Frequently asked questions about genetically modified potatoes

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INTRODUCTION

As with other crops, the production of potatoes is complicated by pests and diseases which attack the crop and lower the quality and yield of the potatoes. Since the start of farming, farmers have selected crops that best suit their environment. Much of this has been selecting crops that can withstand the environmental pressures of the area. These include soil fertility, climate and pests. Crops that did well soon became staples in the local diet.

Since then the process of selection has become more formalized in programmes that not only select good growing characteristics but also breed good characteristics into crops by cross fertilizing between plants in a breeding programme. This crop improvement is carried out in formal breeding programmes that have been set up for all the major and many minor crops worldwide. Breeders were restricted to using genes that are within the population of the crop and its closely related relatives. New technology that identifies specific genes is making breeding easier and faster.

For the last forty year breeders also have introduced new characteristics by mutating the genes in crops using chemical and radiation mutation. This technology has added new characteristics to the potato gene pool. Potato breeders have selected and bred potato varieties for specific environments (temperate, tropical, dry), uses (food, processing, starch) and with protection against specific pests (bacterial wilt, blight; viruses).

Each newly bred potato variety is tested for several years in field trials at various locations to be sure that it is as good as or better than varieties already grown in those areas. Once breeders are confident they have a good new variety, they register it and make it available for commercial use. In many countries the variety registration process is regulated and all new varieties are tested by regulators in variety trials to make sure they are stable, uniform and distinct:

- Stable varieties perform in a similar manner over several growing seasons in a specific location.
- Uniform varieties maintain a similar appearance and productivity over several growing seasons in a specific location.
- Distinct varieties are easily distinguishable from other varieties of the same crop.

In the last twenty years potato breeders have introduced new characteristics into their breeding programmes using genetic modification. This biotechnology tool identifies and isolates genes of interest from any living organism and moves these genes into crops by inserting them into the genetic material of the plants. The varieties produced by genetic modification are called genetically modified (GM) or transgenic.

This brochure introduces tuber moth resistant potatoes. It addresses frequently asked questions about the crop, the technology used to produce them and consumer acceptance issues.
What is a GM potato?

A GM potato (moth resistant potato; biotech potato; transgenic potato; Bt potato) is a variety that has one or more new or modified genes obtained through modern biotechnology. GM potatoes contain new, desired genes that have been inserted or changed in a laboratory rather than the plant obtaining them through natural or human-assisted pollination. The resulting potato variety is said to be 'genetically modified'. In fact, most conventional crops also have been genetically modified from their original wild state by domestication, selection and breeding over long periods of time.

What is a moth resistant potato?

An moth resistant potato is a genetically modified variety with a gene that protects the variety from attack by potato tuber moths. The gene comes from a soil bacterium and selectively controls potato tuber moth caterpillars that feed on the moth resistant potatoes. Farmers who plant moth resistant potatoes do not have to spray their crop for potato tuber moth, although they may need to spray for other insect pests.

Why make moth resistant potatoes?

Potato breeders could not find resistance to potato tuber moth in any potato varieties and so looked for this characteristic in other living organisms. They found a protein in a soil bacterium that selectively controls only a few kinds of insects, including the potato tuber moth pest. The protein has been used as a biocontrol agent for over 50 years and has had a history of safe use and consumption during this time. Potatoes expressing the new gene are able to protect themselves from even very heavy infestations of potato tuber moth. This makes farming easier for the farmers, by reducing the time spent managing the crop and reducing the cost and hazards of using sprays for potato tuber moth.

GM technology enables plant breeders to transfer useful genes from a wide range of living sources, not just from within the crop species or from closely related plants. Gene transfer expands the source of new genes beyond the limits of conventional plant breeding.

