POTATO INDUSTRY RESEARCH STRATEGY: 2014-17
ISSION
To provide knowledge to enhance the sustainability of the South African potato industry

VISION
Knowledge towards excellence in the South African Potato industry

BACKGROUND TO RESEARCH AND RESEARCH FUNDING IN THE POTATO INDUSTRY
Potatoes South Africa’s first application for statutory measures on potatoes, which included a statutory levy, was approved by the then Minister of Agriculture and promulgated in the Government Gazette on 10 September 2004. Potatoes South Africa successfully reapplied for the implementation of the statutory measures to the Minister of Agriculture, Forestry and Fisheries in 2007 and 2011, the latter approval expiring on 4 August 2015. One of the purposes of the statutory measures is to fund basic and applied research including cultivar development and evaluation, and the dissemination of all relevant information.

STAKEHOLDERS

KEY STAKEHOLDERS
Potato Industry Development Trust (PIDT)
To conform to the purpose of the statutory measure the Potato Industry Development Trust (PIDT) was established. The main objective of the PIDT is to promote and enhance the potato industry in South Africa. This means that the statutory income held in the Trust will be used solely for projects that are reconcilable with aims of the trust and in the interest of the potato industry. Research must therefore be needs driven and identified by all interested stakeholders.

Role of the PIDT in respect of research management:
• Approve the funding of research projects
• Ensure compliance with Potato Industry Research Strategy.

PIDT Research Advisory Committee
The PIDT appoints members representing each of the business units of PSA to advise the Trust on:
• Research governance compliance
• Whether research priorities are addressed
• Recommendations regarding research funding decisions

PIDT Risk and Audit Committee
The PIDT Risk and Audit Committee advises the Trust on:
• Corporate governance
• Compliance with budget

Potatoes South Africa Board of Directors
All potato production regions and the National Seed Growers Committee are represented on the Board of Directors (BoD) of Potatoes South Africa by the Chairpersons of the Regional Managements and the Chairperson of the aforementioned Committee. The annual research budget, together with project reports and proposals for recommended new projects, are submitted to the BoD in March every year.

Role of the BoD with respect to research management:
• Approve the Potato Industry Research Strategy
• Make recommendations regarding the annual research budget
• Oversees the implementation processes

Potatoes South Africa Audit Committee
Role of the Audit Committee in respect of research management is to:
• Ensure corporate governance
• Ensure compliance with budget

Potatoes South Africa Research Committee
The Research Committee has five ware potato producer members each representing a total production region of 10 000 hectare, as well as two producer representing the seed growers in South Africa. The Chairperson is appointed by the Board of Directors. The Research Committee co-opts persons representing various stakeholders in the industry, for example Potato Certification Service, Potato Laboratory Services, processing companies, and small holder farmers.

Role of the Research Committee is to:
• Develop and maintain a research strategy
• Determine priorities for research project funding
• Prioritise projects against evaluation criteria (see below)
• Identify research projects to be funded

Expert Advisory Group
The Research Committee and Manager: Research and Development relies heavily on the inputs of expert advisory groups to assist in screening research proposals.

Role of expert advisory groups is to:
- Pre-screen proposals
- Assess project progress reports

Research Management and Administrative Support
PSA Research Department

Role of PSA’s Department: Research and Development is to:
- Call for proposals
- Administer the proposal
- Manage proposal evaluation process
- Manage quality of proposal
- Communicate research project decisions

OTHER STAKEHOLDERS
- Research institutions
- Research funders
- Input suppliers
- Research service providers
- Producers (seed - and ware potato producers)
- Relevant government / state owned entities (all spheres)
- Consumers
- Processing companies

STRATEGIC GOALS
- Research and development
- Research information provision
- Information / technology transfer
- Capacity management

DRIVERS OF RESEARCH
- Industry sustainability at an economical, ecological and social level
- Innovation

RESEARCH AND DEVELOPMENT AREAS IN THE VALUE CHAIN

FARMER DEVELOPMENT
According to the database of Potatoes South Africa (2012) there are 635 active commercial potato producers. Although reliable statistics are not readily available, it seems that more than 1 000 small-scale farmers grow potatoes. Suitable land for potato production is still available in the former homelands and on communal lands. In 1993 almost 56 000 hectares of potatoes were planted by more than 2 000 producers, with an average of 27 hectares planted per producer. In respect of the 2012 crop year, 635 producers planted potatoes on 54 294 hectares which yielded a record crop of 2.246 million ton. Thus, approximately 85 hectares of potatoes were planted per producer. As the cost squeeze is also evident in the potato industry, farmers are relying more and more on economies of scale to survive. Potato production is not only costly, but also highly capital intensive.

POTATO PRODUCTION
In South Africa, potatoes are not categorised as a seasonal product. Due to the different climatic conditions, e.g. temperature, rainfall and soil type in the 16 production regions, potatoes are planted and marketed at different times by the relevant regions to ensure a continuous supply of fresh potatoes throughout the year. Potatoes are grown mainly under irrigation, but in some of the production regions potatoes are grown successfully under dry land conditions. Potatoes are mainly grown in a three-to-five year rotation with maize, grasses and wheat.

Compared to the world average of 860 mm of rainfall per year, South Africa’s average annual rainfall is 450 mm and more than 60% of the country receives less than 511 mm and is characterised by the occurrence of frequent droughts. In contrast devastating floods are also not uncommon. Notwithstanding these unfavourable agricultural conditions, South Africa is self-sufficient in potatoes.

The primary change in commercial potato crop production during the past few years has been the decline in the number of potato producers and hectares planted, while the average yield per hectare and therefore the size of the crop has increased. The cultivation of potatoes under dry land conditions decreased from almost 50% of the total hectares planted in 1990, to 13% in 2011. Despite the decline in hectares planted, the yield has increased from 21.1 t/ha in 1990 to 43 t/ha in 2013. This increase can be attributed mainly to the following factors: increased production under irrigation, use of quality seed potatoes, availability of improved cultivars and application of research results.

