Ministry of Agriculture
Kenya

SELECT THE BEST

POSITIVE SELECTION TO IMPROVE FARM SAVED SEED POTATOES

TRAINERS MANUAL

Peter Gildemacher, Paul Demo, Peter Kinyae, Mercy Wakahiu, Moses Nyongesa, Thomas Zschocke

Farmer group harvesting a 'Select the Best' demonstration trial, Njoro, Kenya

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The International Potato Center (CIP) seeks to reduce poverty and achieve food security on a sustained basis in developing countries through scientific research and related activities on potato, sweetpotato, and other root and tuber crops, and on the improved management of natural resources in the Andes and other mountain areas.
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Preface

A lot of efforts have been made in the past to improve seed potato production. Most of these efforts have focused on the promotion of specialized seed multipliers. However, in potato farming in Sub Saharan Africa commercially produced seed potatoes remain beyond the reach of the majority of smallholder producers. These producers rely on farm saved seed instead.

To improve the quality of farm saved seed a program was initiated by CIP and KARI in Kenya. Through a participatory research and development program the value of positive selection in potato farming was tested. The technology proved useful. A large proportion of the farmers that were trained immediately adopted the technology (28%). In the participatory trials yields increased on average by 30% through this technology after only practising it in a single season. The farmers who adopted the technology claimed to have increased their yields by over 100%.

With this training manual a methodology becomes available for use by development organizations interested in improving the livelihoods of resource poor potato farmers in developing countries. It can be adapted to local circumstances in potato growing areas in Sub-Sahara Africa and beyond.

Because of the cost effectiveness of the training as well as the easy adoption of the technology this program can change the outlook of potato farming in areas where the development of a specialized commercial seed potato industry is still a long term dream to become reality.

Acknowledgement

This manual is the result of a collective effort of a large number of individuals in developing and executing a training program on positive seed potato selection.

The core team of collaborators that made this work possible consisted of Peter Gildemacher, Paul Demo of CIP and Peter Kinyae, Moses Nyongesa and Mercy Wakahiu from KARI.

Special thanks to the district coordinators Hannah Oduor, Mark Yego, Wilson Bii and Michael Macharia and all other Ministry of Agriculture staff who showed admirable commitment in the execution of the positive selection training program.

Thanks to Thomas Zschocke of CIP the manual obtained its current structure and look.

The execution of the positive selection program and the printing of the training materials were funded by CIP, PRAPACE, KARI, the Ministry of Agriculture Kenya, GTZ-PSDA, IFAD and ASARECA.

Finally, the efforts of all farmers groups involved in testing and re-adjusting the technology of positive selection are gratefully acknowledged.

Introduction

This training manual is designed to provide step-by-step instructions to trainers in teaching potato farmers positive selection, that is, to 'select the best'. Positive selection can be used to improve the quality of the seed potatoes saved from the farmers own crop.

It is assumed that the trainer himself or herself has gone through some practical training on positive seed selection of 2-3 days before using this manual. The trainer should be able to recognize virus symptoms, bacterial wilt and late blight in the field. Further, it is assumed that the trainer knows how to grow potatoes.

The manual guides the trainer through the different stages of the training program. Please note, however, that this manual is not a blueprint to be followed strictly to the letter. Instead, the training program is flexible to give room for the input of the individual trainer.

The manual contains two major sections. The first section provides the background behind the technology: what are the major seed borne potato diseases; when can 'select the best' be helpful; and how does it actually work. This section will help the trainer understand the technology and the theory behind it. This is needed to teach the technique in a convincing way, and to be able to answer questions from the trainees.

The second section outlines the training program to teach positive selection to a farmer group. The heart of the training program is a demonstration experiment. The training methodology is based on learning by doing, using the field as the classroom. The training program avoids too frequent meetings. There are 9 training sessions over a period of around 9 months.

To complement this training manual a photo book has been developed, showing enlarged photographs of potato disease symptoms. This book can be used by the trainer as a teaching aid in the field in addition to direct field observations of disease symptoms.

A simple farmer field aid completes the training package and summarizes the technology of positive selection in simple language and photographs. This leaflet can be used by trained farmers as a reference. It will also be helpful for those farmers who wish to pass their knowledge to others.

SECTION 1

Background

Learning about seed potato quality control, potato diseases and the role of "Select the Best" in fighting potato seed degeneration.

Potato seed degeneration

Bacterial wilt

Viruses

Late blight

Other potato diseases

Select the best

1. Seed potato degeneration

One of the biggest problems for small scale potato farmers in developing countries is the lack of affordable high quality seed potatoes. "Seed potatoes" are those tubers used to multiply potatoes.

It is difficult and expensive to produce seed potatoes. Multiplication is slow as one seed potato mother tuber will produce only around 10 'children'. To get a lot of seed many plantings are needed. During this replanting plants may get infected with diseases. Transporting and storing seed potatoes is also complicated. Seed potatoes are heavy, get spoiled and need to be well sprouted the moment they are needed in the field. Because of this high quality seed potatoes are expensive.

Small scale potato growers are generally not in a position to pay premium prices for seed potatoes as they lack the necessary cash income. Even when poor farmers sell their potatoes to the market for cash, the money is required for basic needs such as health care, clothes and education. Even if farmers can pay for high quality seed potatoes, they are often not available. In some cases there is a lack of awareness among potato farmers of the importance of using high quality seed potatoes.

The high price and limited availability of quality seed and the at times limited awareness among farmers leads to the common recycling of seed. Farmers use the small tubers saved from their last harvest as seed for their next planting. This results in a build-up of diseases. If the seed potatoes are re-used from the own crop over and over again the yield will decrease over the seasons. This is called '**seed degeneration**'. Seed degeneration is the result of a build-up of diseases which are passed on through the tubers.

Seed degeneration

Seed degeneration is the build up of diseases in potatoes over seasons, as a result of replanting tubers infected with viruses, bacterial wilt or other seed borne diseases.

Bacterial wilt and virus diseases are the most important seed born diseases. Bacterial wilt is usually recognized in the field by farmers, but they often misinterpret the actual causes. Virus diseases, a major problem when recycling seed, are mostly not understood and recognized at all.

2. Bacterial wilt

As the name says, bacterial wilt is caused by a bacteria (*Ralstonia solanacearum*). The bacteria enter the plant through the roots. Inside the plant they multiply and eventually kill the plant. Plants that are not heavily infected can still produce tubers. These tubers contain the bacteria and carry the disease to the next season. The bacteria also survive in the soil.

2.1 Bacterial wilt symptoms

Plants infected with bacterial wilt can easily be identified in the field. As a result of the bacteria multiplying in the vascular system of the plant the flow of water from the roots to the above ground plant becomes blocked. The sprout wilts due to a lack of moisture. This occurs despite the fact that there is no water stress visible in other plants, and the soil is actually moist. Typical symptoms include the following:

- Individual plants are wilting, while others in the same field are healthy.

Note:
Colour pictures of the symptoms presented here can be seen in the separate picture book.

Figure 1: Whole potato plant wilting

- Individual stems in one plant are wilting, while other stems of the same plant are growing normally.

Figure 2: Partial wilting of a potato plant

These symptoms give a strong indication that the plants are suffering from bacterial wilt. However, there are other possible causes of the same symptoms. Examples are mole damage or any disorder affecting the root system or vascular system.

If plants are infected in the later stages of development, when tubers are developing, the bacteria will get into the tubers and survive there. If there are many bacteria, this will cause the typical symptoms of bacterial wilt in tubers which include:

- Oozing eyes
- Soil sticking to the eyes

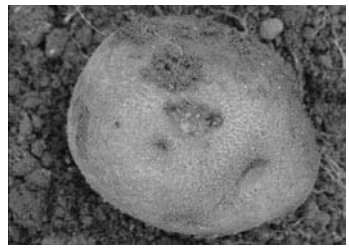


Figure 3a: Bacterial wilt tuber symptoms: Ooying eyes

- Vascular browning

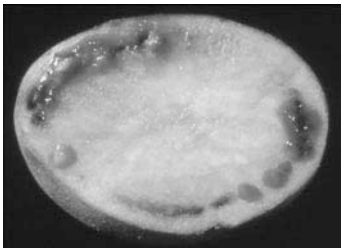


Figure 3b: Bacterial wilt tuber symptoms: Vascular browning

- Ooze coming from the vascular ring

Figure 3c: Bacterial wilt tuber symptoms: Ooze coming from the vascular ring

- Rotting of the tuber

Figure 3d: Bacterial wilt tuber symptoms: Rotting of the tuber

How to ascertain symptoms are caused by bacterial wilt

To make sure that the symptoms you see are caused by bacterial wilt you can do some simple things:

- Dig up a few tubers if they are there and check for the tuber symptoms described above
- If there are no tubers you can cut a wilting stem and see whether there is ooze coming from the vascular system.

If you want to be absolutely sure, use the vascular flow test:

Materials required:
- 1 transparent glass filled with clear water
- 1 knife

Follow these steps (figure 4):

- Cut a piece of 2-3 cm, from the base of the stem
- Place it in clear water, held by a paper clip
- Make sure the top of the stem piece faces up as it was in the plant
- Within a few minutes, milky threads stream downward from the stem piece if the wilting of the plant is caused by bacterial wilt.
- If you tried 2-3 stems that were wilting, and have not seen the flowing ooze, the wilting has been caused by something else.

Figure 4: Ascertain symptoms are caused by bacterial wilt using the vascular flow test (see boxed text)

2.2. Latent or symptomless infection

However, the biggest problem are not the plants and tubers that show outright symptoms of the disease, but rather the so-called latent infection, or symptomless infection. This is the silent carrying of the disease by potato tubers. The tubers do host the bacteria, but show no visible sign of disease.

In symptomless infected tubers the number of bacteria present in the potato tuber is too small to develop any of the above described symptoms. Nobody, even experts, would be able to see that the tubers are actually carrying the disease. The presence of the bacteria can only be established using advanced detection techniques in the laboratory.

Latent infection of tubers with bacterial wilt

Tubers infected with low numbers of bacteria, not showing any disease symptoms. The disease survives in these tubers and produces sick plants when the latent infected tubers are used as seed in the next season. This will also infect the soil of the newly planted field.

The seed with symptomless infection will look absolutely healthy. But once it is planted, the plant will develop bacterial wilt and die. Even worse, it will also infect the soil with the bacteria where it is planted. Bacteria will also spread from the initial symptomless tuber to neighbouring plants and infect them. Whether these plants will actually show symptoms depends on temperatures and soil humidity. They can also become symptomless carriers again, and spread the disease to yet another crop in a different field.

2.3. Measures to prevent bacterial wilt disease

There is no cure once a potato plant or tuber is infected with bacterial wilt. This means that control measures should be applied to prevent initial infection. When

infection has already occurred, then measures are needed to contain the disease.

Positive selection is only feasible in areas where the occurrence of bacterial wilt is incidental. If a large proportion of the potato fields is highly infected with the bacteria more drastic measures are needed to contain the disease. Then training on positive selection may not be sufficient. In areas where bacterial wilt is a very serious problem a specific community based campaign may be required to get the disease under control.

Use of healthy seed

The most important measure to avoid bacterial wilt from entering a potato field is the use of healthy potato seed. When the seed is already contaminated with the disease there is nothing that can be done. Even more problematic is the fact that the soil can also become infected with the disease through the seed. When buying seed it should be purchased from a reputable seller. If it is purchased from a neighbour it would be important to inspect the source field for signs of bacterial wilt during the growing season. If seed is recycled from one's own farm it has to be selected from a field without bacterial wilt.

Use of a clean field

If the disease is present in the soil, even healthy seed will not be enough to get a healthy potato crop. The bacteria have the capacity to survive in the soil very long. The easiest way to make sure the field is clean is to use a wide crop rotation.

Crop rotation

Through crop rotation the bacteria causing the disease will have nothing to survive on and will die due to a lack of food. However, other crops from the potato family can carry the disease and will help the bacteria survive. In other words, the bacteria can "feed" on crops related to the potato. This means that during the rotation period no crops like tomato, tobacco, eggplant, nightshade, capsicum pepper or other Solanaceous crops can be grown.

A crop rotation of only growing potatoes once every four seasons is ideal. However, in most areas where potatoes are grown there is not enough land for such a long rotation. For this reason farmers can be advised the following for their potato fields:

- Minimum 1 season of crop rotation if no bacterial wilt spotted
- Minimum 2 seasons of crop rotation if less than 5% of the potato plants was wilting
- Minimum 3 season crop rotation if more than 5% of the potato plants was wilting

Removal of volunteers

In relation to the above mentioned crop rotation, the removal of volunteers is extremely important. It is a widespread practice to leave the plants in the field that sprouted from tubers that were missed at harvest (Figure 5). This will give scattered potato plants in the crop following potatoes, for example maize. This so-called volunteer crop will yield some potatoes during the second weeding of the maize for home consumption.

