*, et al.* 1985) and in general, smallholder farmers are risk-averse (Ruben 2017). This is reflected in the attitude of farmers to some aspects of the intervention. Trainings and demonstrations targeting fungicide use in the rainy season were not or only partly convincing according to farmers. Therefore, farmers did not change behaviour on the number of fungicide applications and not or only limited on the spraying volume. But, increased knowledge on chemical composition of fungicide products and type of active ingredients, stimulated farmers to reduce the number of products in a tank mix when they learned that many products have the same active ingredients (see point 2 of Table 4.15). Farmers perceived risk of this action was small and therefore reflected in an improved pesticide use efficiency per ton potatoes produced (Table 5.1). Farmers perceived risks of less applications and reduced volumes (so that you cannot see that the total potato leaf area is soaked in spraying liquid), are much larger and therefore not adopted. This perceived risk was substantiated as the demonstrations failed where improved practices on late blight control were applied.

Impact

As stated in section 2.4.6, the scope of control is reducing higher up in the impact pathway and showing statistical significant long-term results on the contribution to improved food security is difficult and outside and beyond the scope of the vegIMPACT program. An Australian project on 'Optimising the productivity of the potato production system in West Java, South Sulawesi and West Nusa Tenggara', established farmer field schools and trained farmers on agronomic potato practices

in the period 2006 to 2010 (Dawson*, et al.* 2011). The project's short-term impact on increased knowledge and improved production practices resembles those of our program. Long-term impacts however, were not addressed, most likely due to comparable difficulties we have to show statistical significant long-term results on the contribution to improved food security.

Sustainability

Farmers suggested reminder meetings and courses, and upscaling to capitalize on the sustainability of the project results. Scenario's for trainings (training materials, training methods and experience) are readily available and can easily scaled up by others, for example, the *Dinas Pertanian* program, which we highly recommend. Furthermore, some farmers would be willing to contribute of own means to a similar training. This positive attitude towards "willingness to pay" (see page 45 top line) may open opportunities for private extension companies in due time to continue trainings on GAP.

5.1.3. The project indicators

Table 5.1 summarizes the results for Atlantic and Granola farmers on the changes of the main indicators, identified through the farm management registrations and the farmer surveys for the dry and rainy seasons.

Most indicators, measured by either the farm management registrations or the farmer surveys, have comparable changes over time and changes are in agreement with the project goals, that is productivity increases, input use per ton produced potatoes decreases (pesticides and nitrogen) and costs for production per ton potatoes decreases. However, the goal to increase the potato area is not met.

It is inevitable to find discrepancies between the different data collection methods and it is difficult to say which are more suitable. However, the results of the farm management registrations support in general most of the findings of the farmer surveys and some discrepancies support effects of trainings (see below).

A decrease in area was found with the farm management registration as well as in the farmer surveys (Table 5.1). Several reasons contribute to this decrease. It could be a consequence of the highly fluctuating market price of potato. Potato farmers, farmers in general, follow highly fluctuating market prices and adjust their production accordingly. It could also be unfavourable weather conditions, which delays planting, and when the delay is too long, the seeds deteriorate and are unfit for planting. This happens in the rainy seasons when farmers wait for the rains to arrive. Fields to be planted in the rainy season have limited access to irrigation so farmers need to wait until the rains come. When rains are delayed, farmers may not plant at all. In the dry season, it might be difficult for farmers to rent good quality fields, which have access to (irrigation) water. The most frequently mentioned reason was the limited availability of good quality seed, especially from the variety Atlantic. The initial vegIMPACT program included the increase of available good quality seed of processing varieties, but that was not pursuit due to unforeseen reasons.

There was a discrepancy found between the farm management registrations and farmer surveys for the planted area with potatoes in the rainy season of Granola: the area according to the farm registrations increases (106%), where the farm surveys show a substantial decrease (33%) (Bold in Table 5.1). It is not clear where this discrepancy comes from.