Yield per hectare has levelled off during the last 4 – 5 years. In addition to this production cost, mainly due to increase price of fertilizer, energy (fuel and electricity) and labour, increased dramatically. This leads to very low return on investment for a farmer, which places tremendous pressure on farmers to improve resource use efficiency and consequently profitability. Well targeted research will contribute towards improved efficiency.
As potato is a cool climate crop production in most production regions takes place in a climate not optimal for potato production. Temperatures in excess of 30°C and fluctuating daily temperatures cause stress in plants which in turn, limits yield potential of even the best adapted cultivars. The potato plant is susceptible to a range of foliar diseases which include virus diseases early and late blight and brown spot, as well as soil-borne diseases such as bacterial wilt, common scab and powdery scab. These pathogens have the ability to survive in the soil for many years, thus limiting the use of scarce arable land. Pests such as aphid, potato tuber moth, leaf miner and nematodes directly cause reduction in yield, while aphid and thrip act as vectors of viral diseases. Research on pests and diseases and their control is vitally important to limit their yield reducing effect.

PRODUCT DEVELOPMENT
The success of potato production in South Africa depends to a large extent on the availability of cultivars adapted to the local climatic conditions and acceptable to the diverse, but sophisticated market. Ten years ago, the dominant cultivars were of local origin (BP1, Up-to-Date and VanderPlank). The scenario changed to one where the market is dominated by one foreign cultivars viz Mondial. The change was brought about by the high yield potential and adaptability of Mondial. Production of the old cultivars is now limited to niche markets by a small number of farmers.

Funding of the local breeding programme was terminated in 2010 as a result of the high cost of maintaining a sustainable breeding programme. This means that the industry is currently dependent upon foreign cultivars for higher yield, resistance to yield-reducing diseases and innovations in the market. The importation, administration and development of new cultivars are done by local licence holders on behalf of foreign breeders. An important aspect of modern cultivars is that they are all protected by plant breeders' rights legislation. Many new cultivars are imported every year and to support both the licence holders and farmers to speed up the development and establishment of improved cultivars, the research programme manages cultivar evaluation trials in the majority of production regions through regional potato working groups, and performs a national project to screen pre-commercial cultivars.
RESEARCH FOCUS AREAS

POTATO PRODUCTION

Focus area 1. Insect control

Vectors of virus diseases
Various aphid species transmit important potato viruses Potato virus Y (PVY) and Potato leaf roll virus (PLRV) whereas thrips, transmit the less common virus, Tomato spotted wilt virus/krommek (TSWV), from one plant to the next. The importance of aphids thus stems from their extremely effective transmission of virus. Virus infection leads to downgrading of seed potato lots during certification, decrease yield and tuber symptoms caused by modern strains of PVY. A national aphid monitoring network has been established and aphid occurrence is communicated to farmers. However, the lack of control of virus in many seed production areas keeps aphids high on the research agenda.

Other insects
Potato tuber moth is generally regarded as the biggest pest problem to potato production South Africa. However, effective monitoring methods and chemical remedies are available. Uncontrolled infestations during the growing season can lead to varying crop losses and damage to tubers is still one of the major reasons for downgrading on markets, especially for regions where dry land production is prevalent. Control by means of chemical remedies, biological and cultivation methods have been developed, packaged and are available. Regular technology transfer sessions, however, appear to be required to maintain the level of knowledge in the field.

Leaf miners (American and potato leaf miners) can cause serious damage if left uncontrolled, but effective chemical remedies are available. White fly and red spider mite are minor pests of potato.

Below ground Below-ground insects
Potato snout beetle is an indigenous, but elusive potato pest. Outbreaks are reported from time to time, but in general the insect is controlled though chemical remedies applied for other pests and rotation with non-host plants. Cut worms, grubs and millipedes are also reported from time to time, but are of minor importance, particularly for small scale/subsistence farmers.

Focus area 2. Disease control

Soil- and seed-borne diseases
A number of soil and seed-borne diseases occur in South Africa and collectively cause considerable yield and quality losses. Bacterial wilt, which is considered one of the limiting factors in many African countries, has been brought under control in South Africa through strict measures set out in the South African Seed Potato Certification Scheme and disciplined control measures by growers through good crop rotation programmes. Potato wilt diseases (fusarium wilt, verticillum wilt, and sclerotium wilt), as well as tuber diseases (silver scurf; black dot/anthracnose; dry rot; sclerotium rot; black scurf and grey mould) are not considered major problems currently, probably as a result of the adoption of research results in the past and the availability of effective agricultural remedies.

However, like in most potato producing countries in the world, common scab, powdery scab, bacterial soft rot and root-knot nematode remain major production limiting diseases in South Africa.

Soft rot is caused by a group of bacterial species (Pectobacterium and Dickeya). Although these are opportunistic pathogens, they are extremely successful pathogens when conditions are favourable for disease development and cause considerable losses during warm, wet seasons. Although a lot is known about the pathogens and conditions favourable to the disease, little is known about the effect of local cultivars, climate, soil and production methods on disease development and the control thereof.

Common scab has been known to occur in South Africa for many years and occurs commonly throughout the country. Despite research in South Africa and elsewhere in the world, control remains very difficult. This bacterial disease is caused by a complex of species of the genus Streptomyces. Control of common scab is thought by specialists internationally to be complicated by the fact that various Streptomyces species – some indigenous to specific areas – causes scab symptoms.

Powdery scab is a relatively new disease in South Africa and is caused by the fungus Spongosora subterranea. Currently, it is thought that the disease is limited to specific regions. Symptoms are galls on roots which restricts nutrient and water uptake and pustules on tubers which result in downgrading of seed potatoes and ware potatoes on markets. The pathogen can survive in soil for decades through resistant spore balls in soil. Research information such as relative susceptibility of popular cultivars, alternative host plants and cultivation methods under local conditions is required to limit the spread of the disease and to develop management strategies.

Nematodes are not classical fungal or bacterial pathogens. However, because the effect they have on crops and the control measures available to manage the disease they cause on plants, nematode is discussed under soil-borne diseases. Nematode is a
soil-borne problem on potato throughout the world. In the past soil fumigation remedies were applied successfully to control their effect. After the withdrawal of MeB r and Aldicarb, farmers no longer have these options available. Therefore, alternative methods of control need to be developed.