There are social and environmental reasons to produce GM crops. By the year 2020, there will be 8 billion people living on this planet. Feeding these people will require improvements in the production, distribution and stability of food products. Unfortunately cropland is diminishing due to urban growth, erosion, less water, and climate change. It is predicted that average global temperatures will rise 2 to 3°C by the year 2100 with increasing fluctuations in weather conditions. Climate change will alter rainfall patterns and may require the migration of people and shifts in agricultural practices. The increasing human population will require safe and reliable sources of food. Providing food will put pressure on wilderness areas, water quality and water and land availability. This will aggravate loss of habitat, which has already resulted in the loss of many species.

Thus, to help ensure food security and to help conserve forests, habitats and biodiversity, it is necessary to produce future food requirements from existing cropland. GM crops together with other farming technology can significantly improve crop production, quality, yields and storage, so that more food can be grown on the same or less land area. In addition, some GM crops will decrease the amount of pesticides used in agriculture, which benefits people and the environment.
**How are moth resistant potatoes grown?**

The moth resistant potatoes should be grown just as any other variety of the crop. The farmer needs to be sure that the variety is well adapted for his growing area and that he gives it the same inputs (weeding, water, pesticides, fertilizers) he would give a conventional variety to get a good crop. Some GM crops come with conditions that need to be met, such as the refugia requirements for Bt crops (more detail in this brochure). These are explained in the seed packaging and are used to reduce resistance build up in the pest populations to the new control measure.

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**How will I know that I am planting GM potatoes?**

The GM potato varieties will be marketed on the basis of their new, improved characteristics. It seems likely that the developers will label all moth resistant planting material, whether or not this is required by the regulators. The developers believe labelling will be in the interests of transparency, informed decision making and enabling choice. In addition, all insect resistant crops that have been approved to date in South Africa have had a requirement for pest resistance management measures. These are ensured through grower contacts, which alert the buyer of planting material to their obligations and to the GM nature of the crop. If pest resistance management is found to be necessary for moth resistant potatoes, these contracts will probably be introduced for the purchase of moth resistant planting material.

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**Will there be a high technology fee for moth resistant potatoes?**

The intellectual property on the moth resistant potato technology is still being negotiated. The technology owners are eager to provide the planting material on a royalty-free basis to subsistence farmers, in the interests of improving household and rural community food security. They are interested in attaching a small royalty fee for small-holder and large commercial production. This fee will be deposited in a trust account dedicated to potato improvement research. Until the negotiations are finalised the potatoes will not be available for use in South Africa and the conditions of sale will not be known. Ultimately, the technology fee for commercial production must be affordable, or the new varieties will not be adopted.
What are refugia and when are they used?

Refugia are areas of the crop that do not expose insects to the control mechanism. These are usually planted with conventional (non-GM) seeds. This allows some insects to survive without developing resistance to the control. These insects breed with insects from the GM crops and lower the chance of resistance developing in the target pest, to the control protein.

Refugia are only used for crops that offer control against pests. They are part of an insect management strategy designed to slow down the development of resistance in the target pest population.

The refugia requirements are specific to crops and to growing areas and are sometimes specified as a condition in the permit to grow a GM crop. The seed suppliers stipulate how refugia are to be planted for different crops. Some examples of how refugia can be planted are given in the diagramme.

The refugia crop is usually a non-GM variety of the same crop. Refugia sizes are determined by the type of crop, the type of pest and the growing area. In some cases refugia can be treated with a different pest control treatment. Generally, where refugia are treated with pesticides, they need to be planted over a larger area.

Will moth resistant potatoes deplete soil nutrients?

All farming depletes nutrients in the soil, because plants take up the nutrients to grow. The moth resistant potatoes, like other high yielding varieties, will need enough soil nutrients to produce a good crop. Thus, farmers need to replenish soil nutrients just as they do with conventional crops. This may be by adding fertilizers, ploughing in plant material or adding compost.
Are moth resistant potatoes appropriate for developing countries?

Yes, the moth resistant potato technology has been developed specifically for subsistence, small holder and emerging farmers in developing countries. Testing in South Africa has shown that the technology works.