Table 5.1 Summary results on main indicators. All numbers indicate a relative change (%) compared to the first record value collected.

			Dry season		Rainy season	
	Indicator	Unit	Registration	Survey	Registration	Survey
Atlantic	Area	m^2	58	56	66	39
	Productivity	t ha^{-1}	115	104	116	174
	Pesticide use	kg A.I. t^{-1}	37	36	60	66
	Nitrogen use	kg N t^{-1}	65	50	**96**	**27**
	Production costs	IND kg^{-1}	65	88	83	33
Granola	Area	m^2	77	69	**106**	**33**
	Productivity	t ha^{-1}	132	134	104	232
	Pesticide use	kg A.I. t^{-1}	45	47	87	39
	Nitrogen use	kg N t^{-1}	61	82	41	44
	Production costs	IND kg^{-1}	88	73	**105**	**47**

The improvement of indicators is closely related to increased productivity as input use and costs are all expressed per ton potatoes produced. Productivity was increased by improved agricultural practices, which not only increased yields but also prevented crop failures. Losing a crop was indicated five times in the baseline surveys and not once after one training session. The low productivity of Atlantic in the baseline survey of the rainy season (Table 4.4) illustrates the low productivity and the subsequent increase when crops are not lost any more. This leads to the conclusion that the trainings have substantially contributed to farmer's knowledge on potato production, good agricultural practices and awareness on what to do and how, to produce good yields. Participating farmers confirmed these findings in the interviews and focus group discussions.
The pesticide use per unit of produced potato decreased over time to 36% and 47% in the dry season for Atlantic and Granola respectively and to 39% and 87% in the rainy season for Granola compared to the first data recorded (Table 5.1). The decrease was a combined result of a reduced number of applications and less mixing of products that have the same active ingredients. The spraying volume per application was also slightly reduced according to the farm management registrations (data not shown). However, farmers were not or hardly convinced that spraying less often and or use lower spraying volumes will sufficiently protect their crops from late blight as the demonstrations were in their view not convincing (section 4.8). They did reduce the number of products with comparable active ingredients as was identified in the end-line surveys.
The farmer survey also indicated that farmers changed from fungicide products with preventive active ingredients to products with curative active ingredients. This was not supported by the farm management registrations, which showed that both active ingredients were used in the first registration already. This discrepancy most likely comes from increased knowledge on pesticide characteristics (see topic 2 of Table 4.15). Farmers did register fungicide products they used but had no knowledge of its active ingredients. After the trainings, they knew that the products they used have different active ingredients, which is reflected in the results of the farmer surveys midterm 1, 2 and end-line. That farmers mixed less products, mainly products with comparable active ingredients, can also be related to increased farmer's knowledge on fungicide use: farmers learned that different fungicide products can contain the same active ingredient and are thus not needed to include in the tank mix.
The nitrogen use per ton produced potatoes decreased over time up to 27% compared to the data first recorded, although this decrease seems a bit optimistic when looking at the decrease based on the farm management registrations (Table 5.1). Farmers learned that products might differ on

nutrient content: a 50 kg bag with fertiliser UREA (46% N) has a different amount of N than a 50 kg bag of Phonska (15:15:15). They also learned how to calculate the optimal dose for their fields. Farmers confessed that calculating the optimal dose was nice but a lot of work and not always done (Table 4.15). Fertilisers are highly subsidised by the Indonesian Government, which makes them cheap and farmers have little to no financial benefit for calculating and subsequently applying the optimal dose. The incentives to reduce application rates per ha to optimal levels are low as it is not clear to farmers what the benefit of all these extra efforts will be.
The production costs per ton potato produced decreased over time up to 33% compared to the data first recorded (Table 5.1). The decrease to only 33% for Atlantic in the rainy season seems very optimistic, as input costs did not decrease in the same order and the decrease based on the farm management registration was much smaller, to 88% only. This may relate to the recall method, their memory may be optimistic as they had a good profit.