**Foliar diseases**

Late blight is regarded as one of the major constraints to potato production in many countries, including those in central Africa. Worldwide pathologists are monitoring the occurrence of mating types which could lead to new forms of late blight. In South Africa, the climate in most production regions is not conducive for disease development and a survey conducted a few years ago, showed that only one mating type occurs in Southern Africa.

Early blight, late blight, brown spot and grey mould are not currently regarded as serious threats to potato production in South Africa, as chemical remedies to effectively manage the diseases are available. The industry recently funded a project on brown spot to confirm the causal agent and although reports on outbreaks are occasionally received, the disease is not regarded as a major constraint currently.

**Viral diseases**

Although several viral diseases have been reported in South Africa, two (Potato virus Y – PVY- and Potato leaf roll virus –PLRV-) commonly result in downgrading of seed and reduction in yield. Tomato spotted wilt virus (TSWV) are reported occasionally. Management of viral diseases is built on three pillars, i.e. correct identification of the virus, limitation of the virus source and limitation of the virus vector. Resistance or tolerance of cultivars to PVY and TSWV can also contribute to improved management.

In recent years the NTN and Wilga strains of PVY have been identified using PCR technology. These strains are now the dominant strains in South Africa. As the NTN strain often occurs symptomless in plants, correct identification is important. No new research need has been identified recently. However, there is an urgent need for practical guidelines to develop region specific virus management strategies.

There is an urgent need for validated PCR technology for application in seed testing laboratories. Funding has been approved and good progress is being made.

**Post-harvest/storage diseases**

Ware potatoes are generally not stored more than a few days in South Africa. Potatoes are, however, left in the ground for weeks or months in many areas to spread harvesting and marketing. Fusarium dry rot and the silver scurf/black dot complex can lead to losses and downgrading on the market. Symptomatic tubers are generally easy to identify and affected tubers are discarded during the grading process. Farmers manage the diseases by maintaining a good crop rotation programme. Treatment of seed tubers against silver scurf and black dot are currently receiving the attention of Potato Certification Service and seed growers. Silver scurf and black dot are, however, a disease complex that may become more important as the disease spreads.

**Focus area 3. Weed control**

Common weed plants (nuts edge, broad leaf weeds and grasses) can cause yield reduction if not managed, but effective chemical remedies and cultivation practices are generally effective in controlling weeds. Controlling volunteer potatoes is a great deal more difficult than the control of most other weeds. The plant is hardy, a vigorous grower, and the biology and physiology of germination make it difficult to achieve control. The absence of cold winter temperatures makes the control of volunteer potato populations in South Africa very difficult. The population of tubers that are either exposed on the soil surface or very close to the soil surface will be reduced by bird and rodent damage, grazing animals and exposure to fungi and bacteria. It is, therefore, clear that the management of tuber depth is crucial.

Some varieties of potato are capable of producing large numbers of true seed as well as tubers if not controlled, and although the main volunteer problems are caused by the tubers, germinating seeds can also cause problems if plants are allowed to form seed. Many methods of control are available to the producer, including cultivation, crop competition and the use of herbicides. Unfortunately none of these methods are the silver bullet, and combining these methods in an integrated plan would appear to be the best management tool.

**Focus area 4. Agronomy**

**Water usage and quality**

Water is the most valuable resource in South Africa, both on macro-economic and farm level. At the same time, maximum yield can only be attained if enough water is available to the potato crop. Research on water usage by potato plants under local conditions have been done in previous years, and this was followed-up by research on irrigation scheduling. The fact that new laws on water usage will place restrictions of water availability on farms, together with increasing energy costs, will increasingly necessitate irrigation scheduling by potato farmers. Concerns about the quality of irrigation water in terms...
of both biological and chemical properties have been raised and need to be investigated.

**Plant nutrition**
Plant nutrition is an aspect of production that has been studied extensively and input suppliers play a valuable role in supporting farmers. As a result of fertiliser costs, however, farmers are asking whether the same yield can be obtained using less fertiliser, and whether cultivar specific adjustments can be made for more efficient use of fertiliser. One aspect of plant nutrition that requires more knowledge transfer is the internal tuber defects related to fertiliser uptake, viz hollow hart, brown spot and black heart.

**Cultivation practices**
Soil cultivation is necessary to prepare soil for the potato plant to grow and yield to its full potential. A number of different steps are normally required before planting. In the current milieu of high fertiliser, fuel and electricity prices and labour cost, coupled with the fact that cultivation has an effect on soil structure and can have negative effect on yield, cultivation practices need to be revisited.

**Crop rotation**
Crop rotation plays a critical role in potato production in terms of nutrient usage, soil structure and soil-borne diseases such as root-knot nematode; bacterial wilt; common and powdery scab and soft rot, and below ground below-ground insects such as potato snout beetle. In seed potato production the main concern with crop rotation is to limit soil-borne diseases, therefore the Certification Scheme prescribes a minimum rotation period between seed potato plantings. Where bacterial wilt and golden cyst nematodes occurred, the minimum period is eight years and specific rotation crops are prescribed.

Rotation crops in South Africa typically include maize, wheat, sunflower, legumes and forage crops, and in some regions also vegetable crops such as onion and cucurbits. The overall objective of crop rotation is to establish a system which guarantees profitable and sustainable farming. Choice of suitable rotation crops is complicated further by the fact that different soil-borne pathogens have different hosts and naturally the profitability of the rotation crops in a specific region.

**Soil health and crop rotation**
Soil health is the integration and optimization of the physical, chemical and biological properties for specific soil types to improve productivity in a sustainable manner. Intensive agronomic crop production has contributed to gradual deterioration of soil health, resulting in reduced yield and profitability. In addition to this, and to some extent as a result of this, soil-

borne diseases are becoming more difficult to control. For some diseases there exist very little to no chemical control options. Soil-borne diseases that have become a major problem in potato production in South Africa include powdery scab, common scab and root knot nematode. Current options are limited to broad spectrum soil fumigants and these prove to be inconsistent at best. In addition, these fumigants not only have a detrimental effect on the soil ecology, but also adversely impact on air quality and may contribute broadly to environmental degradation. Such practices result in major ecological disturbances to the production system as a whole by sterilizing the soil and destroying beneficial micro-organisms. Pathogenic micro-organisms that are introduced by planting material proliferate under these sterile conditions where no competition is offered by beneficial microorganisms. This is especially problematic for the potato industry as potatoes are clonally propagated by planting whole seed tubers or seed pieces, which promotes the spreading of pathogens from one area to another. A more sustainable approach needs to be investigated, ultimately demanding the development of a soil health strategy for potato production.