GM crops are distributed as planting materials which are familiar to farmers in all parts of the world. The moth resistant potatoes will be sold as seed potatoes for planting. Farmers who use this new technology must choose the best varieties for their growing environment and plant and care for them just as they do for any conventional planting material. The farmer will test new varieties and new traits just as he does new conventional varieties. Having assessed the benefits, the farmer will decide whether to continue using the new seed, or to revert to better performing varieties.

In many developing countries, non-governmental organizations (NGOs) play an important role in building local capacity to manage the acquisition, deployment, and monitoring of new crop varieties. Ultimately, it is the farmer who will decide on a case-by-case basis if new varieties are appropriate or not for local growing conditions.

The adoption of GM crops in developing countries is illustrated in the table. There is a steady increase in the use of GM crops in developing countries, where farmers have experienced benefits with the new planting materials.

### Countries and GM Crops in Developing Countries

<table>
<thead>
<tr>
<th>Countries</th>
<th>Million Hectares</th>
</tr>
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<tbody>
<tr>
<td>Argentina</td>
<td>16.2</td>
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<tr>
<td>Brazil</td>
<td>5.0</td>
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<tr>
<td>China</td>
<td>3.7</td>
</tr>
<tr>
<td>Paraguay</td>
<td>1.2</td>
</tr>
<tr>
<td>India</td>
<td>0.5</td>
</tr>
<tr>
<td>South Africa</td>
<td>0.5</td>
</tr>
<tr>
<td>Uruguay</td>
<td>0.3</td>
</tr>
<tr>
<td>Mexico</td>
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</tr>
<tr>
<td>Philippines</td>
<td>0.1</td>
</tr>
<tr>
<td>Colombia</td>
<td>0.1</td>
</tr>
<tr>
<td>Honduras</td>
<td>0.1</td>
</tr>
</tbody>
</table>

List of developing countries with plantings of GM crops in 2004 (Source: James, 2004)

Will my neighbour's GM potatoes affect my potatoes?

The moth resistant potatoes grow like any other potato. If your neighbour’s potato production currently does not affect your potatoes then this will not change should he or she plant moth resistant potatoes. If you are currently able to segregate your production from your neighbour’s production, this will remain unchanged.

One concern about GM crops is the movement of pollen from transgenic fields into conventional fields. This is not a concern with potatoes: even on small-holder farms, the potato planting material of choice is good quality tubers. Tubers are clones of the mother plant (genetically identical) and are not affected by pollen that reaches the mother plant flowers.

Importantly, there is very little movement of pollen out of potato fields and, where cross pollination does occur, the seeds are not collected and used for further planting on production fields. Farmers who produce true potato seed for the market are required to implement measures to minimise inflow of unwanted pollen.
Is genetic modification the only way of increasing food production?

No, GM is not the only tool that is used to increase food production. Together with other tools (see Figure), GM crops will help ensure adequate, safe food for the growing population. For grains and oilseed crops, increasing food production most often means the ability to produce better yields under the same conditions, such as the ability to resist weeds, insects, diseases, poor soils and drought. Given the rate at which the demand for food is increasing, it is necessary to increase the production of food in Africa. In combination with other technologies, GM can help agronomists reach the productivity necessary to supply enough food at reasonable prices.

To answer this question we also need to consider the growth in world population and the impact this has had on farmlands. One way for farmers in developing countries to keep up with population growth has been to convert forests, jungles and wetlands into farmland. This cannot continue indefinitely as access to land will eventually run out and the impact on natural habitats and biodiversity is unacceptable. More productive crop varieties developed during the Green Revolution allowed farmers to grow more food on only slightly more land.

Although effective at boosting yields, vast monocultures of intensively farmed land can have significant ecological impact, especially on biodiversity. Farmers in the developing world will have to rely on low cost solutions that do not require unrealistic practices such as buying expensive chemicals or equipment. Biotechnology can provide seed to farmers that is better adapted to their cultivation requirements. Various GM crops could provide the benefit of pest resistance and tolerance to environmental conditions such as drought that are needed to sustain village farms. These benefits, together with those from other technologies, should enable more sustainable food production and greater food security.