5.2. Conclusions

With respect to the knowledge transfer, it is concluded that:

- The behavioural change of farmers towards good agricultural practices is strongly related to the trainings received and the supporting field demonstrations,
- The interaction between farmer's need/demand, identified in the farmer's surveys, and the adaptation/modification of the trainings and field demonstrations, was highly appreciated and supported farmer's behavioural change.
- Farmers were supportive critical and selective in behavioural change on trained topics when they were not convinced of the positive effects of the improved practice offered or, that the improvements were too much work compared to the expected benefits.

From this study and with respect to the vegIMPACT project objectives, it is concluded that:

- The area (m^2) planted with (process) potato did not increase,
- The productivity (t ha^{-1}) increased by more than 10% for Granola and Atlantic, and in the dry and rainy season,
- The pesticide use (kg A.I. t^{-1} product) decreased by more than 25% for Atlantic, both seasons, and for Granola in the dry season, but not for Granola in the rainy season,
- The nitrogen use (kg N t^{-1} product) decreased for both varieties and in both seasons,
- The production costs (IND kg^{-1} product) decreased for Atlantic, in both seasons, and for Granola in the dry season and not for Granola in the rainy season. The decrease however, is less than the project target of 25%.

The participating farmers highly appreciated the repetitive character of the trainings during subsequent seasons and the practical aspects of the trainings. They indicated that they need to be continuously motivated to improve production practices and that training material, mainly the photos for recognizing a pest or disease, are still used.

6. Recommendations

Success of an intervention depends on the logic of the Theory of Change defined, its' applicability in the specific context, the way it is implemented and among whom. Based on the results and the outcomes we can conclude that the Theory of Change has a valid impact logic and leads to the expected short-term effects. There are however, some contextual constraints for its effectiveness, which are elaborated upon in the previous paragraphs. Additionally, some practical recommendations are given to improve the design of the intervention for more sustainable impact. These are worth to consider in future programs and link immediately to the organization and implementation of the intervention. Some practical recommendations for future interventions are:

- Introduce stricter criteria to select farmers or farmer groups. Like being member of an active farmer group to enable mutual sharing and learning and spill-over effects; additional points of attention for selection in future interventions are:
    - Rich/Poor farmers: the Atlantic farmers are relatively rich; for them there is no actual need to change and to adopt the lessons learnt. It is not matter of 'life and death'. Farmers need an incentive to change and the economic incentives (higher yields or market price, sales market) are important drivers for change.
    - Education level: there is huge variation in educational levels and if there is one module and one type of training, it will be too simple for one farmer and too difficult for another.
    - Labourers: the relatively rich farmers have workers to cultivate the land. Therefore, the owners / farmers are trained but there workers do the actual work. There is hardly knowledge transfer from farmer to worker. In the case of knowledge transfer, the worker is free to decide whether to change and to adopt. There is no regulation or check (e.g. on the use of PPE).
- Trainings need to be practical orientated, with texts that are easy to understand for lower educated farmers;
- Frequent repetition of training topics so that farmers are able to understand and 'digest' the key message of the training provided;
- Demonstrations are essential to convince farmers of newly introduced techniques, they should be preferably located near the farmers' plots, and under responsibility of a colleague farmer or extension worker, they know and trust; adapt the strategy applied to the demonstrations when necessary and adjust based on the actual weather conditions and not on theory. The demonstrations did not always had good yields due to late blight attacks and inappropriate handling;
- Align the interventions with governmental policies. There must be an enabling environment with a supporting policy from the government, not the least in order to replicate and scale the innovations to a larger group of farmers. Collaborate and partner with other stakeholders. Not only for sustainability (who will take over and guarantee legacy) but also for more impact. An enabling environment is very important and farmers do not operate in isolation. The government could play a role via their extension officers but also via policy and regulation towards pesticides and pesticide agents.