**Seed quality**
In South Africa fresh potatoes are available throughout the year because potatoes are produced at different times of the year in the different production areas which means that plant-ready seed is required throughout the year. To supply in the demand seed potatoes are produced in different production regions (KwaZulu-Natal; Western Free State, North West, Sandveld; North Eastern Cape and the Mpumalanga Highveld), each with its own set of environmental conditions which affect the physiology of tubers. As potato seed is propagated vegetatively/-clonally, a number of pathogens can be spread through infected seed tubers. Quality assurance in terms of disease tolerance, variety purity and quantity per unit is assured by the Certification Scheme. However, seed quality is not limited to the aspects managed under the Certification Scheme. Aspects such as physiological age, size and uniformity in size have a major impact on the performance of plants, and thus yield at the end of the season.

Of all different input costs the cost of seed potatoes comprises the biggest component, in some areas as much as 20 to 30%. This, together with the fact that seed quality has a pronounced effect on yield and quality, necessitates that seed potatoes of appropriate quality is available and that ware potato growers use seed as efficiently as possible. Trust between seed potato growers and ware potato producers and knowledge of factors affecting seed potato quality and performance, from the basis for the efficient use of
seed. Research-based information on a number of questions relating to seed potato quality will contribute to improved use of seed potatoes in South Africa.

**PRODUCT DEVELOPMENT**

**Focus area 1. Cultivar development**

*Cultivar development*

Maximum temperature in South Africa is generally higher than optimal for potato plant growth. In some regions, temperatures >35°C are regularly recorded. In addition the diurnal temperature fluctuation can be as much as 20°C during spring and autumn in some production regions. Consequently, the yield potential of all cultivars is lower than in many other potato producing countries. The selection of cultivars able to produce high yields under local conditions, is therefore one of the most critical research needs for the potato industry. As the average temperature is expected to increase as a result of climate change, cultivar evaluation is also expected to enjoy high priority into the future.

The vast majority of cultivars currently planted, were developed abroad and licenced to local agents who are responsible for the screening, evaluation and commercialization of the cultivars. Most regional potato workgroups plant at least one cultivar evaluation trial every year to evaluate potential candidates for adaptability under regional climate conditions and cultivation practices. The availability of results of many workgroup trials from around the country, make it possible to analyse results to identify widely adapted high yielding cultivars. For the benefit of both local distributors of cultivars and farmers, pre-commercial cultivars are evaluated comprehensively by a team consisting of Potatoes South Africa and farmers in different areas to speed up the identification of well adapted high yielding cultivars.

**Focus area 2. New product development**

This research focus area, as well as market development and product promotion will be discussed with the Marketing Committee at an appropriate time.

**MARKET DEVELOPMENT**

Focus area 1. Consumer demands
Focus area 2. Packaging
Focus area 3. Distribution

**PRODUCT PROMOTION**

Focus area 1. Market research
Focus area 2. Commodity nutritional value

**FARMER DEVELOPMENT**

Focus area 1. Farmer needs assessment
Focus area 2. Mentoring process
Focus area 3. Training
Focus area 4. BEE baseline studies
Focus area 5. Natural resource conservation practices

The focus areas above will be discussed at appropriate time with the Transformation and Marketing Committees.
## RESEARCH AREA: FARMER DEVELOPMENT

### Focus area 1. Farmer needs assessment

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<tr>
<th>Element</th>
<th>Objective statement</th>
<th>Outcomes</th>
<th>Priority</th>
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<tbody>
<tr>
<td>Farmer needs assessment</td>
<td>Research focus areas are to be based on a needs assessment.</td>
<td>A consultation process was performed involving potato workgroups, researchers and other stakeholders. Research outcomes have been formulated based on the research, information and technology transfer needs of farmers.</td>
<td>B</td>
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## RESEARCH AREA: POTATO PRODUCTION