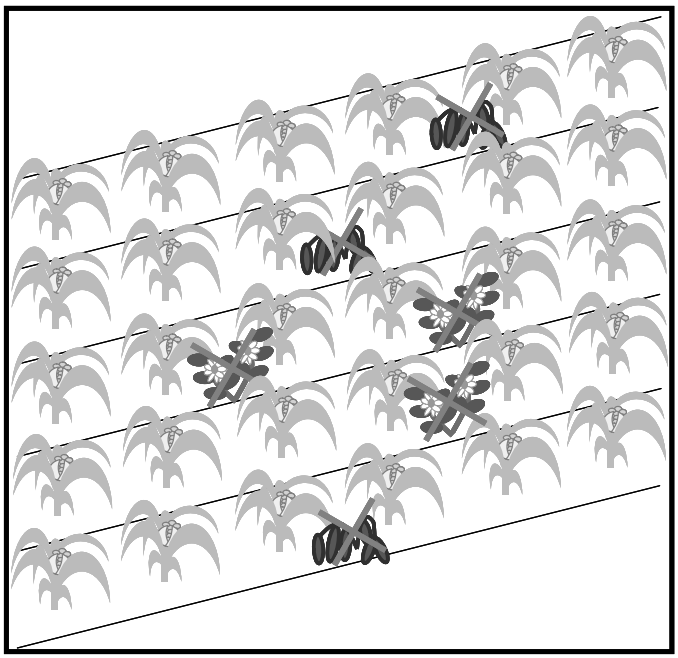


Figure 5: Volunteer potato plants must be removed from the crop following potatoes

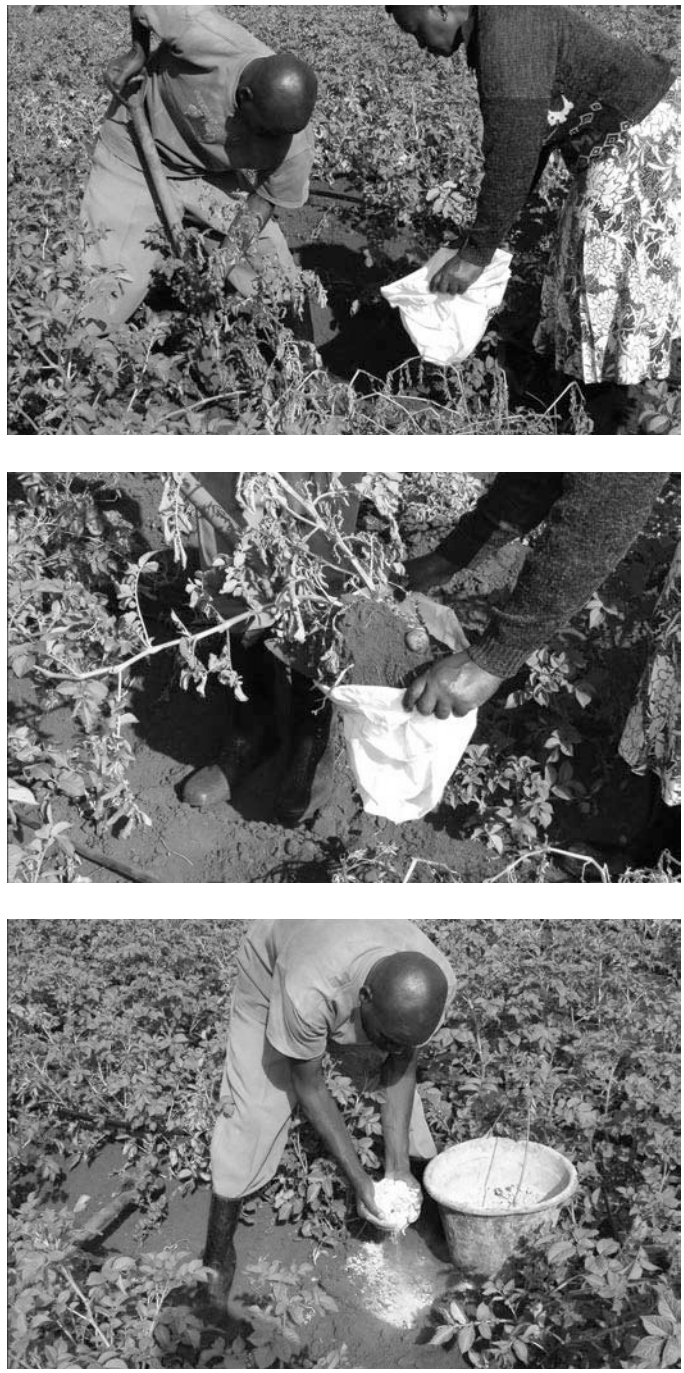


Figure 6: Rouging of a wilting potato plant and applying ashes to the planting hole

Volunteer potato plants

Volunteers are potato plants sprouting from tubers missed when harvesting the previous crop. They are commonly kept as a source of potatoes for home consumption. Allowing them to grow in the rotation crop will make bacterial wilt survive in the soil. They should always be removed.

Rotating crops without removing volunteer has no benefits at all. On the contrary, when volunteer potatoes are kept in the rotation crop, bacterial wilt disease will survive during that season. The presence of the bacteria in the soil will not be reduced as there is plenty of "food" for the bacteria in the form of the volunteer potatoes. Also some the tubers left in the field could already carry the disease and increase the presence of the bacteria in the soil. By allowing the volunteer potato plants farmers are actually "feeding" the bacteria.

Rouging

Another measure to fight the disease is rouging, or the removal of sick plants (figure 6). When the first symptoms of the disease appear a plant has to be removed with all its tubers, if they have already formed, and some of the soil from the planting hole.

It is extremely important that the soil is not spread. It is best to put it in a bucket or other container and carry it out of the field and throw it in a pit. From there no more spreading of the disease can occur.

To enhance the effect of rouging some ashes or lime can be mixed in the hole where the plant came from. Ashes and lime are known to kill the bacteria, probably due to the high soil pH it causes. Ashes have the added advantage of containing nutrients, especially potassium, and some phosphorous. No exact advice on amounts can be given, but as a rule of thumb one handful of lime or two hands full of ashes can be used as a maximum dose per planting hole.

Field sanitary measures

As the disease survives in soil, it can enter a clean field through soil sticking to tools and boots. It can also be carried by runoff water. It is important not to carry dirt to the field that may contain the bacteria. That is why tools, shoes, boots or feet have to be clean.

Especially when surrounding fields are infected, washing alone is not enough and tools and boots should be disinfected with household bleach (sodium hypochloride). Normal household bleach can be diluted 5 to 10 times to around 0.5% sodium hypochloride for this purpose.

Avoiding unnecessary entrance to fields is also important. This however stands in contrast to rouging of sick plants, as one has to enter to control the field, and remove the sick plants. Sticking to paths around the field can be of help.

How to fight bacterial wilt

1. Use healthy seed
2. Use clean land
3. Use clean tools
4. Do not pass through infected land
5. Do crop rotation of at least:
   - One season if no bacterial wilt
   - Two seasons if less than 5% of plants wilting
   - Three seasons if more than 5% of plants wilting
6. Remove volunteers when rotating to stop 'feeding' the bacteria
7. Avoid run-off from infected fields
8. Wash tools and shoes or boots with water or diluted household bleach
9. Remove sick plants with all their tubers and carry them out of the field without spilling soil (in a bucket or bag) and throw them in a pit
10. Mix 2 hands full of ashes or 1 hand full of lime into the soil in the hole after removing a sick plant

3. Viruses

Seed degeneration caused by viruses is much less visible than bacterial wilt, but much more widespread. Once a potato plant becomes infected with a virus, there is no cure. And to make things worse, tubers can carry the disease. So if a plant becomes infected, all its tubers will also be infected. If these tubers are planted in the next season, they produce sick plants. Over the seasons the symptoms worsen as more plants get more and more infected. This quickly results in poor yields.

The number of times seed can be re-used before getting new seed from a commercial seed grower depends on the location where it is planted. It depends on how high the potatoes are grown. Low temperatures in the high mountains reduce the number of insects that transmit many of the viruses from plant to plant. It may also depend on the potato variety. Some varieties degenerate faster than others.

3.1. Virus symptoms

Viruses do not kill the plants, but make the plants sick. Yield reduction depends on how sick the plant is and can range from 10 up to 100%. Some viruses hardly cause symptoms, but still reduce potato yields, others do make plants look very sick.

Colour pictures of the virus symptoms presented here can be seen in the separate colour picture book.

Insect transmission

3.2. Virus transmission

Potato viruses are transmitted in different ways. The most important potato viruses are transmitted by aphids who feed on the sap from the potato plant. The sap from the virus infected plants contains the actual virus. The aphids will carry the virus and infect the next plant they feed on. Also some other sucking insects as whiteflies and thrips can transmit viruses, as well as nematodes and mites.

Mechanical transmission

The second way of transmission of viruses is mechanical. While walking and working in the field some viruses can be transmitted. A plants may be slightly damaged and some plant sap containing viruses is picked up on tools, hands or clothes, and transmitted to other plants where the viruses penetrate through small wounds.

The third way, as mentioned above, is through seed. Strictly speaking this is not really transmission. The virus just survives in the tubers and moves into the plant growing from the sick tuber.

3.3. Measures to prevent virus diseases

As there is no cure once plants are infected, virus management practices are focused on prevention of infection. There are a few things that can be done. They are however not all very economical or practical in ware potato production. Most measures are only applicable to commercial seed potato multiplication.

Use of healthy seed

The most obvious way of preventing yield loss through viruses is the regular renewal of seed potatoes with healthy seed from a reputable source. Some developing countries have a seed certification system that assures the quality of seed. This seed is however often not affordable for smallholder farmers, or not available in sufficient quantities at the right time at the right place.

Rouging

In some countries informal systems exist in which seed is renewed periodically by farmers in lower lying areas with seed bought from highland areas. As aphid populations are lower at cool high altitudes, seed from these areas tends to have lower virus infection rates.

Rouging is the removal of plants with virus symptoms. It is recommended in seed multiplication. In consumption potato production however, it is only justified in the case of very low infection rates (below

5%) to reduce the speed of degeneration and avoid the spread to neighbouring plants. In case of higher infection rates losses in eventual yield would become too high to be justified.

The actual yield loss due to rouging is not always proportionate to the number of plants removed. As a plant is removed, its neighbours will get more space to grow, and yield more than other plants, partly compensating for the lost plant. As such limited rouging does not necessarily give much yield loss.

However, it is extremely difficult to convince a small consumption potato grower to remove plants that are not dead and that will still give tubers, in spite of the virus infection. That is why rouging against viruses is not recommended in consumption potato growing.

Vector control

Another way of minimizing seed degeneration through viruses is the rigid control of insect pests. However, this measure is only essential and economical in the case of commercial seed multiplication. In the case of a consumption potato crop aphid control with expensive insecticides is only justified when aphids cause very serious direct damage to the plants, which is rare.

Minimizing mechanical damage

Mechanical damage can be minimized by not entering the field unnecessarily, timely hilling to avoid tuber damage and weeding timely to avoid the need to enter the crop when it has grown big.

'Select the Best'

Select the best, or positive selection is the most feasible way of reducing seed degeneration as a result of virus diseases in a ware potato crop potato viruses

Potato viruses

- Potato viruses do not kill potato plants but reduce yields
- Potato viruses give many different symptoms that are sometimes hard to see
- Potato viruses are transmitted by insects and contact
- Tubers from infected plants give sick plants
- Viruses are controlled by the use of healthy seed
- If no healthy seed can be found or afforded, "select the best" can help in reducing yield loss due to viruses

4. Late blight

Late blight disease on potatoes is caused by a fungus (*Phytophthora infestans*). Late blight damage can be very severe (Figure 7). If late blight is not controlled, a whole potato crop can be lost. Late blight is rarely affecting tubers. Plants with some late blight symptoms can safely be selected as mother plants for seed.

Late blight and "Select the Best"

Plats with some late blight symptoms can still be selected as mother plants for seed

Figure 7: Potato crop heavily infected with late blight

4.1. Late blight symptoms

The symptoms of late blight are irregularly to round shaped lesions (Figure 8). They may be surrounded by a small band of still green or yellow tissue, that is clearly infected. Lesions are usually not delimited by the veins. If the weather is cold and humid, sporulation is visible as fuzzy white growth on the lesion edges, especially on the underside of the leave. Late blight can also cause lesions on the stems of the potato plant (Figure 9).

Note:

Color pictures of the symptoms presented here can be seen in the separate picture book.

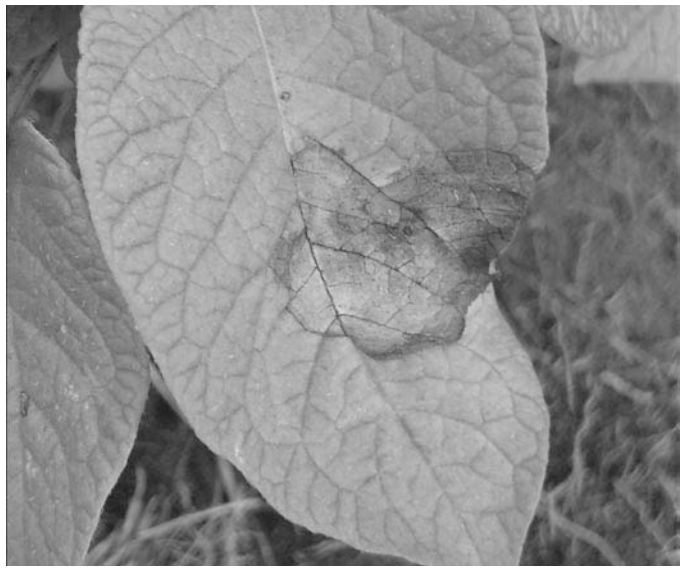


Figure 8: Late blight leaf symptoms

Figure 9: Late blight symptoms on stems

4.2. Late blight transmission

Late blight is transmitted in the form of spores which are formed on the edges of the lesions. They are transmitted over large distances by wind. From one

spore landing in a potato field the whole field can become infected quickly if the weather is right. Late blight growth is fastest under humid and cool (5-20^{0}C) conditions.