In line with the last bullet point is to consider another important aspect related to the efficiency and scalability perspectives. The ratio between allocated resources and the outreach is unbalanced considering the small number of farmers reached. The question is how to reach out to more farmers without losing in-depth training and monitoring and as such without losing quality. A quality – quantity balance between outreach and realistically to-be-expected effects must be ensured when discussing scalability. Important is to find suitable partners and stakeholders to collaborate with and to join forces and resources for upscaling and in addition for guarantee of certain sustainability after withdrawal of the project team. The local *Dinas* is a stakeholder to consider, as it is the first responsible party for extension services to farmers. The intervention has had a project approach with limited resources and small number of farmers targeted. The trainings approach had a strong participatory and innovative component with the farmers' self-recording of management information, which generated important and relevant insights and knowledge. Dissemination of the used approach and gained knowledge is crucial to feed future interventions and project designs.

References

Barham B. L., J. P. Chavas, D. Fitz, V. R. Salas & L. Schechter, 2014. The roles of risk and ambiguity in technology adoption. Journal of Economic Behavior and Organization 97, 204-218.

Blamey A. & M. Mackenzie, 2007. Theories of change and realistic evaluation: peas in a pod or apples and oranges? Evaluation 13, 439-455.

Dawson P., P. C. P. Adnyana, M. Ameriana, M. A. Arifudin, M. M. Assad & R. S. Basuki, 2011. Optimising the productivity of the potato/brassica cropping system in Central and West Java and potato/brassica/allium system in South Sulawesi and West Nusa Tenggara. ACIAR, Canberra, Australia, 114 pp.

De Putter H., N. Gunadi, Uka, R. Wustman & H. Schepers, 2014. Economics and agronomics of Atlantic and Granloa potato production in the dry season of 2013 in West Java. vegIMPACT Internal Report 10. Wageningen-UR, Wageningen, 43 pp.

DeFauw S. L., Z. He, R. P. Larkin & S. A. Mansour, 2012. Sustainable potato production and global food security. *In* Sustainable potato production: global case studies. pp. 3-19. Springer.

Delleman J., A. Mulder & L. J. Turkensteen, 2005. Potato Diseases: Diseases, Pests and Defects. Aardappelwereld & NIVAP.

Dijkxhoorn Y., J. Medah, G. Ton & F. Godeschalk, 2014. Baseline vegIMPACT 2013. Wageningen UR, Wageningen, 69 pp.

Douthwaite B., S. Alvarez, S. Cook, R. Davies, P. George, J. Howell, R. Mackay & J. Rubiano, 2007. Participatory impact pathways analysis: a practical application of program theory in research-for-development. The Canadian Journal of Program Evaluation 22, 127.

Everaarts A. & F. Van Koesveld, 2013. De Inceptie fase van het vegIMPACT programma. December 2012- Maart 2013. Wageningen UR, Wageningen, 21 pp.

FAO, IFAD & WFP, 2014. The State of Food Insecurity in the World 2014. Strengthening the enabling environment for food security and nutrition. FAO, Rome, 53 pp.

Feder G., R. E. Just & D. Zilberman, 1985. Adoption of agricultural innovations in developing countries: a survey. Economic Development & Cultural Change 33, 255-298.

Gunadi N., A. A. Pronk, A. K. Karjadi, L. Prabaningrum & T. K. Moekasan, 2017. Effect of selection methods on seed potato quality. Wageningen Plant Research, pp.

He Z., R. Larkin & W. Honeycutt, 2012. Sustainable potato production: global case studies. Springer Science & Business Media. 539 p.

Hengsdijk H., 2017. Annual report vegIMPACT 2016, March 2017. vegIMPACT Internal Report 22. Wageningen UR, Wageningen. 52 p.

Hijmans R. J. & D. M. Spooner, 2001. Geographic distribution of wild potato species. American Journal of Botany 88, 2101-2112.

McPharlin I., A. Taylor, P. Dawson, P. C. P. Adnyana, M. Ameriana, M. A. Arifudin, M. M. Assad & R. S. Basuki, 2011. Final report appendix 1 Baseline agronomic survey of potatoes ACIAR Project AGB/2005/167, 114 pp.