### Focus area 1. Insect management

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| Aphids  | The importance of plant aphids lays in the fact that they are vectors of the most devastating viral diseases viz PVY and PLRV. The two most common species are the green peach aphid, *Myzus persicae*, and the potato aphid, *Macrosiphum euphorbiae*. Both feed on various plant species. In order to manage virus, aphids need to be managed through monitoring, limiting alternative host plants, effective spray programmes and planting of border crops to reduce aphid infestation. Aphid management is difficult because aphids feed on many plant species, have a short life cycle during warm seasons, are asexually reproduced, winged aphids fly or are carried by wind currents to new plantings when populations become high, they are very small and can easily be missed during field inspection. They are also an extremely effective vector of virus diseases as virus can be transmitted to healthy plants in a matter of a few seconds, thus making it necessary to maintain a rigorous and preventative management programme. | 1. Monitoring and identification of aphids through a network of suction traps in seed producing regions provide seed growers with information of aphid flight patterns and numbers.  
2. The risk of infection is further estimated by monitoring the number of aphids already actually infected with virus. This information can reduce spraying if aphids are virus free.  
3. Where production practices allow, border crops are used to limit landing of immigrating aphids to the border crops rather than the potato crop.  
4. Alternative hosts of the most common aphid species, which includes crops, pastures and weed species, have been identified and this knowledge is used by farmers in an integrated aphid management programme.  
5. Regular information sessions on aphid monitoring, aphid behaviour, life cycle and management are held in seed production regions to maintain the level of expertise in the field. | A, A, B, B, A |
| **Potato tuber moth (PTM)** | The potato tuber moth (*Phthorimaea operculella*) is recognised as the most important insect / pest that was accidentally introduced into South Africa approximately 100 years ago. PTM occurs wherever plants of the potato family are found and is especially damaging in areas with a hot, dry climate. Extensive research has been done in South Africa on the life cycle and control of potato tuber moth and many registered chemical remedies are available to manage the pest. The use of pheromone traps to monitor moth numbers have been developed and are available. Despite the knowledge available major losses occur from time to time in most production regions and PTM damage remains one of the major causes of downgrading of tubers on the fresh produce markets. The reason for the situation is possibly the role of climate (not all seasons are conducive to massive infestation), production practices (cull heaps, availability of alternative host plants in the nearby vicinity, etc.). Management strategies for PTM do always from part of the production planning activities of farmers. | 1. Regular technology transfer sessions are held to maintain and refresh knowledge of the potato tuber moth life cycle and management in the field. Information includes spraying programmes to avoid resistance of PTM to pesticides.  
2. All available chemistry has been tested for incorporation in current spray programmes. | A | B |
| **Leaf miner** | The potato leaf miner (*Liriomyza huidobrensis*) can cause serious damage and was detected for the first time in the Sandveld in 1999. In 2000 it was placed on the list of serious agricultural pests of the Department of Agriculture, Forestry and Fisheries. In addition to potatoes, leaf miners attack almost all other vegetables. Several weed species also serve as hosts. Effective registered agricultural remedies are available however, leaf miner is still regarded as the second most important insect pests in South Africa. Technology transfer sessions, workshops, discussions groups, etc should be held from time to time to refresh knowledge of farmers and representatives. | 1. Technology transfer sessions are held to maintain and refresh knowledge of the leaf miner life cycle and management in the field. Information includes spraying programmes to avoid resistance of leaf miners to pesticides. | B |
| **Below-ground insects** | Potato snout beetle, cut worm, grubs and millipedes are insect pests of lesser importance, but the group is regularly noted as being problematic. Potato snout beetle occurs from time to time in production regions such as the Eastern and Western Free State and KwaZulu-Natal, but can be limited effectively through appropriate cultivation methods, rotation programmes and agrochemicals. Technology transfer sessions, workshops, discussions groups, etc should be held from time to time to refresh knowledge of farmers and representatives. | 1. Technology transfer sessions are held to maintain and refresh knowledge of the potato snout beetle, cut worm, grubs and millipedes and management in the field. Information includes cultivation methods known to limit the pests on potato and spraying programmes. | B |
## Focus area 2. Disease management

<table>
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| Common scab | Common scab caused by Streptomyces species, is a bacterial soil-borne disease that occurs worldwide. It is difficult to control due to the pathogen species complex which vary from area to area, and the interaction between the pathogens, the host plant genetics, soil composition, climate, soil microbes and cultivation methods. The pathogen is known to survive in soil for many years as it survives on alternative host plants, and as a saprophyte, on plant rests. The success of chemical control of common scab is limited due to the complex interactions of the elements mentioned above. Experts on the disease worldwide recommend an integrated disease management approach to contain the disease which includes cultivar choice, crop rotation, soil health maintenance, cultivation methods and judicious use of agricultural remedies. Management of soil moisture levels has proven to be the most effective way to limit the disease in countries such as the UK. As 90% of potatoes in South Africa are irrigated judicious irrigation scheduling could be a valuable tool in our strategies to manage common scab. Research efforts should thus aim to make information available to enable farmers in different production areas to develop integrated disease management strategies to manage common scab. | 1. Knowledge of the relevant tolerance of the most popular cultivars against the common scab complex in South Africa is used for informed cultivar choice in areas or lands where common scab is prevalent.  
2. Updated knowledge of alternative hosts plants (crops and weeds) for common scab is available and is used to develop crop rotation programmes to reduce common scab levels and the survival of the pathogen in soil.  
3. Effective chemical and biological remedies against the common scab complex in South Africa have been identified for use in an integrated disease management programme.  
4. The role of soil moisture levels during plant growth stages when tubers are susceptible to infection, have been tested in various production regions and irrigation scheduling can be applied to limit infection and thus disease development.  
5. Cover crops and green manures which can contribute to common scab suppressive soil have been evaluated and are included in rotation programmes to reduce common scab.  
6. Knowledge of the pathogenic Streptomyces species occurring in different production areas and the disease symptoms caused by them exist and is used to develop relevant IDM strategies.  
7. The role of soil temperature and moisture levels created by local climate and production methods on survival of the pathogens is known, and the knowledge is used in IDM strategies.                                                                                                                                                                                                                                                                                                                                 | A        |
Powdery scab

Powdery scab is caused by the fungus *Spongospora subterranea* f.sp. *subterranea*, a member of the lower fungi known as slime moulds that produce zoospores. As powdery scab generally occurs under cool soil temperature, it was previously assumed that it would not become a problem under local environmental conditions. However, sporadic outbreaks of powdery scab have occurred in various local potato production regions since the first half of the 20th century. In the past few years, the disease has become a serious problem in certain potato production regions. Powdery scab may result in downgrading of seed potatoes and may reduce quality of ware potatoes. Tuber lesions can serve as a locus for other wound pathogens and secondary rotting organisms. Roots and stolons of infected plants develop small necrotic lesions from which milky white galls develop. Under optimal conditions, the galls can be so severe that young plants may wilt and die. Powdery scab is very difficult to manage as resting spore balls can survive in soil for decades. Control by means of chemicals is generally not effective, although some cultivars are more tolerant. No cultivar is immune to the disease and even low levels of spores in soil can lead to serious disease development if the conditions are favourable. The only recognised approach to manage powdery scab is through an integrated disease management (IDM) strategy. In order to develop IDM strategies the South African potato industry needs as much as possible knowledge of the behaviour of the pathogen under local climate, soil and cultivation practices, relative tolerance of local cultivars and the value of agricultural remedies.