Late blight spores

Spores are like the seeds of late blight. They are produced by the fungus on infected leaves and spread by wind. If they land on a wet potato leave, the spore will "germinate", infect the potato plant and form another lesion.

4.3. Measures to prevent late blight damage

Late blight can kill a potato crop. That is why protection against late blight is important. There are three complementing ways of protecting potato plants against late blight:

1. Variety resistance
2. Fungicides
3. Planting out of season

Variety resistance

Some varieties are more susceptible to late blight then others. For smallholder farmers it is advisable to look for varieties that have a level of resistance against the disease. The plants can still get infected by the disease, but not as easily. If they do get infected, the development of the disease is slowed down, and the risk of complete crop loss is reduced. The slower development of the disease will also give the farmer the opportunity to react to the infection with fungicides.

Fungicides

Susceptible varieties can only be protected by a strict fungicide regime. Even when planting resistant varieties, the use of fungicides is recommended to obtain optimal yields.

The best spraying regime depends on the area and the variety grown. For further recommendations on how to spray which variety it is advisable to seek information from the agricultural extension office or potato research institute in the area.

Contact fungicides

In general, there are two types of fungicides. Contact fungicides, which protect the leaves against the entry of the fungus into the plant. They are also called "protectant" fungicides. Mancozeb is the most widely used contact fungicide, of which the Dithane M-45 brand name is most commonly known. There are many other brand names for the same product from other manufacturers, which may be cheaper than Dithane M-45.

Systemic fungicides

The second type of fungicide is systemic. This type can protect the plant from within the plant, and cure the plant from the disease once it gets infected. The most widely used systemic fungicide is Metalaxyl. It is available under different names. The most commonly sold product containing Metalaxyl is Ridomil gold. Ridomil contains both Metalaxyl as well as the protectant fungicide mancozeb. There are few other products that also contain both mancozeb and Metalaxyl and may be cheaper than Ridomil gold.

Planting out of season

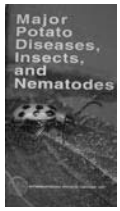
If no resistant varieties and fungicides are available, the only way to grow potatoes is outside of the main rainy season. The disease does not cause problems in hot or dry weather. But the potato plant does not do very well in hot dry weather either.

5. Other potato diseases

Bacterial wilt, viruses and late blight are considered the main three potato diseases of importance in tropical highlands. There are however many other diseases that can attack the potato crop in the field. Some of these diseases can also remain in the seed and cause problems when tubers are planted in the next season. Here, only general measures to prevent other potato diseases are presented briefly. Because of limited space, these diseases themselves are not discussed in this manual.

Note:

The CIP publication 'pests and diseases of potato' describes all potato pests and diseases common in the tropics.



5.1. Measures to prevent other potato diseases

There are some basic principles that will help in reducing the risk of these other diseases causing damage to your potato crop:

1. Good crop husbandry
2. Positive selection in the field
3. Proper skin hardening
4. Seed selection at harvest
5. Proper seed handling
6. Proper seed storage and sprouting

Good crop husbandry

Good crop husbandry means to give the potato plants every opportunity to grow as undisturbed as possible. This strengthens the plants and helps it resist against diseases. Good crop management means thorough land preparation, timely weeding, timely and proper hilling, use of the recommended fertilizers and good control of late blight.

Positive selection in the field

Positive selection will not only work against viruses and bacterial wilt, but also against other seed borne diseases. Any serious seed borne disease will in some way or another give a plant showing symptoms. In other words, the plants will look different, not healthy.

Any plant not growing normally should be disregarded as a mother plant for seed.

It is important to do positive selection just before flowering, or when the very **first** flowers are appearing. It is at this moment when disease symptoms can be detected the easiest. Once the crop has started becoming old (senescence), many different types of symptoms start appearing in the crop. Then it becomes impossible to find the most healthy plants for positive selection.

Senescence

Senescence means the potato plants are becoming old, and start to die. As the plants are growing old they become weak. At this moment leaves start yellowing and showing black spots as a result of fungal diseases that are not harmful to the potato yield. When plants are starting the senescence it is too late to do positive selection.

Skin hardening

The skin of the potato protects it from diseases from outside. It is important to have seed with the toughest skin possible. The potato skin is developing during the senescence of the potato plant. The potatoes develop the hardest skin if they are left in the field till the crop has fully died. If farmers do not want to wait for this, they can instead kill the plants themselves, which is called vine killing or dehaulming. This has to be done 10-14 days before harvesting the tubers.

Seed selection at harvest

Any potato disease may cause tubers symptoms. Here the same rule applies as for the selection of healthy plants. If one or two tubers from a plant selected as healthy look different than normal, all its tubers should be rejected as seed. Tubers that have been damaged during harvesting should also be rejected as seed. As the skin is damaged, it provides an easy entry point for diseases while in storage. From there it may also infect other tubers, and cause problems when planting.

Proper seed handling

All potatoes should be handled with care, to avoid damage to the tuber. Any damage to the tuber can cause the potato to get spoiled faster then needed. This is especially important for seed potatoes as they represents the yield of the next potato crop. Handling them with care means they should not be transported and picked more often than strictly necessary. They should not be dropped or thrown around either.

Proper seed storage and sprouting

Seed potatoes are alive and breathing. They should be kept in a place where they are well preserved, and sprout well. The best place to store seed is a cool and well ventilated area.

Seed is best stored in a place where there is indirect light. The light will ensure that many different sprouts develop on each tuber. In the light the sprouts will become strong. Direct sunlight should be avoided.

To make sure all potatoes receive light they are best kept on shelves, not more than 3-5 tubers high. If piled in a large heap, the potatoes in the middle of the heap do not receive any light.

Breaking dormancy

In areas with 2 rainy seasons or continuous planting farmers have ways of breaking the dormancy of the tubers. In other words, they make them sprout. It is important to expose these tubers to at least 2 weeks of light as described above before planting them. As most methods to break the dormancy quickly involve keeping the tubers in a dark place, the sprouts will often be weak. These sprouts can be hardened by exposing them to indirect light, to make sure the sprouts are well developed and strong at the moment the crop is planted.

The dormancy period of potato varieties varies from just 2 weeks to 3 months. Varieties with a long dormancy are useful for potato growing areas with a single season per year. If these varieties are grown in an

area with 2 rainy seasons, seed has to be stored over a season and be planted the one but next season.

Single sprout

Some varieties will develop one single sprout first, even when kept in the light. For these varieties it is important to inspect the seed 2 weeks before planting and break of the single sprouts. Breaking this single sprout will wake up the remaining eyes and induce their sprouting. Seed potatoes that have been forced to sprout using farmer methods are specifically prone to single sprouting.

Multiple strong sprouts

Tubers should always be well sprouted before they are planted. Every seed potato planted should have multiple strong sprouts. As long as the tuber is in the ground, and the sprouts struggle to come above the ground and develop stems and leaves it is vulnerable. In general, the shorter the period between planting and emergence, the better.

6. Select the best

6.1. What is 'Select the Best'?

'Select the best', or 'positive selection' is nothing more than selecting the best looking plants in a potato field as source of seed for the next season.

Pegging healthy looking plants

Because potato plants die off at the end of their production cycle, the plants have to be selected while they are still growing vigorously. Once the plants have started senescing the healthy vigorous plants can not be distinguished from sick ones. They need to be marked by a peg for easy recognition at harvesting. At harvesting the pegged plants will be harvested one-by-one. Suitability for use as seed will be judged on the basis of the size, number and shape of the tubers of these individual plants.

Basic things to learn

To be able to select the best there are a few basic things that need to be learned:

Disease recognition

- When to do positive selection
- How to recognize virus infected plants
- How to recognize bacterial wilt infected plants
- How to recognize a healthy potato plant
- How to judge plant health on the basis of the tubers

Identifying healthy plants

Not every farmer will become perfect in recognizing sick plants because it is quite a difficult task. However, the basis of the technology is to recognize and mark healthy plants. Identifying healthy plants is much easier than identifying sick plants. Healthy plants are:

1. Big
2. Have many and thick stems
3. Have dark green leaves without malformations
4. Have many, large and well shaped tubers
5. Do not show obvious disease symptoms

Plants that do not look good should not be selected, which is easy to understand and can be applied easily by all farmers.

Positive selection training an eye-opener

Most farmers in Kenya were not aware of virus diseases of potatoes. Members of the Wendi Mwega farmer group from North Kinangop in Kenya said that they were skeptical about what the training could offer them. They had been potato farmers all their lives and believed they knew all there was to it. After the first module they went home and looked at their potato fields. To their great surprise they had to conclude that the majority of their plants was not healthy. From that moment they realized that there was still something they could learn about growing potatoes.

Extension staff also had the idea that they knew all about potatoes. After the 2-day training of trainers they received on positive selection they realized that what they thought were perfectly healthy potato crops, was in fact highly infected with virus diseases. District crops officer in Nyandarua, Michael Macharia said: "The training was a real eye opener, we never knew that most of our potato plants were sick" "This technology responds directly to the need of our potato farmers because they have no access to healthy seed."

6.2. Why 'Select the Best'?

In a situation where the largest proportion of seed potatoes used by farmers comes from their own harvest, 'select the best' is an appropriate technique to fight declining yield as a result of seed degeneration.

The concept is easily understood. Positive selection makes sense once it is understood that there are potato diseases surviving in the tubers. All farmers can understand easily that a healthy tuber produces a healthy plant, and that a tuber carrying a disease will produce a sick plant.

No cash investment needed

The technology can be practised by any farmer in small sized potato plots. No cash investments are needed to practice the technology and as such it is accessible to all. The only investments required are:

- Time to learn the technology
- Time to mark healthy plants
- Time to harvest the marked plants individually
- Sticks to mark the healthy plants

30% yield increase

In farmer managed trials in Kenya yields improved by an average of 30% in a single season using this method of seed selection, compared to the common practice of seed selection from the bulk of potatoes after harvest. Farmers who adopted the technology claim doubling their yields after several selection rounds.

Potato thieves prove positive selection a success in Kenya

Wainaina Njoroge is a member of Pagima group, Naivasha division. He adopted positive selection from the first day he got trained in using it. "I have just retired from teaching, and I am concentrating on farming now, so I though I can give it a try to grow potatoes using positive selection". "I have done positive selection for three seasons now [. . .], and it doubled my yields. I expect to harvest 20 bags from this quarter acre (22 tons / ha)". "Fellow farmers are now coming to me to buy seed as they have seen it is better than what they have". "My last crop looked so good that thieves came during the night to harvest. I now want to spread the technology to others, so no one has to come and steel my potatoes."

Peter Kinyae, a researcher of KARI-Tigoni says: "interestingly we have seen several cases of theft from fields where groups had planted positive selected seed. This is a good indicator that the technology works. Other farmers see the benefit and even resort to theft to get the seed."

6.3. Who should use 'Select the Best'?

'Select the Best' suitable for smallholders

Select the best can typically be used by small potato growers who can not buy high quality seed potatoes regularly. It is meant for those farmers who source seed from their own crop. It is a valuable technology in areas where quality seed potatoes of the desired varieties are not available or for some reason or another not affordable to the farmer.

'Select the Best' not suitable for commercial seed multiplication

'Select the best' is not suitable for commercial seed multiplication. Any farmer wanting to specialize in multiplying seed to sell to other farmers needs to learn other techniques more suitable for this. He would have to source basic seed from a certified seed source, and use negative selection opposed to positive selection to keep the quality of his material high.

Negative selection

Farmers practising positive selecting for several seasons may want to switch to negative selection as it becomes hard to select all healthy plants as most plants will look just as healthy. Pegging all healthy plants would be too much work.

Negative selection

Negative selection is the removal of sick plants from a potato field to keep the quality of the seed high. Negative selection is suitable for the multiplication of high quality seed. For fields with a high number of sick plants negative selection will give too much loss of yield to be of use for smallholder potato farmers.

'Select the best' is not a guarantee for continued good potato harvests. The technology can only reduce the speed of seed degeneration. It can increase yields of degenerated seed to an extend, but the technology has its limits. If farmers want to maintain the highest yield potential they still have to source seed from a reputable source regularly to replenish what they have.

Bacterial wilt and 'Select the Best'.

In cases of infection with bacterial wilt, positive selection is discouraged in fields with high incidence of infection. If infection rates go above 2%, in other words, where two in every 100 plants are infected, it is better to source seed from a more healthy field. If there is no alternative seed source, care should be taken not to select any plant close to a wilting plant. Never select the two neighbours on either side of the plant within the row, nor the adjacent plants in the next row (see Figure 10).

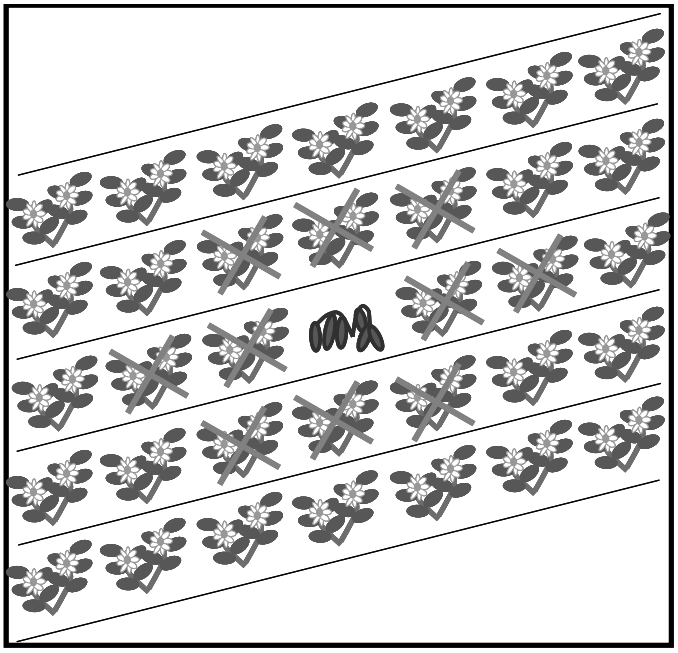


Figure 10: Never select plants close to a wilting plant

SECTION 2

Select the Best training program

Teaching farmers to apply 'Select the Best' using a training program of 9 modules.