OECD, 1991. Guidance for Managing Joint Evaluations.

Pronk A. A., L. van den Brink, N. Gunadi & U. Komara, 2017. Economics and agronomics of Atlantic and Granola potato production in the dry season 2014 in West Java. vegIMPACT External Report 36. Wageningen-UR, Wageningen, 47 pp.

Rogers P. J., 2008. Using programme theory to evaluate complicated and complex aspects of interventions. Evaluation 14, 29-48.

Ruben R., 2017. Impact assessment of commodity standards: Towards inclusive value chains. Enterprise Development and Microfinance 28, 82-97.

Schepers H., N. Gunadi, H. de Putter, T. Moekasan, L. Prabaningrum & A. Karjadi, 2016. Results of potato late blight demonstrations in Pangalengan, Indonesia: November 2016-February 2016. vegIMPACT, pp.

Schepers H., N. Gunadi, H. de Putter, T. K. Moekasan, L. Prabaningrum & A. K. Karjadi, 2015. Results

of potato late blight demonstrations in Garut and Pangalengan, Indonesia, October 2014-January 2015. Wageningen UR, pp.

Schepers H., N. Gunadi, H. De Putter, R. Wustman, T. K. Moesakan, L. Prabaningrum & A. K. Karjadi, 2014. Late blight demonstrations - December 2013 - February 2015. 4 Wageningen Plant Research, Wageningen, 40 pp.

Van den Brink L., N. Gunadi, R. Wustman, T. K. Moekasan, L. Prabaningrum, A. K. Karjadi & H. Hengsdijk, 2015a. Results of fertilizer demonstration trials in Pangalengan and Garut, Indonesia, May-August 2014. vegIMPACT External Report 17. Wageningen UR, Wageningen.

Van den Brink L., N. Gunadi, R. Wustman, U. Uka, T. K. Moekasan & H. Hengsdijk, 2015b. Agronomics and economics of potato production in West Java, Indonesia. vegIMPACT External Report 16. Wageningen-UR, Wageningen, 22 pp.

Van den Burg J., N. Gunadi & R. Wustman, 2013. Potatoes. Wageningen UR, Wageningen, 9 pp.

Weiss R. S., 1995. Learning from strangers: The art and method of qualitative interview studies. Simon and Schuster.

Annex 1 Baseline Survey: Improved potato production and marketing

Instruction for enumerators: Interview the person who is mentioned on your list. When he or she is not available, come back later for the interview. Thank you!

Remember to write down -999 or thick the box "Don't know" when a farmer does not know and thus does not give an answer! Write down na (short for not applicable) when a question does not apply to the farmer's situation).

The questions are related to the last dry (2012) and rainy season (2013). Unless otherwise mentioned.

01 Date of interview (dd-mm-yyyy):……..

02 Name of enumerator:……

03 Region:
1. West Java
2. Central Java
3. East Java
4. South Sulawesi
5. Sumatra

04 Intervention crop:
1. Potato Atlantic
2. Potato Granola
3. Shallots
4. Long hot pepper
5. Other, please specify….

A: General questions and labour

A.0 Gender
1. Male
2. Female

A.1 What is your name: ……

What is the phone number on which we can reach you (e.g. his mobile phone number, or from his relatives): ……

A.2 What is the highest level of education that you have finished?
1. None
2. Elementary school
3. Middle school
4. Senior high school
5. Other……..

A.3 What is your age? .....

A.4 Where is your farm located? (village and sub district) :……

A.5 How many people are part of your household? ……

A.6 What is your position in the household?

1. Household head:
2. Spouse:
3. Child:
4. Other:

A.7 What is the total size of your land?: ……. (please mention size indicator, in bagian or other)

A.8. What was your crop rotation schedule during last dry and rainy season of the land size indicated in A.7?