| 1. Knowledge of the relevant tolerance of the most popular cultivars against powdery scab in South Africa is used for informed cultivar choices in areas where common scab is a risk. | A |
| 2. Updated knowledge of alternative hosts plants (crops and weeds) for powdery scab is available and is used to develop crop rotation programmes to reduce pathogen levels and survival in local soils. | A |
| 3. Effective chemical and biological remedies against the powdery scab in South Africa have been identified for use in an IDM programme. | B |
| 4. The role of soil moisture levels during plant growth stages when tubers are susceptible to infection have been tested in various potato production regions and relevant irrigation scheduling is applied to limit infection and thus disease development. | A |
| 5. Cover crops and green manures which can contribute to restoring soil heath have been evaluated and are included in rotation programmes to reduce powdery scab. | A |
| 6. The role of soil temperature and moisture levels created by local climate and production methods on the survival of the pathogen is known, and the knowledge is used in IDM strategies | A |
| 7. Knowledge regarding the relative importance of soil and seed inoculum levels is available and used in risk assessment strategies. | B |
**Soft rot and black leg**

Blackleg and soft rot diseases cause major losses worldwide. These symptoms are caused by a complex of bacterial pathogens of various species within two major genera namely, *Pectobacterium* spp. and *Dickeya* spp. The species of interest on potatoes are *Pectobacterium atrosepticum* (Pa), *Pectobacterium carotovorum* subsp. *carotovorum* (Pcc), *Pectobacterium subsp. brasiliense* subsp. nov. (Pcb), *Pectobacterium wasabiae* (Pw), *Dickeya dadantii* (Dd) and *Dickeya solani* (Ds). Ds is not currently present in South Africa and is therefore a very important quarantine disease. In the South African potato production regions, the occurrence of blackleg and soft rot have been sporadic and are associated with specific climatic conditions. These conditions have to be further investigated and include, but are not limited to, the role of water, temperature, inoculum levels in the soil and on tubers and host plants in disease development.

| 1. Knowledge of the relevant tolerance of the most popular cultivars against the soft rot and blackleg pathogens in South Africa is used for informed cultivar choice in areas or lands where common scab is prevalent. | A |
| 2. Updated knowledge of alternative hosts plants (crops and weeds) for soft rot and blackleg is available and is used to develop crop rotation programmes to reduce common scab levels and the survival of the pathogen in the soil. | A |
| 3. Effective sterilising agents (wash water treatment), chemical seed treatments and biological remedies against soft rot and blackleg pathogens in South Africa have been identified for use in an IDM programme. | B |
| 4. The role of climate (moisture and temperature) in disease development has been tested in various potato production regions. | A |
| 5. The role of soil and tuber inoculum levels has been tested in various potato production regions. | B |
| 6. Cover crops and green manures which can contribute to restoring soil health have been evaluated and are included in rotation programmes to reduce soft rot and blackleg in different potato production regions. | A |
| 7. Continuous monitoring of bacterial species that cause blackleg and soft rot in South Africa is done in an ongoing basis. | B |
| 8. The role of cold chain storage of potato seed in disease development. | A |
| 9. IDM strategies are developed for the control of soft rot and blackleg. | A |
Root knot nematode

Root knot nematode (RKN) caused by *Meloidigyne* spp. is the most important type of plant parasitic nematode in potato production, and has become a severe threat because of the removal of effective nematicides from the market. Since there is a movement away from harsh chemicals more environmentally friendly options need to be investigated and tested in combination with new chemistry.

1. Rotation, cover crops and green manures which can contribute to restoring soil health have been evaluated and are included in rotation programmes to reduce RKN.
2. Alternative control methods like new chemistry, soil solarisation, plant extracts and biological remedies against RKN in South Africa have been identified for use in an IDM programme.
3. Knowledge of the relevant tolerance of the most popular cultivars against RKN in South Africa is used for informed cultivar choice in areas or lands where RKN is prevalent.
4. Continuous monitoring of RKN species that pose a threat to potato production in South Africa is done in an ongoing basis.
5. The interaction between cultivation practices and climate i.e. timing of harvest in RKN severity is determined and integrated into and IDM strategy to control RKN.
6. Economic threshold levels have been determined and are used to develop management strategies.
7. RKN survival in water is determined.

Brown spot / ‘malroes’

Brown spot is a relatively new disease that has become a problem in potato production in South Africa. Work done by the University of Pretoria has shown that *Alternaria alternata* is associated with the disease and has also been shown to cause the disease under certain conditions. However, the role of stress factors is still believed to play an important role in disease development. These stress factors include oxygen stress in water-logged situations, nutrient toxicity, specifically manganese, nutrient deficiency, specifically potassium and magnesium, ozone burn and growth inhibitors. The type and importance these stress factors play in combination with the pathogen in disease development need to be elucidated.

1. The role of *Alternaria alternata* and / or stress factors including oxygen stress in water-logged situations, nutrient toxicity, specifically manganese, nutrient deficiency specifically, potassium and magnesium, ozone burn and growth inhibitors in the development of brown spot.
2. The influence of cultural practices in brown rot disease development has been determined and is included in the IDM strategy to control the disease.
3. Knowledge of the relevant tolerance of the most popular cultivars against brown spot in South Africa is used for informed cultivar choice in areas or lands where brown spot is prevalent.
### Virus diseases

Although several viral diseases have been reported in South Africa, two (Potato virus Y – PVY and Potato leaf roll virus – PLRV) commonly result in downgrading of seed potatoes and reduction in yield. Tomato spotted wilt virus (TSWV) is reported occasionally. Management of viral diseases is built on a three pillars: correct identification of the virus, limitation of the virus source and limitation of the virus vector. Resistance or tolerance of cultivars to PVY and TSWV can also be contributed to improved management. In recent years the NTN and Wilga strains of PVY have been identified using PCR technology; these strains are now the dominant strains in South Africa. As the NTN strain often occurs symptomless in plants, correct identification is important. No new research need has been identified recently. However, there is an urgent need for practical guidelines to develop region specific virus management strategies. There is an urgent need for validated PCR technology for application in seed testing laboratories. Funding has been approved and good progress is being made.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Technology for identification of viruses have been tested or developed and appropriate technology has been validated for indexing of seed potatoes in approved testing laboratories during the certification process.</td>
</tr>
<tr>
<td>2.</td>
<td>Alternative host plants for the major viruses (crop, forage and weed species) have been identified and the information is used in integrated virus management strategies.</td>
</tr>
<tr>
<td>3.</td>
<td>Regular surveys are conducted to determine whether new viruses or new virus strains occur in South Africa in order to develop and/or test techniques for identification.</td>
</tr>
<tr>
<td>4.</td>
<td>Technology transfer sessions, which could include discussions, workshops or demonstration trails are carried out from time to time to reinforce the principles of the management of virus diseases.</td>
</tr>
<tr>
<td>5.</td>
<td>Knowledge of the relevant tolerance of the most popular cultivars against the common viruses in South Africa is used for informed cultivar choice to manage virus diseases.</td>
</tr>
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</table>