Training methodology

Introduction and group formation

Select healthy plants in an existing field at first flowering

Checking the health status of selected plants

Harvesting

Planting of the experiment

Positive selection

Field day

Harvest of the experiment

Evaluation and graduation

1. Training methodology

1.1. Learning by doing

Learning by doing

The basic approach is farmer group training through learning by doing. In this training program the field will be the classroom. The core of the training program is an experiment in which the farmers' way of selecting potato seed is compared with positive selection. During and at the end of the training period the farmers will be able to analyze by themselves the benefits of the newly proposed technology compared to their own way of selecting seed.

The training curriculum is focused entirely on the problem of potato seed quality. Although potato farmers face many other problems, seed potato quality always surfaces as a priority problem for smallholder potato farmers. The focus of the training program on this problem helps to limit the amount of time required by both trainer and trainees as much as possible.

1.2. Preparations before you start

Training of trainers

Anyone using this training manual should have gone through a short training of trainers course. In this 2-3 day training course the background and principles of positive selection are presented in the classroom on the first day. This is followed the next day by a field practical in which the participants will practice positive selection themselves in the field. After this the farmer group training process is planned.

A trainer could be an extension agent with a basic knowledge of potato farming. After the training the agent should be ready to start training a farmer group on positive selection, under supervision of his own institute as well as the entity providing the initial training.

Farmer trainer

Another type of trainer could be a member of a farmer group who has already graduated from a positive selection training course. This farmer trainer would still have to go through a training of trainers course to get the additional background and principles required to transfer the technology to other farmers.

Group selection

The International Potato Center (CIP) and the Kenya Agricultural Research Institute (KARI) have organized several training of trainers courses in Kenya. Based on this experience a process manual will be developed that can assist other institutions in designing their own training of trainers course. CIP and KARI are very interested to share the training expertise with other organizations.

Using an existing group

The training program is group-based. For this a group of participants needs to be selected. It is easiest to work with a pre-existing group that has shown cohesiveness. This pre-existing group could be a graduated farmer field school, a common interest group with prior training experience, a women group attached to a church, or any other group of people that is used to working together. Most importantly the group needs to be motivated to improve their potato production. Ideally it is the group itself that asks for assistance, for example during a field day organized by a group that was trained, or through contacting the extension staff.

Forming a new group

If a group does not exist, a group can also be formed. This however, is a much more tedious process, and chances of staying together are lower than with existing groups. But the group needs only to exist for the duration of the demonstration experiment. If a new group is formed it is important to stress the need for an equal representation men and women in the group, ideally at least 50% women. Also a chairman

and secretary need to be chosen as contact persons, who have the responsibility of mobilizing the group for meetings and field work.

Clear information

From the beginning it has to be made clear that the training program is a joint venture between the trainer and the group, and that it will last over a period of about 9 months. In addition it is mandatory that all participants attend from the first untill the last meeting. The training program is constructed in such a way that it would be difficult to catch up when the first lessons are missed. Participation in training modules 1 to 8 is essential in order to fully comprehend 'select the best'.

It is also important to state clearly from the beginning what the training program will provide and what the group responsibilities are. The training program will only provide information and training materials. The seed potatoes, fertilizer and fungicides as well as the land and labor required for the experiment need to be contributed by the farmer group. Compensation for the owner of the plot from which the group will get the farmer seed and positive selection seed needs to be arranged by the group. Also compensation for the owner of the land used for the demonstration experiment needs to be discussed by the group.

1.3 Training set-up

Training modules

The core training program consists of module 0 for group formation, followed by 8 training modules that need to be executed at specific crop stages. Each training module consists of different activties. These activities are described in detail in the following section. Furthermore the time, the materials and the preparation needed (by the trainer and/or the trainees) are also specified. Some training tips which the trainer could use are given as additional support. An overview of the training program is given in figure 11.

1.4 Training materials

Data collection

In Annex 2 a data collection sheet is provided. This will help the trainer to keep track of the activity, and will assist in obtaining the basic data required to report to his or her supervisor. Data collection is kept to the bare minimum so that it will not require much time. You are advised to keep the form in the book blank, and to make a photocopy for use in the field.

Training materials

In addition to this training manual a color picture book of disease symptoms and a farmer field aid are available. The picture book contains color pictures of the most important potato diseases in A4 size and is designed as an addition aid for the trainer.

Picture book

The picture book can not replace direct field observations by the participants. The picture book is designed to assist the trainer in explaining the different disease symptoms in the field, before farmers start looking for the same in the field. It complements the life examples that can be found in the actual practical field, as all possible disease symptoms are not always present, or not as clear as in the picture book.

Farmer field aid

The farmer field aid is an 8-page leaflet that summarizes "select the best" for the farmers. It contains color pictures of the most important disease symptoms. It will help the farmers in the field during the training and serve as a reference after the completion of the training program. It can also be of help to trained farmers that want to share the acquired knowledge with other farmers.

The farmer field aid is written in simple language and is very suitable for translation into local languages. It is kept brief and affordable so that it can be distributed in large numbers to farmers.

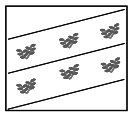
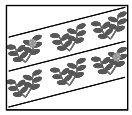
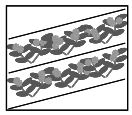
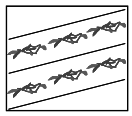
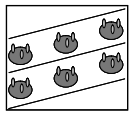
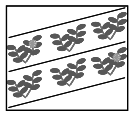
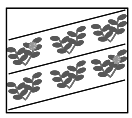
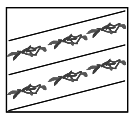
Module	Crop stage		Time required	Objectives
Module 0 Group formation		Germination	2 hours	Find or form an interested group Explain the training objectives Plan the training
Module 1 Select healthy plants in an existing field		First flowers; plants not yet touching	6 hours	Collect baseline data Learn positive selection Select mother plants and plan the experiment
Module 2 Check the health of selected plants		Full flowering; full ground cover	2 hours	Verify the health status of the selected plants
Module 3 Harvesting		Senescence	4 hours	Learn positive selection at harvesting Harvest two types of seed potato for the demonstration experiment
Module 4 Planting the experiment		Planting; seed well sprouted	4 hours	Planting the demonstration experiment
Module 5 Positive selection		First flowers; plants not yet touching	2 hours	Asses the farmer ability to do positive selection Correct gaps in knowledge of the farmers
Module 6 Field day		First flowers; plants not yet touching	4 hours	Create interest among other farmers in positive selection
Module 7 Harvest of the experiment		Senescence	4 hours	Harvest the demonstration experiment and record the data
Module 8 Evaluation and graduation		Soon after harvest	2 hours	Analyze the outcomes of the trial Evaluate the training Official farmer graduation

Figure 11: Structure of the training program

Module 0:

Introduction and group formation

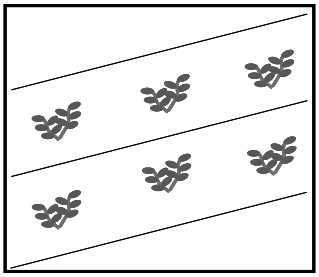
When:
By the time potatoes are emerging in your area.

Objectives:
- Identify or form a farmer group that wants to be trained
- Inform the farmers of the training objectives
- Plan the training

Activities overview:
1. Introduction of the 'select the best' training program
2. New group formation
3. Discussion on rules of conduct
4. Registration
5. Plan the first training module

Time needed:
Two (2) hours

Preparation
- Make an appointment for this meeting.
- If it is an existing group, insist that all members must be present at this information meeting.
- If you are creating a new group, make sure to notify the community where you want to create this group of the information meeting through different channels, existing farmer based organizations, during other public meetings, at the rural market or at the church or mosque.



Activity 1: Introduction of the "select the best" training program

What is on offer?

You can start by explaining that "select the best" is a method that farmers can use to improve the seed potatoes they get from their own farm. This will improve the potato yield of the next season.

This method can be learned through a training program that takes almost 2 seasons of potato growing. In case of an area with 2 rainy seasons, about 9 months. During this nine months the farmers participating will meet 8 times for about half a day. During the training the trainer and the farmers will together conduct an experiment to test if the new method is better than the own farmer practice. At the end the farmers will have learned how to apply "select the best". They will also be able to see if this method is better than common farmer practice or not.

It is important at this stage to emphasize that what will be offered from the side of the trainer is just information and time. There will be no gifts in the form of planting materials, inputs or tools.

What do farmers have to contribute?

The farmers will have to contribute a field suitable for potato farming of around 600m^2, or 20 * 30 meters for the experiment during 1 season.

The planting material for the trial will be selected from an existing potato field. The owner of this field will somehow have to be compensated for this by the farmer group. A total number of around 2,000 seed potatoes is required.

The labour required for the maintenance of the experimental field will have to be supplied by the farmer group. Also the fungicides and fertilizer needed for the trial will have to be arranged by the group.

Discuss whether the group is willing to take on this activity or not at these terms.

Tips for the trainer

- Give the farmers a lot of room to ask questions to better understand the program
- You can give as an example that farmers in Kenya claim to have doubled potato yields after being trained

Activity 2: New group formation

This activity is only relevant for trainers creating a new group specifically for this training.

Gender balance

If forming a new group it is important to stress that the training is meant for all who are involved in producing potatoes. This means that women and youth need to be represented in the group. Depending on the local customs of the area you can insist on a fair balance between men and women (at least 50-50). Also insist that the youth are the future farmers, and they need to be trained.

If you are working in a region where men and women do not freely interact on an equal basis, you may consider organizing a group of women alone.

Group size

To make the training possible, you should avoid having a very large number of group members. Too few members would mean your efforts reach very few people. Ideally a group would have not less then 20 members and not more than 30. If you end up with more than 40 members, you can decide to split them into 2 separate groups. If later group numbers fall, or you have no time to train the two groups separately, you can still train them together. They would however have two separate experiments.

Group member commitment

In any effort of group formation you will start with a large number of enthusiastic farmers. Along the way individuals will drop out for different reasons. Individuals may feel you are not adding to their knowledge, they may have too much other side activities or the training is not what they expected.

What you want to avoid is having group members that are not motivated from the start. Some farmers may want to join to see whether there will be any free seed of new varieties. Or free farm tools, or a free wheelbarrow. This is what they have observed from other projects, if you participate, you may end up getting some material benefits. It is very important to explain from the start that there will be no gifts. State this very explicitly. All the farmers will receive from the project is information.

Group rules

As you are dealing with a new group, a discussion is required on the establishment of rules for the group. These rules need to be agreed upon by all group members and need to be documented. This does not necessarily have to be finished during this first meeting, but may be discussed further during the next meetings. In many countries groups can officially register themselves. You may want to assist the new group in this process during the time you are training them.

Some groups insist on a membership fee to become a member, to make sure all members are serious participants.

Group officials

You will have to make sure the group chooses a chairperson, a secretary, and if they are dealing with money, a treasurer as well. Make sure that there is a balance between men and women among the officials.

Insist that it would be fair to still give others the opportunity to join if they are motivated. The final group composition can be registered in the next

meeting. This will also give the starting group the opportunity to include more women or youth if necessary.

Tips for the trainer

- Instead of forming a new group you could use an existing group, even if the group has not been working in agriculture before.
- Ask the farmers present who is working in their potato fields, to explain the importance to train everybody, including youth and women.
- It may be best to choose a woman as treasurer, as in many places women have a better reputation in handling community funds then men.

Activity 3: Discussion of the rules of conduct

Experience from the training in Kenya shows that there is a need to discuss at the start of the training the rules of conduct during the group training.

There are 4 basic rules that apply:

1. All group members contribute to the field work.
   The field work will be done jointly, disregarding age and gender.
2. Everybody's opinion counts.
   The group will listen to the opinions of all group members, and give everybody the opportunity to talk, disregarding age and gender.
3. Group members have to attend all group meetings.
   If a member can not attend, he will have to inform the chairman or secretary. A farmer missing more than 2 of the total 8 meetings will not receive a graduation certificate.
4. Both trainer and farmers will respect time.
   The time of both the trainer and the farmers is valuable. The starting time of the meetings can be discussed to suit all. It should be respected not to disrupt other activities.

Activity 4: Registration

Make sure that both you and the secretary register the following:

- Names and contacts of the group officials
- Names of the other group members present
- Names of the group members absent plus the reason for absence

Activity 5: Plan the first training module

As a last activity the first training module has to be planned. This training module takes place when or just before the first few flowers appear in the potato crop.

Demonstration field requirements

The field has to satisfy the following requirements:

- About 0.1 ha or larger (minimum 4000 plants)
- Potato field of average quality, not the best field possible
- Pure stand of a single much grown variety
- Field owner is ideally a group member, but at least a farmer willing to collaborate.
- The potato plants should be about 8 weeks old (showing first few flowers) when the training takes place.