Dry season 2012

Crop	Planting date – Harvest date (day/month/year)	Area planted (in square meter)	Yield per crop (in kg)	Price per kg (Rp)	Seed generation (years)*	Land: Owned (1) or rented (2)	Rental fee or estimated rental price, if land would be rented out	Soil condition (bad 1-average 2- good 3)	Weather condition for cultivation (bad 1-average 2- good 3)	Comments
1a	1b	1c	1d	1c	1d	1e	1f	1g	1h	
2a	2b	2c	2d	2c	2d	2e	2f	2g	2h	
3a	3b	3c	3d	3c	3d	3e	2f	3g	3h	
4a	4b	4c	4d	4c	4d	4e	2f	4g	4h	

Rainy season 2013

Crop	Planting date – Harvest date (day/month/year)	Area planted (in square meter)	Yield per crop (in kg)	Price per kg (Rp)	Seed generation (years)*	Land: Owned (1) or rented (2)	Rental fee or estimated rental price, if land would be rented out	Soil condition (bad 1-average 2- good 3)	Weather condition for cultivation (bad 1-average 2- good 3)	Comments
1a	1b	1c	1d	1c	1d	1e	1f	1g	1h	
2a	2b	2c	2d	2c	2d	2e	2f	2g	2h	
3a	3b	3c	3d	3c	3d	3e	2f	3g	3h	
4a	4b	4c	4d	4c	4d	4e	2f	4g	4h	

A.9 Do you have people working for you?

1. Yes
2. No → please go to section B.
3. I do not know

A.10 Indicate the number of people that work for you only in potato production related to the realized output and land size indicated in question A.

Dry season

Activities	Own days by farmer	Male	Labour days* per person	Daily wages/contract	Female	Labour days* per person	Daily wages/contract
Field preparation	1a	1b	1c	1d	1e	1f	1g
Planting	2a	2b	2c	2d	2e	2f	2g
Weeding	3a	3b	3c	3d	3e	3f	3g
Fertiliser	4a	4b	4c	4d	4e	4f	4g
Spraying	5a	5b	5c	5d	5e	5f	5g
Harvesting	6a	6b	6c	6d	6e	6f	6g

Rainy season

Activities	Own days by farmer	Male	Labour days* per person	Daily wages/contract	Female	Labour days* per person	Daily wages/contract
Field preparation	1a	1b	1c	1d	1e	1f	1g
Planting	2a	2b	2c	2d	2e	2f	2g
Weeding	3a	3b	3c	3d	3e	3f	3g
Fertiliser	4a	4b	4c	4d	4e	4f	4g
Spraying	5a	5b	5c	5d	5e	5f	5g
Harvesting	6a	6b	6c	6d	6e	6f	6g

	Yes	**No**	**Why do you use PPE?**
Overall or long sleeves	1a	1b	1c
Hat	2a	2b	
Mask	3a	3b	
Gumboots	4a	4b	
Goggles	5a	5b	
Other….	6a	6b	
Other….	7a	7b	
Other….	8a	8b	

C.4 How often did you, your family members or any of your workers need medical attention after an injury on the farm, in the last dry and rainy season? For example fractures or wounds requiring stitches during the following activities:

1. One occasion
2. Two occasions
3. More than three occasions
4. No occasions, → please go to question C7
5. I do not know

C.5 In which activity was this?

1. Field preparation
2. Planting

3. Weeding
4. Fertiliser
5. Spraying
6. Harvesting
7. I do not know

C. 6 Did this involve a male or female?

1. Male
2. Female
3. I don't know

C.7 Who is responsible for spraying pesticides at your potato crop? (MC possible)

1. Not applicable, I don't use pesticides
2. I do it myself
3. Female workers
4. Male workers
5. I do not know

C.8 How often did you, your family members or your workers experience severe effects within 24 hours after spraying, during the last wet and dry season (e.g. headache, icing, irritation due to exposure of pesticides)?