### Silver scurf and black dot

Silver scurf and black dot are known as blemish diseases which can cause losses as a result of downgrading of table potatoes on the market, as well as seed potatoes. Silver scurf has a limited host range and survival in soil. However, black dot has a wide range of host plants and survives in the soil for up to 8 years. Worldwide, the importance of this disease complex has increased, especially as a result of consumer demand and the fact that infected tubers are susceptible to rooting pathogens. Extensive research has been carried out at the ARC prior to 2000 and the knowledge generated in the process is still relevant.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Technology transfer sessions are held to maintain and refresh knowledge of silver scurf and black dot in the field.</td>
</tr>
<tr>
<td>2.</td>
<td>As storage of tubers in soil is generally practiced by seed potato growers and ware potato producers, more information is required on the effect of the storage period on disease incidence under different soil and climate conditions.</td>
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<tr>
<td>3.</td>
<td>Effectiveness of different seed treatment chemicals and application methods has been tested and the available knowledge has led to a decrease in down-grading and rotting.</td>
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</table>
### Focus area 3. Weed management

<table>
<thead>
<tr>
<th>Element</th>
<th>Objective statement</th>
<th>Outcomes</th>
<th>Priority</th>
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</table>
| Volunteer potatoes | During harvest a percentage of tubers, especially the small tubers remain in the soil. These tubers have an amazing ability for regrowth and are then known as volunteer potato plants or weeds. As volunteer potato plants support survival of soil-borne pathogens, control of volunteer potato plants is critical for maintaining a good rotation programme, especially in respect of seed potato production. Cultivation is not completely successful as volunteer tubers can occur deep and under local climatic conditions tubers can survive in the soil for a long time. Chemical control is thus required. The choice of suitable herbicides is a huge problem for seed potato growers as the sprouting ability and vigour of seed potatoes may not be affected by the herbicide. With ware potato production, the choice is easier as sprouting ability is not required. As soil-borne diseases is a concern for the whole industry, more effective management strategies for volunteer control is required. | 1. A survey has been done to identify herbicides registered for volunteer control in other countries and those with potential locally have been selected for trails to determine their effectiveness and to promote possible registration by the distributor.  
2. Various ways to improve volunteer management have been investigated and implemented.                                                                                                                                                                                                 | A        |

### Focus area 4. Agronomy

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<tr>
<th>Element</th>
<th>Objective statement</th>
<th>Outcomes</th>
<th>Priority</th>
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</table>
| Cultivation practices | Soil cultivation is necessary to prepare soil for the potato plant to grow and to yield to its full potential. A number of different steps are normally required before planting. In the current situation of high inputs, fuel and electricity prices and labour cost, coupled with the fact that cultivation has an effect on soil structure and can have negative effect on yield, cultivation practices need to be revisited. | 1. Multi-functional implements to limit negative effects on soil and reduce input costs (also labour) have been developed and tested and are being used to reduce fuel cost.  
2. The effect of different soil preparation implements have been evaluated in different potato production regions and adapted where required. See conservation practices.                                                                 | C        |
### Plant nutrition

Plant nutrition is an aspect of production that has been studied extensively and input suppliers play a valuable role in supporting farmers. However, as a result of fertiliser costs farmers are asking whether the same yield can be obtained using less fertiliser, and whether cultivar specific adjustment can be made for more efficient use of fertiliser.

One aspect of plant nutrition that requires more knowledge transfer is the internal tuber defects related to uptake, viz hollow hart, brown spot and black heart.

<table>
<thead>
<tr>
<th>1. Best practices for judicious use of N is available and can be adapted for specific potato production regions as the need arises.</th>
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<tbody>
<tr>
<td>2. Effect of P and K on sugar content of tubers has been determined and appropriate fertiliser programmes have been developed.</td>
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<tr>
<td>3. Best practice guidelines to limit internal tuber defects such as hollow hart and brown spot have been developed and adapted to region-specific conditions.</td>
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<tr>
<td>4. Need for information on cultivar-specific needs for nutrients is identified from time to time and trials to generate a better understanding are undertaken in the specific potato production regions.</td>
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### Seed quality

Costs related to certified seed potatoes comprise the biggest component of input costs in South Africa. Every step of production, harvest, post-harvest handling, delivery and on-farm handling, has an effect on the performance of the plants after planting. Seed potato production and supply in South Africa is complicated by the fact that potatoes are planted throughout the year in various potato production regions, thus plant ready seed potatoes are required throughout the year. This means that seed potatoes are produced in various seasons in different regions and that the internal quality of seed potatoes varies accordingly. This situation places pressure on all role players in the value chain. More information is required on the effect of practices on the performance of seed potatoes in order to contribute to our understanding of the performance of seed potatoes after harvest.