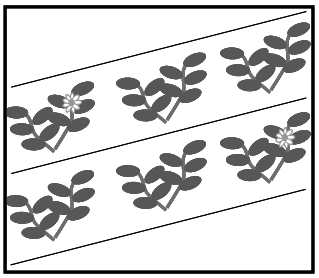
Discuss with the group members where such a field can be found. If none of the members has an appropriate field, a field from another farmer can be used. This does mean that an agreement must be reached between this farmer and the group to compensate him for the potato seed that will be taken out of his field.

The owner of the field that will be used should also realize that the group needs to harvest seed **before** the rest of the crop is harvested. This means the farmer can not sell his potatoes quickly if prices are high, but has to make sure the group harvests seed first.

It is important that the selected field will is neither in a very good nor in a very bad condition. It should be an average potato field so that all farmer can imagine their own potato field is similar.

Module 1:

Select healthy plants in an existing field



When:
At the onset of flowering, when the very first flowers are visible, viruses can be seen best. This is the best time for the first selection of healthy potato plants.

Objectives:
- Collect baseline data
- Learn how to do positive selection
- Select mother plants for positive selection experiment
- Plan the planting of the experiment

Activities overview:
1. Questionnaire to asses training impact
2. Introduction of 'select the best' training program
3. Practical on recognition of diseases on potato plants
4. Practical on estimating disease levels
5. Practical on selecting and pegging healthy looking plants in half of the practical field
6. Discussion on the logistics of harvesting the crop and when and where to plant the experiment
7. Plan the first training module Summary of the days lessons and appointment for the next meeting

Time needed:
Four (4) hours

Preparation
- Organize 300 sticks for pegging plants
- Find a suitable potato field of minimum 0.1 ha in the right stage (see module 0 for further field requirements)
- Photocopy annex 1 as many times as there will be participants
- Bring 9 seed size and 7 large size potato tubers
- Bring 2 different colour ball points or marker pens

Activity 1: Questionnaire to asses training impact

To be able to asses after the training whether the participating farmers learned from the training, changed their practices and increased their yields a simple questionnaire has been designed (see annex 1). This questionnaire needs to filled in by as many participating farmers as possible at the start, and again at some stage after the training.

Section A of the questionnaire starts with 5 multiple choice questions to asses the level of knowledge of the farmers and has to be filled by as many individual farmers as possible. Farmers have to tick all the answers they think are right. During the last training module the same questions will be filled in again, by the same farmers. Then by giving a point for all right answers and deducting a point for all wrong answers, it can be seen whether the farmers actually learned. It will give the trainer an idea where he has to put more emphasis when training his next group.

Section B of the questionnaire measures whether farmer practice is actually changing compared to before the training. Section C tries to capture whether there is actually a yield improvement by the farmers who were trained. Section B and C are filled in before the training, and should be filled again 2 seasons after the end of the training.

If this is done by all trainers in a program it can be analysed if the training program has contributed to improving the potato production of the participating farmers. This is especially important for the managers of the program. It will help them convince policy makers to invest in this training program.

Activity 2: introduction of 'Select the Best'

Low yields and bad seed

The trainer discusses the problem of low yields and bad seeds with the farmers. Topics that need to be covered are:

- Explain that there are many potato diseases that stay in the seed
- Explain that a sick plant will give sick seed and this seed again a sick plant
- Ask the farmers how they select their seed. Make them find out that this seed contains sick tubers. At harvest, when they select, you can not see the difference between sick and healthy plants.
- Let the farmers come up with possible solutions for this and make sure you conclude with three options:

Solutions to low quality seed potatoes

1. Pegging healthy plants and use them for seed
2. Buying healthy seed
3. Remove all sick plants from the field

- Discuss which of these 3 options is suitable for the farmers. Most likely option 2 is out of the question because of the cost and the non-availability of disease free seed. Option 3 is probably not preferred, as farmers would loose yield. The sick plants may still give some potatoes which can be sold or consumed. Option 1 remains as something to be tried out.
- Explain that the objective of the training program is to learn how to peg plants, and to see for themselves the difference between their own way of selecting seed and positive selection.
- To do this an experiment will be planted by the group to compare the two types of seed
- The first step is to learn positive selection, and peg plants to use in the experiment, which will be done this day.

- This will be followed by seven more meetings:
  1. Verifying the health of the selected plants
  2. Harvesting
  3. Planting of the experiment
  4. Positive selection in the experiment
  5. Field day
  6. Harvesting of the experiment
  7. Evaluation of the results of the experiment and graduation

Tips for the trainer

- You can compare sick plants giving sick tubers with a unhealthy mother bearing a weak child
- You can ask farmers whether they know where to get healthy seed, and why they do not buy it
- Allow the farmers to discuss amongst themselves, and let them together find the answers to questions you ask.
- You may know of another crop where seed is selected from the best looking plants, and you can use this as example.

Activity 3: Practical on recognition of diseases on potato plants

Theory

The trainer discusses with the group different potato diseases important in the field. Make sure it is a discussion and there is interaction. Most likely farmers do know bacterial wilt. Let them describe it and only interfere when you feel it is needed. The three diseases that need to be covered are:

Bacterial wilt:

- Discuss symptoms
- Show pictures of symptoms in the picture book
- Show examples in the field if present
- Discuss transmission through seed
- Discuss symptomless infection of seed
- Mention there is no chemical treatment
- Discuss the 10 steps to manage bacterial wilt (see page 13)

Virus diseases:

- Most probably not recognized by the farmers as a disease
- Show pictures of plants and tubers with viruses in the picture book
- Show examples in the field
- Mention the plants do not die, but give fewer and smaller tubers
- Mention it passes from plant to plant by contact and by insects
- Mention there is no chemical treatment against viruses.
- Do the virus spread exercise as illustrated in the boxed text on the next page.

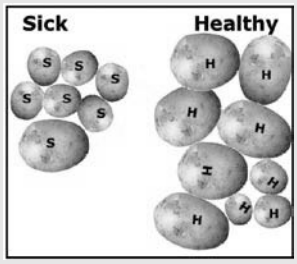
Late blight:

- Show pictures of plants with late blight
- Show examples in the field
- Explain this disease rarely goes to tubers. Some late blight is not a reason to reject a plant as a mother plant for seed
- Late blight is controlled by using resistant potato varieties and by using fungicides
- Late blight is not the focus of this training as it does not effect the seed.

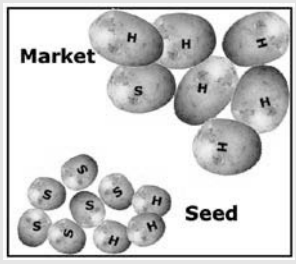
Virus spread exercise

Required:

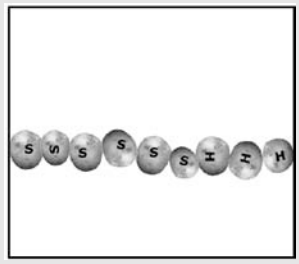
- 9 small potato tubers and 7 large potato tubers
- Ball points or marker pens in 2 different colours



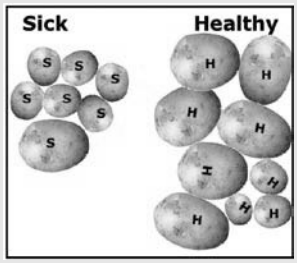
Arrange the tubers as above. Left represents a sick plant, right a healthy plant. Mark the tubers with S for sick and H for healthy.



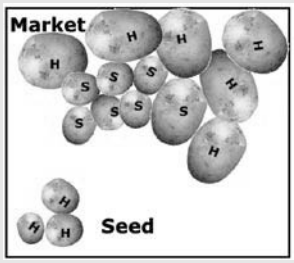
Put all tubers together, as farmers do at harvest, and ask the farmers to sort the tubers for seed and for sale / consumption.



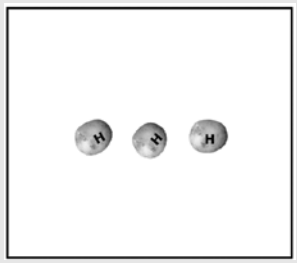
Show that this would result in 2 sick plants for every healthy plant. The sick plants will yield again small tubers.



Rearrange the tubers as above. Left represents a sick plant, right a healthy plant. Mark the tubers with S for sick and H for healthy.



Ask the farmers to select seed through positive selection, and put the remaining tubers aside for sale / consumption.



Show that this would result in 3 healthy plants while we started with 1 sick and 1 healthy plant. These plants will yield well.

The exercise demonstrates:

- The principle of positive selection
- How virus problems build up over seasons
- Positive selection can not be used to multiply large amounts of seed, but enough to improve the self-saved seed
- Tubers from rejected plants are not thrown away, but consumed or sold instead

Practising in small groups

After the discussion divide the group in small groups of 5 individuals. These small groups are sent to different parts of the field and have to find 5-10 plants with different diseases.

The trainer will pass by all small groups and discuss the following:

- The symptoms of the 5-10 sick plants they have identified
- Point to some other symptoms of plants around that the small group may have missed
- Point out a plant with multiple virus symptoms and ask the group to mention them all
- Let the group of 5 people investigate 20 plants in a row and decide whether they are healthy or not under your supervision

Get all small groups back to one point and answer questions. Make sure that good questions raised in the small groups are repeated in front of the whole group, and answered by the person who asked it in the first place.

Tips for the trainer

- Viruses are probably known to farmers under different names. They probably know of plants that stay very small, of mosaic disease in beans, of leaf roll in potatoes. All these are caused by viruses.
- Recognition of diseases if difficult. Make sure to show all possible examples of sick plants available in the field.
- When forming the small groups, make sure they are mixed according to age and gender
- Make sure all participants get the chance to talk. If the men tend to talk and the women and youth are quiet, make sure to ask questions specifically to women and youth to involve them.
- Make sure the crop is in the right stage for disease recognition. The crop has to be around 6-8 weeks after emergence, or when the very first flowers are appearing.

Activity 4: Practical estimating disease levels

In this activity the percentage of sick plants in the two halves of the field is estimated by the farmers.

Divide the field into two approximately equal portions, and mark the division clearly with large sticks. The best looking part according to the farmers will be used for positive selection, while the other half will finally be used to collect seed at harvest as the farmers practice. If your field is small, you may decide to divide it in 1/3 and 2/3, using the 2/3 part for positive selection, and the remaining 1/3 for farmer seed selection.

Every group of five people will first count the number of plants sick with viruses and the number sick with bacterial wilt in two rows. Then they will count the total number of plants in two rows. The data is recorded by the trainer on the data collection sheet (Annex 2). Record separately for the positive selection and the farmer selection part of the field. Select the rows to be counted evenly over the field.

Tips for the trainer

- You already practised this with the small groups under activity 3, but may want to repeat by having a single farmer count sick plants in a row, and have the whole group comment on his performance.
- Try to count 1-2 rows yourself and see if this is somehow in line with the figure the farmers get.
- Check with a few farmers while they are counting aloud, so you can get an idea of how they are doing.
- Make sure plants with late blight are not counted

Activity 5: Practical on selecting the best

Explain that positive selection is not about selecting sick plants. Selecting healthy looking plants is much easier than selecting sick ones.

Asks the farmers what very healthy plants look like, and the farmers will give characteristics. Some examples:

What do healthy plants look like?

- Big plants
- Many stems
- Thick stems
- Dark green leaves
- Large leaves
- Big tubers
- Many tubers
- Other...

Ask one participant to peg five healthy plants suitable for seed selection in front of the group. Discuss whether the group agrees. Make sure it is remembered that plants close to plants with bacterial wilt are discarded as mother plants.

What can go wrong in seed selection

In a farmer group in Kisiriri in Kenya the field that was identified for positive selection was too small. The farmers did positive selection in this plot, and used another plot, of another variety, as the source of farmer selection seed. Consequently in the experiment the positive selection plot was planted with another variety then the farmer selection plot. As a result the experiment failed. It could not be concluded whether the difference in yield was due to positive selection, or due to the difference in variety.

If the plot was too small the farmers could have decided to add another plot. Both plots should have been split into two, with positive selection on one half, and farmer selection on the other half. Then they would have planted 2 smaller experiments with the two different varieties.

Explain that the principle of positive selection is that as soon as you doubt whether a plant is healthy or not, it is not selected. To increase their yields they have to "select the best".

Go to the part of the field that was chosen for doing positive selection. Count and record the number of sticks before placing them in the field. Make sure they are at least 300. Now let all farmers use these pegs to mark a number of healthy plants. From these plants seed will be selected for planting the positive selection part of the experiment. The farmer selection seed will come from the other part of the field. It will be selected according to common farmer practice at harvest.

Tips for the trainer

- You can put a stick at a healthy looking plant close to a wilting plant and ask if the plant is suitable for seed selection.
- Positive selection can be done in any field. If a farmer has any choice, he should do it in his best potato field.
- If bacterial wilt levels are high it is advisable to renew the seed from a healthy source.
- You may want to decide with the farmers that they will all do the same experiment in their own fields.
- If sticks are hard to come by, other methods can be used for marking the plants, like tying strings around the plant, or using maize stalks as pegs.

Activity 6: Logistics of harvesting, storing the seed and planting the trial

Some logistics need to be discussed regarding the trial:

- When will the field where the pegging is done be harvested?
- The owner has to wait for the group to harvest the required seed first
- Who will the owner of the field contact in case of a problem with his field?
- How will the owner be compensated for the seed that will be harvested?