1. Not applicable, I don't use pesticides
2. One occasion
3. Two occasions
4. More than three occasions
5. No occasions
6. I do not know
7. Never (also not more than 12 months ago)

D: Training experience

D.1 Indicate type and source of training received and your opinion on the training. Only mention the training received during the last dry and rainy season.

Name of the training or other activity	Source of training	Month/ Year	Number of training days	Did you complete the training?	Would you recommend the training to your neighbour?	Did you share obtained knowledge with farmers who did not participate in the training?	Did these farmers change their practice based on the shared knowledge?	How did they change their practice?
1a	1b	1c	1d	1e	1f	1g	1h	1j
2a	2b	2c	2d	2e	2f	2g	2h	2j
3a	3b	3c	3d	3e	3f	3g	3h	3j
4a	4b	4c	4d	4e	4f	4g	4h	4j
5a	5b	5c	5d	5e	5f	5g	5h	5j
6a	6b	6c	6d	6e	6f	6g	6h	6j
7a	7b	7c	7d	7e	7f	7g	7h	7j
8a	8b	8c	8d	8e	8f	8g	8h	8j
9a	9b	9c	9d	9e	9f	9g	9h	9j
10a	10b	10c	10d	10e	10f	10g	10h	10j
1. Veg Impact staff 2. Extension services / Ministry of Agriculture 3. USAID 4. AusAID 5. Pesticide company 6. Other 7. Don't know		E.g. 06/2013		1. Yes 2. No 3 I don't know	1. Yes 2. No 3 I don't know	1. Yes 2. No 3 I don't know	1. Yes 2. No 3 I don't know	

D.2 Who is your main source of information on agricultural practice? (MC possible)

1. Input supplier
2. Buyer
3. Extension worker
4. Other farmers
5. Television
6. Newspaper and other written media
7. Internet
8. vegIPACT team
9. Other, please specify….
10. I do not know

D.3 Who is your main source of information on the market? (MC possible)

1. Input supplier
2. Buyer
3. Extension worker
4. Other farmers
5. Television
6. Newspaper and other written media
7. Internet
8. vegIMPACT team
9. Other, please specify….
10. I do not know

E: Inputs

Please indicate type and source of input used for your potato production during wet and dry season:

Dry season

E.1: Fertiliser (chemical) List common/ trade names incl. composition (N,P,K):	Quantity used in dry season 1, 2, 3, ½, ¼, ¾ etc.	Unit and size: (bottle, bag, ...)	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e
5a	5b	5c	5d	5e
6a	6b	6c	6d	6e
7a	7b	7c	7d	7e
E.2: Organic fertilisers, compost, manure List types, if any:	Dosage used in dry season 1, 2, 3, ½, ¼, ¾, etc.	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e
5a	5b	5c	5d	5e

E.3: Pesticides/ herbicides/ insecticides, if any: List common/ trade names:	Dosage used in dry season 1, 2, 3, ½, ¼, ¾ etc.	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e
5a	5b	5c	5d	5e
6a	6b	6c	6d	6e
7a	7b	7c	7d	7e
8a	8b	8c	8d	8e
9a	9b	9c	9d	9e
10a	10b	10c	10d	10e
E.4: Planting material, if any List the name of the variety and the origin	Dosage of seeds or young plants bought for dry season	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e
E.5: Other input used:	Quantity used in dry season 1, 2, 3, ½, ¼, ¾ etc.	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e

Rainy season

E.1: Fertiliser (chemical) List common/ trade names incl. composition (N,P,K):	Quantity used in rainy season 1, 2, 3, ½, ¼, ¾ etc.	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e
5a	5b	5c	5d	5e
6a	6b	6c	6d	6e
7a	7b	7c	7d	7e
E.2: Organic fertilisers, compost, manure List types, if any:	Dosage used in rainy season 1, 2, 3, ½, ¼, ¾ etc.	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e
E.3: Pesticides/ herbicides/ insecticides, if any: List common/ trade names:	Dosage used in rainy season 1, 2, 3, ½, ¼, ¾ etc.	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e
5a	5b	5c	5d	5e
6a	6b	6c	6d	6e
7a	7b	7c	7d	7e
8a	8b	8c	8d	8e
9a	9b	9c	9d	9e
10a	10b	10c	10d	10e
E.4: Planting material, if any List the name of the variety and the origin	Dosage of seeds or young plants bought for rainy season	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)