Which countries grow moth resistant potatoes?

An application for approval for moth resistant potatoes has not yet been submitted, but is being prepared. As such, there are no potatoes with this specific modification in commercial use yet. However, other potato varieties with transgenic insect resistant characteristics have been approved for growing and consumption in the United States and Canada and for import and consumption in Australia, Japan and the Philippines (AGBIOS database). Despite approval, GM potatoes are not grown in North America, but recent, new pest pressure from potato tuber moth has renewed interest in these varieties.
What GM crops are grown in South Africa?

Over thirteen GM crops/trees have been tested in South Africa under confined field trial conditions. Of these, five have been approved for general use. These are:

- Insect resistant cotton
- Insect resistant maize
- Herbicide tolerant cotton
- Herbicide tolerant soya
- Herbicide tolerant maize

<table>
<thead>
<tr>
<th>Crop</th>
<th>National planting (x 1000 ha)</th>
<th>GM planting (x 1000 ha)</th>
<th>Percentage GM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>2,600</td>
<td>400</td>
<td>15</td>
</tr>
<tr>
<td>Maize</td>
<td>140</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>Soya</td>
<td>35 - 40</td>
<td>30</td>
<td>85</td>
</tr>
</tbody>
</table>

Summary of GM crop planting in South Africa in the 2004 season (Source: James, 2004)

What Bt crops are grown in South Africa?

The South African government has approved Bt insect resistant technology in maize and cotton. These crops have been grown commercially since 1997 and are used by small-scale, emerging and commercial farmers. Post-marketing studies indicate that the new varieties perform well in certain growing environments and reduce the need to use pesticides.

Will GM potatoes be labelled?

It seems likely that the developers will label all moth resistant planting material, whether or not this is required by the regulators. The developers believe labelling will be in the interests of transparency, informed decision making and enabling choice. However, as the insect resistance has been achieved without changing the nutrition, food and feed safety or composition of the potatoes, they will not require labelling under current food safety regulations.

Will growing GM potatoes affect my markets?

Farmers selling to the general markets are unlikely to be affected, considering that the GM nature of maize, cotton and soya has not affected these markets. Farmers who supply organic markets will need to ensure that their planting material is conventional seed. Gene flow cannot influence conventional potato harvests and current segregation of harvest suggests that commingling will not be a problem for these suppliers.
Which countries grow GM crops?

Four countries are principal growers of GM crops: the USA with 47.6 million hectares (59% of global total); Argentina (16.2 million hectares, 20%); Canada (5.4 million hectares, 6%); and Brazil (5.0 million hectares, 6%). Other countries growing GM crops are Australia, China, India, Mexico, Paraguay, the Philippines, Romania, South Africa, Spain, and Uruguay.

In 2004, the global area covered by GM crops increased by 20%, from 67.7 million hectares in 2003 to 81.0 million hectares in 2004. During the nine-year period from 1996 to 2004, global area of GM crops increased more than 47 times, from 1.7 million hectares in 1996, with an increasing proportion grown by developing countries. In 2004 GM crops were grown by approximately 8.25 million farmers in 17 countries, up from 7 million farmers in 18 countries in 2003.

In terms of crops, soybean contributed the most to global growth of transgenic crops, followed by maize, cotton, and canola (rapeseed). (Source: Clive James, 2004)

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What is biotechnology?
Biotechnology is the culmination of more than 8000 years of human experience using living organisms to make products such as bread, cheese, curd, wine, and beer. Today modern biotechnology describes processes used in food, agriculture, healthcare, industry, environmental clean-up and conservation.

The word, 'biotechnology' is a contraction of ‘biological technology’ and came into general use in the mid-1970s. A common definition of biotechnology is the ‘application of scientific and engineering principles to processing of materials by biological agents to provide goods and services’. ‘Biological agents’ are microbes, plant and animal cells, enzymes, etc.