- Where will the seed be stored?
- When can it be replanted and how will the dormancy be broken if necessary?
- Where will the group provide around 0.10 hectares of land for planting the demonstration trial (space for 2,000-4,000 plants)
- Explain it is important that both types of seed get exactly the same conditions, so a homogenous site should be chosen. The whole field must have the same fertility, drainage and plot history.
- Explain clearly that in an experiment both types of seed need to be treated exactly the same at all times (storage, breaking dormancy).

Tips for the trainer

- Make sure the owner of the farm will be compensated for his seed by the group, in a way discussed by the group
- Follow up regularly with the owner of the field, as it has happened that the field was already harvested because of an urgent need for cash, which ruins the training program. Harvesting has to wait till the group has harvested the selected plants and the farmer practice seed.

Activity 7: Summary of the days lessons

- Appoint one of the farmers to summarize the lessons of the day, and let a second farmer complement, before allowing the group to add what has been left out.
- Assure that the women get a chance to talk.
- Ask whether there are any remaining questions / issues
- Make sure the attendance list is completed
- Make an appointment for the next meeting

Module 2:

Checking the health status of selected plants

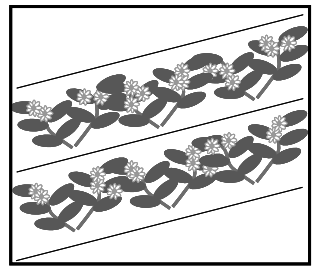
When:
At full flowering, before senescence starts, approximately 2-3 weeks after Module 1.

Objectives:
- Verify the health status of the selected plants

Activities overview:
1. Repetition of the lessons of the first day
2. Checking the health status of selected plants and its neighbors; removal of pegs from newly sick plants, or plants with wilting neighbors

Time needed:
Two (2) hours

Preparation
- Make sure that you can answer questions remaining from the first meeting



Activity 1: Repetition of the lessons of the first day

- Check how many of the people present were there last time and how many are missing. Discuss the causes.
- Stress again the need for continuity and the importance of being there every time, as only then the technology can be fully mastered. Insist no certificate will be awarded to those missing a session without informing the group officials, and those missing more then 2 sessions
- Let one of the farmers explain to one of the newcomers what is positive selection and what has been done last time to learn how to do it.
- Ask participants to repeat virus and bacterial wilt symptoms discussed last time.
- Ask participants to repeat measures to control viruses
- Ask participants to repeat measures to control bacterial wilt

Activity 2: Checking the health status of selected plants and its neighbors

In the two weeks that have past since the selection and pegging of the healthy plants, some plants may have developed disease symptoms. All pegged plants need to be controlled. When a pegged plant is showing virus symptoms the peg must be removed.

If a pegged plant or any of its close neighbors are wilting (see Figure 9), the peg should be removed.

Count the number of pegs removed and record (see annex 2). Calculate the number of remaining pegs and note.

Activity 3: Summary of the days lessons and scheduling the next meeting

- Let one of the participants summarize the lessons of the day
- Answer questions
- Assure the attendance has been recorded
- Make an appointment for harvesting the experiment

Module 3:

Harvesting

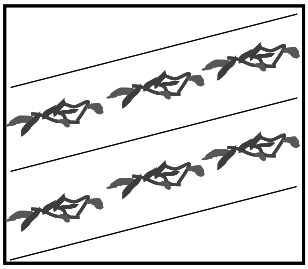
When:
At full maturity of the potatoes.

Objectives:
- Learn positive selection at harvesting
- Get the seed potatoes required for planting the demonstration experiment

Activities overview:
1. Repetition of the lessons of the first two days
2. How 'Select the Best' applies to harvesting
3. Harvesting of the pegged plants individually and selecting the good ones
4. Harvesting of the farmer practice seed
5. Seed grading
6. Theory of seed potato storage
7. Discussion about storing the seed, breaking dormancy and when and where to plant
8. Summary of the day's lessons and scheduling the next meeting

Time needed:
Half a day

Preparation
- 8 gunny bags for seed transport
- A scale to weigh the total harvest
- Know the recommended fertilizer rate for potatoes in your area



Activity 1: Repetition of the lessons of the first two days

- Check how many of the people present were there last time and how many are missing. Discuss the causes.
- Stress again the need for continuity and the importance of being there every time, as only then the technology can be fully mastered.
- Let one of the farmers recall the last two modules lessons.

Activity 2: How 'Select the Best' applies to harvesting

Selection criteria at harvest

- Explain that the selection process continues at harvesting and plants will be harvested one by one. Show pictures of tuber bacterial wilt and virus symptoms.
- Ask which criteria the farmers want to use for discarding a plant. Some suggestions:

1. Low number of tubers (let the group decide on the minimum number)
2. A malformed tuber among the tubers
3. Small tubers
4. An oozing tuber
5. Soil sticking to the eyes of on of the tubers

Activity 3: Harvesting of the pegged plants individually and selecting the good ones

Harvest pegged plants individually

1. Harvest all pegged plants individually and leave the tubers next to the plants.
2. Pass by 20 plants to decide with the whole group and discuss if they can pass, and collect the tubers of the plants that pass.
3. Let pairs of participants select acceptable plants form the remaining pegged plants.
4. Count the number of plants rejected at harvest and record.

5. Take the total weight of the accepted tubers and record

Activity 4: Harvesting of farmer practice seed

Harvest a number of rows from the farmer practice plot. Harvest roughly 300 plants.

You may consider harvesting the whole field to assist the farmer who has volunteered his field for this exercise.

Activity 5: Seed grading

Grade the harvested seed from both treatments into consumption and seed potatoes according to farmer practice. Target a minimum number of 1000 tubers for both types of seed.

Seed health more important than seed size

The size of tubers does not matter too much for the health of the plant growing from it, although a very small tuber will give a weak plant and often fewer stems, and large tubers are preferably consumed or sold. Still it is better to plant a rather small or big tuber then a sick tuber. Any tuber between 25 mm and 90 mm can still be considered as seed.

Record the number of tubers going into storage as seed for both treatments as well as the total weight of the tubers on the data collection sheet (annex 2).

Activity 6: Theory of seed potato storage

Diffused light storage

Seed potato storage conditions are very important for obtaining good quality seed. Explain that a good seed tuber has many and strong sprouts. To get the best sprouts the seed potatoes need to be exposed to light. Because of this seeds are best stored in a light place (light enough to read the newspaper), but out of direct sunlight. To make sure that all potato tubers receive

light, the potatoes should be spread out, not be kept in a heap. Potatoes should not be stored more than 3-4 tubers deep.

It is advisable to make shelves in a light well ventilated area to store the tubers. On the shelves the tubers are easily accessible, and many tubers can be stored in a small space and still receive light.

The light storage condition will delay sprouting, which is not what many farmers in the tropical highlands want. Farmers can apply their usual methods to promote sprouting, as long as the tubers are stored for at least 2 weeks under the conditions described above to get multiple and strong sprouts.

An existing store can be converted into a diffused light store

An existing storage facility may be very easy to convert into a diffused light store. A dark store with corrugated iron roof can be turned into a diffused light store by replacing one sheet with a transparent sheet (figure 12a-b).

In Ethiopia diffused light stores are build with wood and a thatched roof (figure 13).

Figure 12a: Maize store in Kenya converted into diffused light store. (outside view)

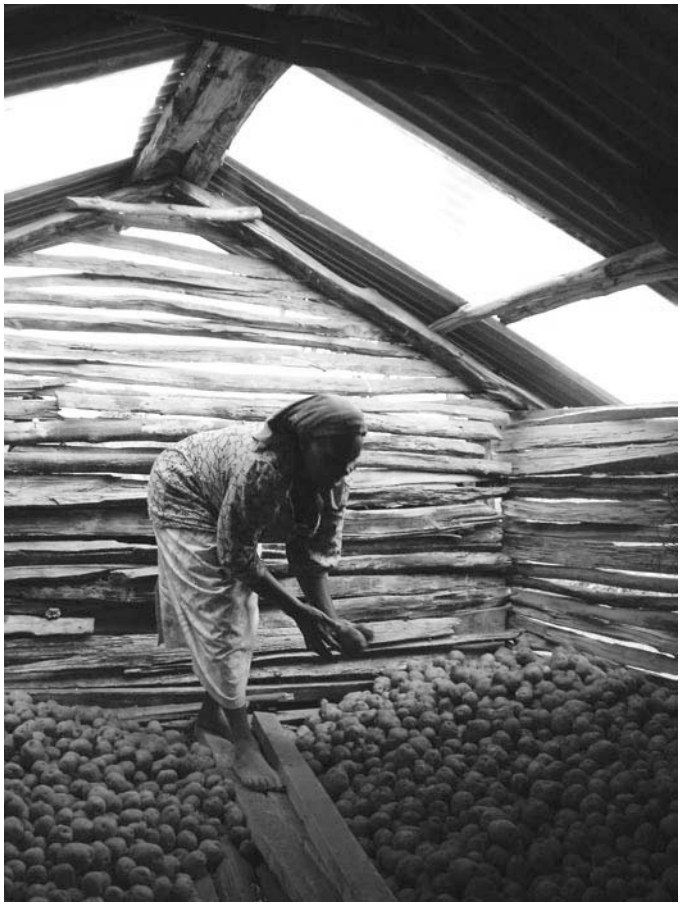


Figure 12b: Maize store in Kenya converted into diffused light store. Note that shelves are still missing (inside view)

Figure 13: Diffused light store in Ethiopia made with wood and a thatched roof.

Single sprouts

Especially when potatoes are forced to sprout fast tubers may develop a single sprout. The first eye that produces a sprout inhibits other eyes to sprout. This is a natural mechanism, called apical dominance. This apical dominance can be broken by breaking off this single sprout. Within a few days the other eyes will start sprouting.

Activity 7: Discussion about storing the seed, breaking dormancy and when and where to plant

Demonstration of strong sprouts

Select 40 tubers of seed size, and store them in your home out of the sun. Store 20 of them loosely packed in two leaves of a newspaper and another 20 next to it on top of two leaves of a newspaper. You will need these to demonstrate the difference in sprouting in the next session.

Where to store the seed

Agree with the group on a good place to store the seed until planting of the demonstration experiment. Emphasize that the seed must be stored secure, well labelled and not be mixed up. The seed potatoes of positive selection and farmer selection need to be stored under exactly the same conditions.

Breaking dormancy

You have to discuss whether there is need for specific action to break dormancy according to the farmers. Discuss when and where the trial will be planted. When to plant is specifically important under rain fed conditions. The farmers will know when rain can be expected and whether the particular variety used will be sprouted by that time.

Land preparation

Emphasize that before you will come for the planting of the experiment the land needs to be prepared and ridged. Ridging of the land needs to be done at a square angle to the slope of the field (see figure 14). The farmers can use the planting distance and soil preparation methods they are used to in their own farms.

Where to plant

Try to avoid a plot with trees on one side. Trees give shade and compete with the potato plants for nutrients and water. The plot next to the trees will suffer extra in case of drought and plants will grow slower because of the shade and have less available nutrients.

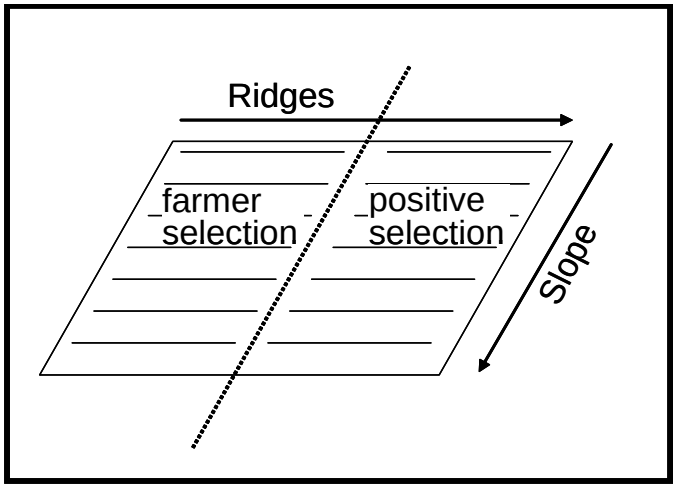


Figure 14: Sketch of the field lay-out

Fertiliser

Emphasize that the farmers need to provide the fertilizer. Discuss the rate they want to apply. The recommended rate for Kenya is 500 kg of DAP per hectare. In other places the advice will be different. The farmers can decide themselves what they find a reasonable amount of fertilizer. If they are used to using less then recommended or even nothing at all they may decide to do the same in the experiment as it reflects their normal practice. In the end the experiment is meant to find out whether positive selection can be of use to them. As long as both positive selection and farmer selection get exactly the same amount per plant, the farmers are free to decide how much they want to apply.

How the seed storage can go wrong

In Kenya a farmer group stored the positive selection seed in someone's house, and the farmer selection seed in a maize field. The farmer seed in the maize field sprouted faster and emergence was quick. The positive selection was not well sprouted, and emergence took longer. The farmer selection plot yielded better then the positive selection plot.

If both types of seed would have been stored together under the maize, it would have been fine. Storing both types in someone's house is also fine. But storing them separate makes the conditions differ. As a result it could not be concluded whether the difference in yield was a result of the seed selection, or a result of the different storage method.

Activity 8: Summary of the day's lessons and scheduling the next meeting

- Let one of the participants summarize the lessons of the day
- Answer questions
- Make an appointment for planting of the experiment

Module 4:

Planting of the experiment

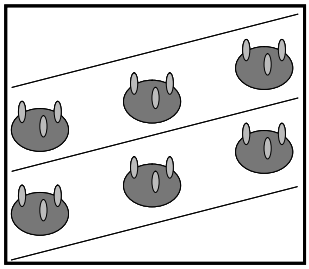
When:
When the farmers feel the season is right and the seed is well sprouted.