1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e
E.5: Other input used:	Quantity used in rainy season 1, 2, 3, ½, ¼, ¾ etc.	Unit and size:	Price per unit input (this may be a cost of zero: if so fill out 0)	Total price (quantity * price)
1a	1b	1c	1d	1e
2a	2b	2c	2d	2e
3a	3b	3c	3d	3e
4a	4b	4c	4d	4e

F: End

That was the last question in this questionnaire. Thank you very much for your time and effort to help us understand more about vegetable production. Is there anything else you would like to tell us or ask us?

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Please read through the questionnaire to make sure no questions were left unanswered before ending the interview!

Annex 2 Questionnaire for the evaluation of work package Potato training activities in the period of June 2013 – September 2016

No.	Question	Answer
1	The overall program in the Potato WP (VegImpact Program)	a. Not appropriate/ fit b. Appropriate/ fit
2	The implementation of bi-weekly training	a. Not appropriate/ fit b. Appropriate/ fit
3	The overall demoplot/ training implementation	a. Not appropriate/ fit b. Appropriate/ fit **Reasons for not appropriate**
4	Is the program of demoplot/ training in the dry season or in the rainy season, reached the farmers' target	a. Not reached the target b. Reached the target **Reasons for not reached the target**
5	The usefulness of the training/ demoplot	a. Useful b. Not useful
6	If the training/ demoplot already appropriate, could the results of the demoplots/ training affected in your farm activities?	a. Affected b. Not affected **Example of activities in the farm caused by the training**
7	How long for you to decide whether to adopt the technology given in the training?	a. Directly b. After one planting season c. More than one planting season
8	Is the technology from the VegImpact program also spread to other potato farmers?	a. Yes b. No
9	The lack of Potato WP (VegImpact Program)?	
10	If there is other similar program, what kind of other activities you would like to propose?	
11	The overall point for Potato WP-VegImpact Program (scale 1-10)	

Annex 3 Theoretical framework interview and Focus Group Discussions

Criteria	Definition criteria	Detailed description of criteria	Assessment criteria
Relevance	Is the intervention suited to the priorities and policies of the target group, recipient and donor?	To what extent are the objectives of the program still valid? Are the activities and outputs of the program consistent with the overall goal and the attainment of its objectives? Are the activities and outputs of the program consistent with the intended impacts and effects?	Appreciation and satisfaction of the training and demo plots; Relation WP Potato objectives and vegIMPACT objectives Verification ToC WP Potato and result chain
Effectiveness	How effective is the intervention in attaining its objectives?	To what extent were the objectives achieved / are likely to be achieved? What were the major factors influencing the achievement or non-achievement of the objectives?	Concrete lessons learnt Changes in cultivation practices (adoption) and production of potato Drivers of change Barriers in non-achievement of objectives
Impact	The positive and negative changes as a result of the intervention, directly or indirectly, intended or unintended. This involves the main impacts and effects resulting from the activity on the local social, economic, environmental and other development indicators.	What has happened as a result of the program or project? What real difference has the activity made to the beneficiaries? How many people have been affected?	Concrete benefits as a result from the training (yields, productivity, profitability, farm financial management, healthier produce , healthier farmers, and other unintended changes) Attribution of achieved objectives to the intervention Direct and indirect target group
Sustainability	Do the benefits of the intervention continue after it stops?	To what extent did the benefits of a program or project continue after donor funding ceased? What were the major factors which influenced the achievement or non-achievement of sustainability of the program or project?	Will benefits / achievements last after closure of the intervention Chance of continuation of adoption and changed practices (including farm recording) Conditions and drivers for sustainability