Biotechnology is an inter-disciplinary field with contributions from basic life sciences (molecular biology, breeding, biochemistry, genetics), engineering (chemistry, instrumentation and control) and information technology (bioinformatics, data management, data mining).

What is tissue culture?
Tissue culture is one of the biotechnology tools used for crop improvement. It is based on the principle that every cell has all the genetic information to make the whole organism. Cells or tissues from most parts of a plant can be isolated and grown in a laboratory to produce new plants. This technique is used to produce disease-free planting material (e.g. bananas, tea, trees) and to produce transgenic plants from individual cells that have taken up new genes.
How are moth resistant potatoes made?

The moth resistant potatoes are made through a process known as genetic engineering or genetic modification. There are several ways to introduce a new gene from one organism into another. The two most popular methods for inserting new genes into plants are biolistic and bacterial gene transfer (see Figure). The first involves a device called a ‘gene gun’. The gene of interest (DNA) is coated onto tiny gold or metal particles. These particles are shot onto plant cells. The gene comes off the particles and is either incorporated into the genes of the host cell (successful gene transfer) or is destroyed by the host cell (unsuccessful gene transfer).

The second popular method to transfer new genes into a plant uses a bacterium (Agrobacterium tumefaciens). This bacterium has been transferring genes into plants for thousands of years and scientists use its natural ability to get their genes into plant cells.

For both methods, the cells that have successfully taken up the new gene are grown into new plants using tissue culture methods. Successful GM plants have the new gene in every cell and can pass the gene onto their progeny through pollen, seeds or cuttings. Both of these gene transfer methods have produced successful GM crops.

The moth resistant potatoes were produced using bacterial transfer to specific varieties. Thus Bt plants are protected from caterpillar pests day and night, making them a more efficient delivery system for the Bt control proteins.
What is Bt insect resistance technology?

‘Bt’ stands for *Bacillus thuringiensis*, a common soil bacterium that is found in most soils in most parts of the world. The Bt bacteria have genes which produce proteins that selectively kill the caterpillars of moths, butterflies and some other insects including the Colorado potato beetle, cotton bollworm, and the Asian and European corn borers. Some of these are common plant pests which can have devastating effects on crop yields and quality. Much research is being done to access the agronomic value of these insecticidal proteins. To date, more than 200 (check this number) different Bt proteins have been identified with varying degrees of toxicity to different insects.

Traditionally Bt bacteria have been cultured and sprayed onto crops to help control caterpillars. Extensive safety research for pesticide registration in the 1950’s found the Bt proteins to be safe for human exposure and consumption. Bt pesticides have less environmental impact than broad spectrum chemical insecticides and they are registered for use on organic crops. The Bt proteins are susceptible to UV light damage and so are not effective for long. In addition, the proteins need to be eaten by young caterpillars before they bore into the plant, where they are protected from exposure to the insecticide.

Interestingly, in some parts of Africa, farmers have traditionally sprinkled soil into the leaf axes of maize as a protection against caterpillars. This may be coincidence, but it may also have worked if the hatching moth caterpillars were exposed to Bt in the soil as they bored into the plant stalks (pers. comm., Zimbabwe and Zulu farmers). Gene transfer of Bt genes into plants enables the plant to produce a small amount of Bt protein in each cell. The Bt protein produced by the plant does not get washed away, nor is it destroyed by sunlight. The caterpillars are exposed as soon as they begin to feed on the plant, Thus Bt plants are protected from caterpillar pests day and night, making them a more efficient delivery system for the Bt control proteins.
What is the difference between conventional plant breeding and plant biotechnology?

GM crops are very similar to conventional crops. They serve the same purpose: to produce superior food, feed and fibre and be easy to grow. The difference lies in how breeders obtain the characteristics to achieve this.