<p>| 1. Guidelines for good practice in the handling of seed potatoes have been developed and adapted for each seed potato production region and information leaflets are available. |
| 2. Seed is sold by weight (25 kg bags) with a tolerance of a 5% weight loss within the first week after packing. The effect of climate in different seed potato production regions, cultivar and storage conditions has been evaluated and guidelines for expected weight loss have been developed. |
| 3. Variation between field inspection reports and post control results regarding to virus content of seed potatoes currently complicates seed potato production and expectations of the buyer of seed potatoes. Technology for accurate testing of seed at harvest has been tested and is available on request. |
| 4. The effect of plant readiness of different cultivars on its performance after planting has been studied and this information is used by seed potato growers and ware potato producers. |
| 5. The effect of different storage conditions on performance of seed potatoes after storage has been studied for the most popular cultivars and this knowledge used. |</p>
<table>
<thead>
<tr>
<th>Soil health</th>
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<tr>
<td>Soil Health is the integration and optimization of the physical, chemical and biological properties for specific soil types to improve productivity in a sustainable manner. Intensive agronomic crop production has contributed to gradual deterioration of soil health, resulting in reduced yield and profitability. In addition to this, and to some extent as a result of this, soil-borne diseases are becoming more difficult to control. For some diseases there exist very little or no chemical control options. Soil-borne diseases that have become a major problem in potato production in South Africa include <strong>powdery scab, common scab and root-knot nematode</strong>. Current options are limited to broad spectrum soil fumigants and these prove to be inconsistent at best. In addition, these fumigants not only have a detrimental effect on the soil ecology, but also adversely impact on air quality and may contribute broadly to environmental degradation. Such practices result in major ecological disturbances to the production system as a whole by sterilizing the soil and destroying beneficial micro-organisms. Pathogenic micro-organisms that are introduced by planting material proliferate under these sterile conditions where no competition is offered by beneficial micro-organisms. This is especially problematic for the potato industry as potatoes are clonally propagated by planting whole seed tubers or seed pieces, which promote the spreading of pathogens from one area to another. A more sustainable approach needs to be investigated, ultimately demanding the development of a soil health strategy for potato production.</td>
<td>1. Soil health parameters that are tailor-made for potato production have been developed</td>
<td>A</td>
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<tr>
<td>2. Knowledge has been acquired of the success and feasibility of different cultural practices in potato production that are aimed at increasing soil health, i.e. conservation agriculture practices, minimum tillage, crop rotation, green manures, bio-fumigation, etc.</td>
<td>3. Knowledge has been acquired on the success and feasibility of increasing soil health to suppress/control soil-borne diseases including, but not limited to, common scab, powdery scab, blackleg, soft rot, root knot nematode, etc.</td>
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<tr>
<td>4. A feasible and successful soil health program is incorporated into the IDM strategy of most important soil-borne diseases.</td>
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<thead>
<tr>
<th>Crop rotation</th>
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<tr>
<td>Crop rotation is a key element of any integrated disease management strategy, in particular for soil-borne diseases. Knowledge regarding alternative host plants survival of target pathogens in soil, soil type and history, water quality, climate etc., all affects the development of IDM strategies. Farmers identified common scab, powdery scab and root-knot nematode as the most threatening for soil health in potato production regions. Although the information mentioned above is incomplete, the development of region-specific rotation programmes needs urgent attention as this requires long term research, observation and adaptations.</td>
<td>1. Region specific crop rotation programmes have been developed based on prevalent soil-borne diseases, other agricultural activities, soil condition, etc.</td>
<td>A</td>
<td>B</td>
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<tr>
<td>2. Information to reduce rotation periods for more efficient use of irrigated land has been developed for specific potato production regions.</td>
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<td>B</td>
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</table>
# Focus area 5. Sustainable resource usage

<table>
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<th>Element</th>
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<th>Outcomes</th>
<th>Priority</th>
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| Water usage and quality  | Water is the most valuable resource in South Africa, both on macro-economic and farm level. At the same time, maximum yield can be attained only if enough water is available to the potato crop. Research on water usage of potato plants under local conditions have been done in previous years, and this was followed by research on irrigation scheduling. The fact that new laws on water usage will place restrictions of water availability on farmers, together with increasing energy cost, necessitates irrigation scheduling by more potato farmers. Concerns about the quality of irrigation water in terms of both biological and chemical properties have been raised and need to be investigated. | 1. Farmers and service providers in specific potato production regions are being supported to encourage more farmers to make use of professional service providers.  
2. A desk top study to assess available information has been done and recommendations are used as a guideline for future research.                                                                                                   | A        |
| Conservation practices   | In the development of sustainable agricultural systems, the balance between management practices that support conservation of natural resources, and practices that result in degradation of those same resources are dependent on numerous factors including soil type and climate. Both these factors can directly affect plant biomass production and consequently influence crop residue levels or live plant cover. The interaction between climate and soil, external inputs such as irrigation and the crop being produced, influence the soil moisture regime which in turn can affect the soil’s response to compaction forces, wind and water erosion. Factors such as tillage practice and cover crop management that minimise the negative climatic impacts on a system and enhance the soil’s potential to support the production systems of concern must be developed within the context of specific soil types and climates. | 1. Long term projects to evaluate the effect/influence of conservation farming practices on soil loss (due to wind erosion), potato yields, the physical, biological and chemical status of soil, and water use efficiency in potato production in different potato production regions have been initiated, and information gathered is used to develop conservation farming guidelines for each potato production region where projects are being carried out. | A        |
RESEARCH AREA: PRODUCT DEVELOPMENT

### Focus area 6. Cultivar development

<table>
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<th>Priority</th>
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</table>
| **Cultivar evaluation** | Yield potential is largely determined by genetic characteristics of potato cultivars. The success of potato production in South Africa depends to a large extent on the availability of cultivars adapted to the local climate and acceptable to the diverse, but sophisticated market. Ten years ago, the dominant cultivars were of local origin, but currently the market is dominated by one foreign cultivar namely Mondial which has a high yield potential and is adapted to the diverse local production conditions. Many new cultivars are imported annually. Following screening by the licence holders, pre-commercial cultivars need to be evaluated for their potential for high yield, adaptability, possible risks and advantages. Farmers tend to grow one, or a few cultivars and do not like to change a thus it is difficult to establish new cultivars in the market. An important aspect of cultivar trials is that they are performed on commercial farms in various potato production regions. | 1. Pre-commercial cultivars with potential benefits for the industry are identified at an early stage due to intensive evaluation in different potato production regions by a national team of which four farmers are part. Cultivars with inherent weaknesses are identified at an early stage, which means reduced risk for the licence holder and the farmer.  
2. Potato workgroups carry out cultivar evaluation trials in most potato production regions to determine yield potential and adaptability of cultivars in each specific region.  
3. From time to time, potato workgroups evaluate cultivars for specific purposes, such as short growing periods, processing and dual purpose.  
4. To develop a more cost effective method to determine the cooking qualities of cultivars which include preparation of ‘slap chips’. | A        |