Objectives:
- Planting of the demonstration experiment to compare farmer practice with positive selection

Activities overview:
1. Repetition of the set-up of the trial
2. Assessment of the quality of the sprouts
3. Planting the trial
4. Summary of the day's lessons and appointment for the next meeting

Time needed:
Half a day

Preparation
- Assure that the farmers have arranged for the fertilizer
- Assure that the ridges are prepared
- Bring the tubers that have sprouted in the dark as well as in the light
- Bring some seed tubers with a single sprout



Activity 1: Repetition of the set-up of trial

Trial set-up

Explain the set-up of the trial. Potato seeds obtained through positive selection will be planted next to seed obtained using the common farmer practice. This will allow the farmers to see for themselves whether positive selection is worth the effort or not. In other words, seeing is believing!

In the two plots the incidence of viruses and bacterial wilt will be measured by the farmers. And of course the yield of the two plots will be compared.

To be able to compare the two plots in an objective manner, it is important to do everything the same in the two plots. That means that both types of seed need to be planted on a homogenous field next to each other. If there is a slope in the field, divide the field into two along the slope, so that both plots run from the lower to the higher part of the field (Figure 13). This makes both plots just a susceptible to drought and soil fertility difference between the upper and lower part, and drainage problems in case of high rainfall.

How the management of the experiment can go wrong.

When there was a drought a farmer group decided to hand water the experiment to avoid it to fail. The moment they had finished the farmer selection plot the trainer passed by. He told the farmers to stop watering, as it would not reflect the normal way the farmers grow potatoes. The farmer selection plot yielded better then the positive selection plot. It would have been fine if they had not watered at all, as both plots would have suffered equally from the drought. It would also have been fine to water the whole experiment, as both plots would have benefited from the extra water. Stopping the watering halfway was the worst thing to do. The difference in yield between the two plots can no longer be explained by the source of the seed alone, but is also the result of a difference in drought stress.

Explain to the farmers the basic principle of an experiment. All other circumstances are exactly the same, except for the factor we want to investigate. In our case the management of the two plots is exactly the same, except for the source of the seed, so that in the end we can conclude that any difference in yield was caused by positive selection.

Activity 2: Assessing the condition of the sprouts

Comparing dark and light sprouted potatoes

You now need the seed you stored in your home in and on the newspaper. If all is well the tubers stored in the light will have developed coloured, short, strong and multiple sprouts. The tubers stored inside the newspaper, in the dark, will have white, long and weak sprouts.

It is possible that the tubers inside the newspaper have sprouted faster. Tubers kept in the dark, and with limited ventilation can sprout faster.

Show the tubers with a single sprout. Demonstrate to the farmers that from such tubers this single sprout should be broken off to stimulate the other eyes to sprouts. After breaking off the single sprout, tell the farmers to observe the same tubers one week later. Other eyes will have started to sprout.

Activity 3: Planting the trial

Assure the ridges are made according to the sketch in Figure 13. Make sure that both plots are equal in size. If you have no tape measure you can do this roughly by counting steps and the number of ridges.

Fertiliser application

Divide the fertilizer in two equal amounts, and then divide it evenly over the ridges within each plot. Apply the fertilizer in the ridges and mix it lightly with the soil using a stick. Direct contact with the fertilizer when the soil is dry may damage the sprouts of the seed tubers.

Calculating fertilizer requirements and application

Fertilizer requirements

The amount of fertilizer required per plant:
Fertilizer recommendation per ha / number of plants per hectare
Number of plants / ha = 10,000 m^2 * number of tubers per m^2.
Number of tubers per m^2 = 1 m^2 / space per tuber.
Space per tuber = distance between tubers in the row * distance between rows.

If the distance between plants is 30 cm, and between ridges 75 cm and the fertilizer recommendation is 500 kg DAP / ha this results in:
Space per tuber = 0.30 m * 0.75 m = 0.225 m^2
Number of tubers per m^2 = 1 m2 / 0.225 = 4.444
Number of plants / ha = 10,000 m2 * 4.444 = 44,444 plants / hectare.
Amount of fertilizer per plant = 500 kg / 44,444 = 0.011 kg = 11 grams of DAP.

Fertilizer application when you have a weighing balance

1. Calculate the amount required per ridge by multiplying the amount needed per plant by the number of plants in the ridge.
2. With a balance weigh this amount, put it in a container and mark to where the fertilizer reaches.
3. Give every ridge this amount of fertilizer.

Fertilizer application if you do not have a weighing balance

1. Calculate the total amount required in the trial. In the above example you need about 1 kilo of DAP for every 100 plants. If your trial has 300 plants per plot, you require 6 kilo's for the two plots.
2. Let the group purchase exactly 6 kilo's of fertilizer at the input dealer
3. Divide the fertilizer in two equal portions, one for the positive selection side and one portion for the farmer selection side.
4. Sub divide this in a total number of portions equal to the number of ridges per plot.
5. Give every ridge the required amount.

Divide the tubers evenly over the ridges, so that every ridge receives the right amount of tubers. The tubers are then divided evenly within the row at a distance of around 30 cm from the center of one tuber to the center of the next.

Once you have verified the right number of tubers is put at equal distances in every ridge, the tubers can be covered.

Note very clearly where positive selection and farmer selection seed was planted and make sure the secretary notes this as well. Ask the farmers to label the plots clearly.

Tips for the trainer

- Allow the farmers to plant the trial the same way they normally plant their potatoes. Do not be too worried about measuring out exactly the spacing. As long as planting is done the same in both plots, and the same number of potato tubers is put per line in both plots, the trial will be fine.
- Measure out the fertilizer required per plot, and evenly distribute it over the number of ridges in the plot, before applying it (see boxed text).
- As the time between planting the trial and the next meeting is long, inquire about the progress informally with group members you meet in between meetings, or pass by the experiment for a follow up visit in between meetings.

Activity 4: Summary of the day's lessons and scheduling the next meeting

- Let one of the participants summarize the lessons of the day
- Discuss the management of the crop, who will do the spraying, weeding, hilling etcetera
- Emphasize again that weeding, spraying and hilling needs to be done exactly the same in both plots.
- Answer questions
- Make an appointment for the next visit (first flowers appearing, or 6-8 weeks after emergence) for positive selection.
- Plan a date for the field day, shortly after module 5

Tips for the trainer

As an example you may ask the farmer what should be done if it starts raining when they have just finished weeding one of the plots. The right answer is that the other plot should be weeded the next day at latest.

Module 5:

Positive selection

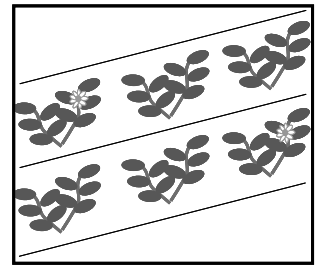
When:
When the very first flowers appear, or 6-8 weeks after emergence.

Objectives:
- Asses the ability of the farmer group to do positive selection
- Correct any gaps you observe in the knowledge of the farmers
- Plan the field day

Activities overview:
1. Positive selection
2. Difference between commercial seed production and positive selection
3. Explain negative selection
4. Discuss the organization of a field day
5. Summary of the days lessons and appointment for the next meeting

Time needed:
Two (2) hours

Preparation
- 200-400 sticks to do positive seed selection



Activity 1: Positive selection

Options for the future of the experiment

You need to discuss with the farmers what they want to do after the end of the season with the plants that will be selected as mother plants today. Some possible options are:

1. Harvest the seed from the selected plants and distribute among the group members
2. Plant another trial next season to compare 3 types of seed:

    a. Positive selection from the positive selection plot (2nd generation positive selection)
    b. Positive selection from the farmer selection plot (1st generation positive selection)
    c. Seed selected from the remaining plants in the farmer selection plot

3. Plant another trial next season to compare two types of seed:

    a. Positive selection from the positive selection plot (2nd generation positive selection)
    b. Farmer seed selection from the farmer selection plot

Depending on the option the farmers positive selection will be done in only the positive selection plot (option 2) or in both plots (option 1 and 3).

Repetition of positive selection

Let one farmer repeat the criteria for selection of a plant and demonstrate selection of a number of plants to the group. Let other farmers fill the gaps and correct.

Let the farmers peg between 200 and 400 healthy looking plants, depending on the choice made by the group regarding the future of the group work.

As the trainer just observe whether the positive selection is done well, without interfering.

After the selection discuss what went wrong and what went right in the selection process. Inspect with the whole group a number of selected plants and discuss whether their selection is justified or not.

Conclude with the farmers that they are now specialists in positive selection. Ask them what is the next step in the selection process and conclude that this is the checking of the heath status in two weeks time. Explain you feel that this is the group's responsibility, and that you do not need to be there until harvest time, except for attending the field day.

Farmers are now positive selection experts

Tips for the trainer

This is an ideal moment to see whether the farmers have learned positive selection properly, and your last chance to correct misunderstandings.

Activity 2: difference between commercial seed production and positive selection

Explain that positive selection is meant for keeping the quality of the own re-used seed high. It is not meant for commercial seed production. Higher yields could still be obtained by using certified healthy seed potatoes regularly.

Positive selection meant for farmer saved seed

In commercial seed multiplication farmers have to start with healthy seed, and remove plants that fall sick from the field to keep the level of infected seed low.

Commercial seed multiplication

Commercial seed multiplication is a specialized business and needs the following:

- A committed and honest farmer
- Money to invest in basic seed from a reputable seller, most often a research institute
- Funds to build a proper diffused light store for the seed
- Funds to invest in the recommended rate of fertilizer, fungicides and insecticides

- Enough land to produce at least 0.5 ha of seed potatoes per season. As seed potatoes require a minimum 4 season rotation, the farmers need at least 2 ha of arable land.
- Customers to sell the seed to.
- Patience, as it will take time to build a name for good seed and get the trust of customers.

Farmers who feel they want to make seed potato production their profession should seek advise and training from the national research institute with the mandate for seed potato multiplication or through the national extension service.

Activity 3: Explaining negative selection

Indicate to the farmers that the experience of positive selection learns that after 2-3 times positive selection it becomes difficult to peg the healthy looking plants. If the positive selection has been done well, all the plants look just as healthy. At this stage it may be easier to remove the sick plants from the field. Removing the ones carrying diseases is called negative selection.

Negative selection

The advantage of negative selection is that the source of the virus diseases is removed. A sick plant in a field will make the disease spread to other plants. Through contact and by aphids the virus will be spread to other potato plants in the field.

It may be hard for farmers to do negative selection. Even a sick potato plant will still produce food. The tubers of a plant infected with viruses may be fewer and smaller, they are still edible and marketable. An alternative to removing the sick plants could be to peg the sick plants, and specifically avoid pegged plants for seed selection. Tubers from these plants should be sold as ware potatoes or be consumed.

Activity 4: Discuss the organization of a field day

The field day is meant to share the newly acquired knowledge with other farmers. The more farmers attend the field day the better. The best time to organize the field day is when virus diseases can still be recognized well, so very shortly after this meeting. With the group you will have to agree on:

1. The date for the field day
2. Discuss who will invite who
3. Discuss a program for the field day. Suggested topics:
   - Present the experiment
   - Explain how positive selection is done
   - Let the visitors practice positive selection in a neighbouring field
4. Arrange for publicity for the field day

Tips for the trainer

- It will help to announce the field day in church, at the market or in another public gathering to assure a high attendance.
- It is important to make sure that your superiors get exposed to your work. Visiting the field day will increase their appreciation, and help you to gain their support for further training of other groups.

Activity 5: Summary of the days lessons

- Let one of the participants summarize the lessons of the day
- Answer questions

Module 6:

Field day

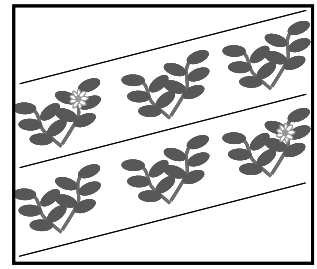
When:
Just after the onset of flowering (after positive selection was done by the group in the experimental field). For example a week after module 5.

Objectives:
- Create interest among other farmers in positive selection

Activities overview:
1. The farmers present the experiment to other farmers and explain the principles of positive selection
2. The visitors are taught to recognize virus diseases
3. The visitors practice positive selection in a neighbouring field

Time needed:
Half a day

Preparation
Make sure that:
- All interested people are informed
- The program management is informed
- It is clear who will explain what during the field day



Activity 1: Presenting the experiment

Let the farmers present the experiment to other farmers. Let them explain the principles of positive selection.

Activity 2: Teaching how to recognize virus diseases

Let the group members explain to the visiting farmers how to recognize potato diseases that are caused by viruses.

Activity 3: Teaching how to do positive selection

Let the group members teach the visitors how to do positive selection. Allow the visitors to select some healthy potato plants under the supervision of the group members in a potato field other then the experimental field

Tips for the trainer

- Make sure all people coming for the field day get some information, and not only the ones coming first. Different short tours can be organized so that all get the principles.
- It is not the trainer who is doing any explanation during the field day, but the farmers that were trained
- The field day is a good moment to scout for new groups that want to be trained
- You may want to record the names and contacts of the visiting farmers to be able to see later whether any of the visitors has adopted positive selection
- In Kenya in some cases it was perceived that the field day provoked theft of the experimental material. It is important to discuss this with the farmers, and decide whether the trial has to be guarded close to harvesting time.