Traditional plant breeding uses the random mixing of thousands of genes between two genetically different but related plants in order to get new, desired traits. With gene transfer, breeders choose the specific characteristics they want and add these individually to a crop. The difference between these two techniques is dramatic.

Imagine trying to add one word of English to a Zulu dictionary. With traditional plant breeding, you’d have to mix both dictionaries together and hope that the word you wanted ended up in the Zulu version. Of course, lots of other words you weren’t interested in would have been added at the same time. The breeder then works meticulously to remove as many of the unwanted ‘words’ as possible before the book can be used. With genetic engineering you would find the exact word you needed and add just that word to the Zulu dictionary. Plant biotechnology allows breeders to identify and move single, specific characteristics they want – it is streamlined, efficient, faster and produces effective results.
Are moth resistant potatoes safe to grow and eat?

The moth resistant potatoes have been evaluated in South Africa at up to 6 locations over the last 4 years and evaluations are on going. Safety tests have also been conducted in the laboratory, and will complete the safety assessment following internationally recognized guidelines. All the data collected so far suggest that the moth resistant potatoes are as safe to eat as their conventional counterparts.

Governments around the world have developed, or are developing, national biosafety systems to help ensure that GM crops are used responsibly and that they will be safe for human health and the environment.

All GM crops have to undergo a safety assessment before they can be grown and used. This is called a biosafety review and is coordinated by governments. The result is either permission or refusal of permission to use a specific GM crop and the products derived from it.

The safety review covers three areas (see table): details on the changes in the GM crop relative to the conventional varieties; an assessment of the environmental impact of the GM crop in the release environment; and an assessment of the food and feed safety of the GM crop and any products derived from it. In addition, some governments review non-safety impacts, i.e. socio-economic issues.

The safety is reviewed by one or more groups of scientists that are independent of the developers of the GM crop. These scientists check that the information submitted on the safety of the crop is scientifically accurate and that all the correct questions about safety have been asked and answered. If they want more information they ask for it.

When the review scientists are satisfied that the GM crop will be safe for the environment and for human health, they recommend that the crop be approved for use. If they feel that the GM crop is unsafe, or if they feel there is not enough information to indicate that it is safe, they will recommend that it is not approved for use.

In some countries the scientific reviewers are the decision makers and the GM crop will be approved or rejected based on its safety. In other countries, a separate body makes the final decision on whether a GM crop will be approved. They consider the safety findings of the scientific reviewers and may also consider non-safety issues of relevance such as the social or economic impact of using the GM variety.

After a decision is made, approved products can be used, marketed and grown. Regulators may require monitoring for a specific safety concern after an approval. For this, the applicant monitors according to the regulators requirements and keeps the regulator informed. After several months or seasons of safe use the requirement for post-market monitoring will be removed.

South Africa has a functioning biosafety review system that is described in more detail elsewhere in this handout. It involves several ministries and the review process allows the regulators to consider human safety, impact on the environment and socio-economic impact before decisions are taken.

Crop varieties are better suited to some growing areas than others and the same is true for GM crops. In South Africa agronomic attributes of GM varieties are tested in variety trials undertaken at several locations.
**Some safety and non-safety considerations in the approval of GM crops**

<table>
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<th>Core studies:</th>
<th>Environmental Impact</th>
<th>Socio-economic impact</th>
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<td>Host plant history of use</td>
<td>Impact on other living organisms</td>
<td>Access</td>
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<tr>
<td>Gene donor history of use</td>
<td>Biodiversity</td>
<td>Appropriateness</td>
</tr>
<tr>
<td>Molecular changes</td>
<td>Invasiveness / Weedingness</td>
<td>Economic empowerment</td>
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<tr>
<td>New gene products</td>
<td>Non-target organisms</td>
<td>Poverty alleviation</td>
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<td>Genetic stability</td>
<td>Pollen flow</td>
<td>Vulnerable communities</td>
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<td>Inheritance</td>
<td>Horizontal gene transfer</td>
<td>Heritage and tradition</td>
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<td>Ethics and choice</td>
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**Are GM crops regulated in South Africa?**

Yes. South Africa has had guidelines for the safe development of biotechnology products since the mid-1980’s. The country had an interim approval mechanism for activities with GMOs from 1989 to 1999, when the GMO Act (15, 1997) was implemented. The Act regulates all activities with GMOs and the process for applications is illustrated in the Figure.
Diffuse light potato storage trial

Safety and Regulation

Are there concerns about moth resistant crops?

A number of concerns are investigated before insect resistant crops are approved for general use. Concerns associated with the use of insect resistant crops include:

- the potential for harming non-target organisms,
- the development of resistance in populations of pests, and
- the potential movement of genes from GM crops to other plants which might affect the ecological balance.

These concerns merit continued attention on a case-by-case basis in order to ensure that the moth resistant potatoes have the maximum positive impact with the minimum risk to agriculture and biodiversity. Careful use of insect resistance potatoes will help ensure their usefulness and availability over a long period of time. Other Bt genes have been successfully used in cotton, maize and potatoes. They have potential applications in eggplant, tomato, sugar and many other crops and trees attacked by caterpillars. As they are used more, the chance of insect resistance developing can increase.

Is food and feed derived from moth resistant potatoes safe?

The moth resistant potatoes must have a food and feed safety approval before they can be used. The food and feed safety review for moth resistant potatoes is currently being undertaken. This review considers all foods and feeds derived from the crop. It considers composition, nutrition, allergenicity and toxicity. Potatoes have natural glycoalkaloid toxins, which have been decreased by traditional selection and breeding processes. The levels of glycoalkaloids will be tested in moth resistant potatoes to be sure that the new genes have not caused an increase in these compounds.
What risks were investigated for moth resistant potatoes?

A summary of some of the considerations is given here.

Safety of the gene products

✓ Major food safety authorities, including the European Food Safety Authority, have approved the antibiotic marker that is used in moth resistant potatoes. This marker gene has been approved 36 times for food and feed use in 12 crops, including potato (AGBIOS database). These approvals have come from Argentina, Australia, Canada, China, the EU, Japan, Mexico, Philippines, South Africa, Taiwan and United States.

✓ Analysis of the new protein sequence indicates that the insect control protein is not similar to any known human allergen or a toxin.

Food and feed safety

✓ The moth resistant potato nutrition and composition is the same as in the convention- al variety.

✓ The new proteins show no similarity to known allergens or toxins.

Environmental impact

✓ Insect control genes are already common in soils. If present in local soils, the gene will be no more readily available for gene transfer to other organisms than it already is.

✓ The impact of the moth resistant potatoes on non-target insects and other species is considerably less than the impact of current spraying protocols. Safety data show that the gene used in moth resistant potatoes does not impact negatively on non-target species.

✓ Pollen and seed production in potato varieties is limited and this, plus the absence of sexual compatibility in wild relatives greatly limits gene flow to wild relatives or neighbouring farms. Should gene flow occur by outcrossing of pollen, the new host plant will only be advantaged if it under heavy pressure from potato tuber moth or another lepidopteran species.

✓ Potatoes are not considered to be weeds in South Africa and insect resistance is not expected to give plants new weediness or invasive characteristics.

Socio-economic impact

✓ Insect resistance management will take into account the presence of existing natural refugia and the volumes of moth resistant potatoes grown in an area.

✓ Distribution will be the same as for conventional varieties.

✓ Farmers will remain free to choose the varieties they wish to grow.

✓ Plantings of conventional and GM varieties will depend on markets.
What are the potential benefits of GM crops?