Module 7:

Harvest of the experiment

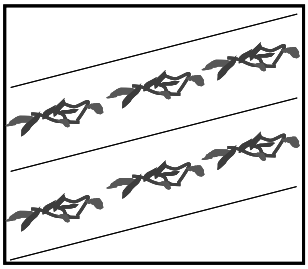
When:
When the crop is fully mature.

Objectives:
- Collect yield data to compare the performance of two types of seed

Activities overview:
1. Harvest of the positive selection plot
2. Harvest of the farmer selection plot
3. Calculation of yield differences between the two plots

Time needed:
Half a day

Preparation
- Bring a scale to weigh the yield; make sure the balance has a level of precision of minimum 1 kg
- Get gunny bags to store the positive selection seed and the rest of the harvest
- Bring a pocket calculator



Activity 1: Harvest of the positive selection plot

Let one farmer explain how harvesting of the positive selection seed is supposed to be done (see module 3). Make sure other farmers fill the gaps in his explanation.

Harvesting pegged plants

Harvesting is very hectic. It is very important that the data required to analyse the effect of positive selection is taken accurately. To achieve this you have to take the lead as the trainer during harvesting. It is very easy to make a mistake at this stage that would make the experiment useless.

Start with the positive selection plot and follow these steps:

1. Count the total number of plants and record
2. Harvest all pegged plants individually and leave the tubers next to the plant.
3. Let the farmers judge the harvested plants one by one and remove the tubers of REJECTED plants and place them in a heap next to the plot.
4. Count the number of ACCEPTED plants and note
5. Collect the tubers of the accepted plants
6. Sort out the potatoes from the accepted plants in very small tubers (below 25 mm), seed tubers (between 25 and 90 mm) and marketable and consumable tubers (above 90 mm).
7. Count the number of seed tubers and note
8. Weigh the seed tubers and note, put them in a bag, label them and put them aside
9. Put the consumable and marketable tubers (above 90 mm) clearly aside
10. Harvest all remaining plants in the positive selection plot and add the tubers to the tubers from the rejected plants
11. Sort out the very small tubers (below 25 mm).
12. Put the remaining tubers (above 25 mm) together with the large tubers from the accepted plants.
13. Count and the number of tubers and note
14. Weigh these tubers above 25 mm and note

Activity 2: Harvesting the farmer selection plot

If you have done positive selection in the farmer selection plot, follow exactly the same steps as above. If you have not selected any plants in the farmer selection plot the procedure is much easier:

1. Count the total number of plants and record
2. Harvest all plants in the plot
3. Sort out the very small tubers (below 25 mm).
4. Count the number of tubers above 25 mm and note
5. Weigh the these tubers above 25 mm and note

Activity 3: Calculating benefits of positive selection

Use the yield data to calculate the total yield per plot, the yield per plant and the average number of tubers per plant for positive selection and farmer selection. Discuss this with the farmers.

Experiment results

Module 8:

Evaluation and graduation

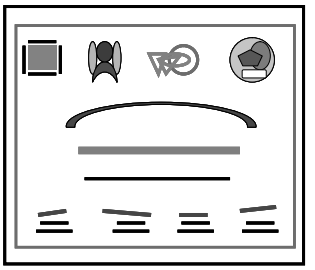
When:
Soon after the harvest.

Objectives:
- Analyse and discuss the outcomes of the trial
- Evaluate the training
- Official farmer graduation

Activities overview:
1. Presentation and discussion of research results
2. Distribution of certificates for mastering 'select the best'
3. Completing the questionnaire (annex 1A)
4. Evaluation
5. Discussion on the way forward for the group

Time needed:
Half a day

Preparation
- Get certificates from the project coordinators and fill in the names of the graduating participants
- Asses with the group chairperson and secretary which participants will graduate
- Copy annex 1A
- Calculate the total yield per plot for positive selection and farmer selection, and translate to yield per unit area
- Bring a pocket calculator



Activity 1: Presentation and discussion of the research results

Economic analysis

- Present the differences in yield between the two plots
- Calculate together with the farmers how much bags difference this is per unit area
- Transform this with the farmers in money at the farm gate against the prices of the day, the minimum prices for potatoes and the maximum prices for potatoes
- Discuss how much the farmers would have to invest to achieve this in terms of labour and materials, and whether it is worth it.

Activity 2: Distribution of certificates

Make sure all farmers get their certificate. For an example, see figure 15.

Figure 15: Certificate of graduation used in Kenya

Activity 3: Completing the questionnaires

Make sure that as many farmers as possible complete the multiple-choice questionnaire in annex 1A individually.

Activity 4: Evaluation

Group discussion on the good and bad moments of the training program and how it can be improved. Note the outcomes of the discussion for your final reporting.

Group discussion

- Ask the group what is the best thing they have learned
- Ask what they have missed during the training
- Ask what they liked most and least
- Ask how the program can be improved
- Document how many farmers have already used the technology on their own farm.
- Ask the non-adopters why not

Activity 5: The way forward for the group

Discuss with the group what their plans are.

Future plans

- Do they want to continue experimenting as a group?
- Will they do positive selection on their own?
- Do they have any other plans as a group?
- Are there plans to transfer their newly acquired knowledge to others?

SECTION 3

Annex

Support tools to facilitate the training program on positive seed selection.

Questionnaire for measuring training impact

Technical data collection sheet

Annex 1:

Questionnaire for measuring training impact

- To be completed by every individual participant at the start and at the end of the training program
- Make as many photocopies as you require
- Translate the questionnaire into local language, if needed
- Assist illiterate farmers by interviewing them
- If too much time is required in completing this questionnaire, take a random sample.

Name	Location	Group	Date

A. Test your knowledge about potato diseases.
Tick ALL the right answers

1. What causes bacterial wilt?
Multiple answers are possible
A. Infected seed
B. Too much fertilizer
C. Drought
D. Insects
E. Infected tools
F. Run-off water from other fields
G. Infected soil on feet or shoes
H. Cold weather
I. Other .....

2. How can bacterial wilt be avoided?
Multiple answers are possible
A. Use pesticides
B. Thorough weeding
C. Disinfection of tools
D. Use of healthy seed
E. Use of fertiliser
F. Cleaning shoes or feet
G. Crop rotation
H. Other .....

3. How are viruses transferred?
Multiple answers are possible
A. Through infected seed
B. By wind
C. By contact
D. By insects
E. Through manure
F. By run-off water
G. Other .....

4. How can viruses be avoided?
Multiple answers possible
A. Use pesticides
B. Use of healthy seed
C. Timely weeding
D. Intercropping
E. Crop rotation
F. Other .....

5. For what can positive selection be used?
Multiple answers possible
A. To fight potato late blight
B. To select healthy seed from a potato crop with little bacterial wilt
C. To make seed potatoes sprout well
D. For commercial seed potato multiplication
E. To select seed potatoes with low virus infection levels
F. To select seed potatoes in a field destroyed by bacterial wilt
G. To improve seed from varieties not available from seed growers
H. Other .....

Name	Location	Group	Date

B. Test your skills in positive selection

6. How do you select your seed?

A. Select seed tubers immediately after harvest
B. Select tubers after storage
C. Always buy seed tubers
D. Peg good looking plants at flowering and harvest separate for seed
E. Select seed tubers form the harvest of the best field
F. Other .....

7. How do you store your seed?

A. In a dark place in a heap
B. In a light place in a heap
C. In the field
D. In bags
E. On shelves in the light
F. Other .....

8. How do you make your seed sprout?

A. I just wait
B. By burying it in a pit
C. By putting it in bags
D. By keeping it in the field
E. By exposing it to the sun
F. By keeping it in the dark
G. Other .....

Name ______________ **Location** ______________ **Group** ______________ **Date** ______________

C. Enter yield levels

(If more than 2 varieties, ask about the 2 major ones)

	Field size	Source seed planted (see codes)	If seed from own field		Harvest date (month)	Amount of seed used	Potatoes harvested
			Date acquired	Original sources (see codes)			
Most recent season							
Variety 1							
Variety 2							
Season second to last							
Variety 1							
Variety 2							

Seed source:

A = Market
B = Neighbour
C = Own field
D = Seed grower, not certified
E = Certified seed
F = other (specify)

Annex 2:

Technical data collection sheet

- To be completed by the facilitator and the group secretary
- Make copies for yourself and the group secretary for use in the field

Name of the group: _____

Name of the facilitator: _____

Location of the group: _____

Module 1: Positive Selection

Date: _____

Variety:

Estimated field size: _____

Name of the owner of the field:

_____

Crop stage during the first module:

_____

Number of sticks placed (count before placing them):

_____

Estimate the virus and bacterial wilt infection percentage:

- Estimate the virus infection percentage by counting the number of infected plants
- Do this separately for the half of the field where positive selection is done and the half where farmer selection will be done.
- Check a total number of around 400 plants spread through the field, for example through counting the sick plants on 5 ridges, and than counting the total number of plants on these ridges. If the ridges are short, take a larger number of ridges.
- Make sure the ridges counted are spread through the field, and not just in one corner.
- Ignore late blight and early blight. Just count plants with virus infection symptoms and plants with bacterial wilt symptoms and note these separate in the table below.

Viruses

	Positive selection plot			Farmer selection plot		
	No. of sick plants	Total no. of plants	% of sick plants	No. of sick plants	Total no. of plants	% of sick plants
Row 1						
Row 2						
Row 3						
Row 4						
Row 5						
Row 6						
Row 7						
Row 8						

Bacterial wilt

	Positive selection plot			Farmer selection plot		
	No. of wilted plants	Total no. of plants	% of wilted plants	No. of wilted plants	Total no. of plants	% of wilted plants
Row 1						
Row 2						
Row 3						
Row 4						
Row 5						
Row 6						
Row 7						
Row 8						

Module 2: Verification of the health status

Date: _____

Crop stage: _____

Number of sticks removed in positive selection plot:

_____

Estimate the percentage of plants wilting again:

- Same procedure of counting as in Module 1, count in about 400 plants, in 5 ridges or more, if only few plants in a ridge

Bacterial wilt

	Positive selection plot			Farmer selection plot		
	No. of wilted plants	Total no. of plants	% of wilted plants	No. of wilted plants	Total no. of plants	% of wilted plants
Row 1						
Row 2						
Row 3						
Row 4						
Row 5						
Row 6						
Row 7						
Row 8						

Remarks: _____

Module 3: Harvest of the research material

Date: _____

	Positive selection plot	Farmer selection plot
Number of selected tubers		
Total weight of tubers selected		

Describe the storage conditions:

_____

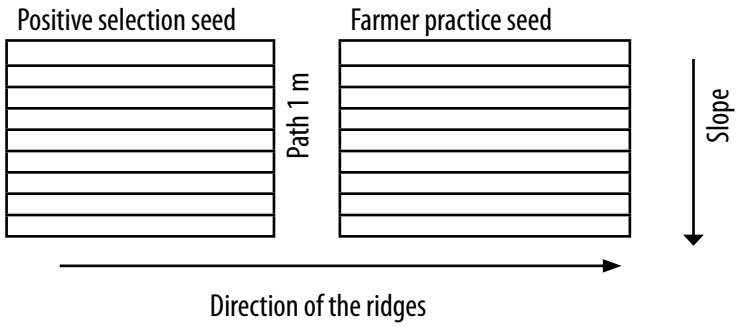
Remarks: _____

Module 4: Planting

Note: Plant the trial according to the sketch

- Put the path between treatments at a right angle to the ridges
- Put the ridges at a right angle to the slope
- Plant the experiment on a homogenous plot, giving both seed sources the same growing conditions
- Put the farmer practice plot next to the positive selection plot
- Remember that both treatments need to receive the same treatment regarding crop protection, weeding, hilling and fertilization to make them comparable

Sketch of the trial layout:



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Date: _____

Fertilizer type: _____

Amount per plot: _____

Number of tubers planted per plot:

_____

Remarks: _____

Module 5: Positive selection

Date: _____

Crop stage: _____

Estimate the virus and bacterial wilt infection percentage

- In both plots select 8 or more rows well spread over the plot.
- Let the farmers count in these ridges the number of virus and bacterial wilt infected plants, as well as the total number of plant in the row and register in the table below
- Ignore late blight, early blight and nutrient deficiency symptoms

Viruses

	Positive selection plot			Farmer selection plot		
	No. of sick plants	Total no. of plants	% of sick plants	No. of sick plants	Total no. of plants	% of sick plants
Row 1						
Row 2						
Row 3						
Row 4						
Row 5						
Row 6						
Row 7						
Row 8						

Bacterial wilt

	Positive selection plot			Farmer selection plot		
	No. of wilted plants	Total no. of plants	% of wilted plants	No. of wilted plants	Total no. of plants	% of wilted plants
Row 1						
Row 2						
Row 3						
Row 4						
Row 5						
Row 6						
Row 7						
Row 8						

Remarks: _____

Module 6: Field day

Date: _____

Crop stage: _____

Number of visitors: _____

Remarks: _____

Module 7: Harvest

Date: _____

	Total number of plants	Number of plants selected	Number of seeds selected	Weight of seed selected	Number of remaining tubers	Weight of remaining tubers
Positive selection						
Farmer selection						

Calculate:

	Total number of tubers	Total weight	Average tubers per plant	Average weight per plant	Tonnes / hectare*	Value of production / hectare
Positive selection						
Farmer selection						

* If farmers are used to a different area measurement, for example, acres, you can use this. It may also help to express yield in a different unit than tonnes.

Remarks: _____