In developed and developing countries, including South Africa, the use of GM crops has resulted in significant benefits. These include:

- Reduced use of pesticides
- Reduced use of ploughing and fossil fuels
- Reduced production costs
- Improved environment (air, water, soil)
- Improved worker health
- Easier crop management
- Higher crop yields
- Increased farm profit

The first GM crops have proved their ability to lower crop production costs. The ‘second generation’ GM crops feature improved nutrition and quality. These crops will have more direct benefits for consumers. Examples include:

- Rice enriched with iron and pro-vitamin A
- Potatoes with high quality starch and higher protein content
- Edible vaccines in food and feed crops
- Maize enriched with vitamin A and iron
- Healthier oils from soybean and mustard.

What are the potential risks of using moth resistant potatoes?

The data collected during the four years of field trials have not identified any hazards associated with the use of moth resistant potatoes. These data evaluate food and feed safety, environmental impact and socio-economic impact. The moth resistant potatoes must be considered as safe as conventional potato varieties to grow, process and eat before approval will be sought for their use.
What are the potential benefits of moth resistant potatoes?

Four years of field trials in six locations in South Africa have shown that moth resistant potatoes have good built-in protection against potato tuber moth infestations. It is expected that the benefits of using moth resistant potatoes will include:

- Reduced pesticide use for stored potatoes
- Better insect protection for small-scale farmers who do not have access to pesticides
- Better ability to store potatoes, including seed potatoes
- Easier management of potato crops
- Environmental renewal in potato fields resulting from reduced pesticide use
- Improved human health resulting from reduced pesticide use.

What are the potential risks of GM crops?

All technology comes with risks. In order to access the benefits of technology the risks need to be understood and managed, e.g. insulating electricity cables manages the risk of electrocution from electrical current in live wires. In the case of GM crops, scientists identify potential risks and eliminate unlikely risks for each new crop. Some potential risks that have been considered for specific GM crops include:

- Unintentional introduction of allergens or anti-nutritional factors into foods that may impact on their safety.
- Movement of transgenes from cultivated crops into wild relatives that may disrupt the ecological balance of the release environment.
- Development of pest resistance to GM crops that may result in loss of a useful technology.
- Unintended impact on non-target organisms that may upset ecological balance.

Where GM crops have been approved for use, any identified risks are managed, e.g. refugia are planted to slow the development of pest resistance to Bt cotton. These management requirements are set by the developers and the regulators. Over the last 10 years, risk management has prevented any of the potential risks becoming problems in approved crops. The moth resistant potato safety data thus far show none of these potential risks. If the testing indicates any unacceptable risk, the moth resistant potatoes would not be approved, nor would they be submitted for approval.

There are also potential socio-economic problems that are associated with the introduction of improved planting material, but these are not specific to GM technology, for example, poor access to new technology; high costs of planting materials, loss of traditional knowledge through adoption of new technology, etc. These con-
A Basic Biotechnology Glossary

Biotechnology: A set of techniques that use plants, animals and microbes to make new products or improve existing products.

Bt: An abbreviation for Bacillus thuringiensis, a common soil bacterium that produces proteins which kill selected insects. It has been used as a biopesticide for over 50 years.

DNA: A molecule which stores genetic information and is found in the cells of plants, animals and microbes.

Gene: A length of DNA that produces a specific protein. Genes are inherited from parents.

Genetic engineering / genetic modification (GM): The deliberate modification of specific genes in plants, animals and microbes by man.

Genome: The entire set of genes in a plant, animal or microbial cell.

Gene transfer: The movement of a new or altered gene into a plant, animal or microbe. Gene transfer results in a transgenic plant, animal or microbe.

GMO: A genetically modified organism is a microbe, plant or animal that has received one or more new or modified genes using gene transfer techniques.

Modern biotechnology: The use of genes to improve plants, animals and microbes for the production of new products.

Moth resistant potato: A genetically modified potato variety that has built-in protection against potato tuber moth and so requires less pesticide treatment.

Traits: Inherited characteristics, such as size, shape, taste, colour, yield and tolerance or resistance to disease.

Transgene: A gene that has been transferred into a plant, animal or microbial cell in a laboratory.