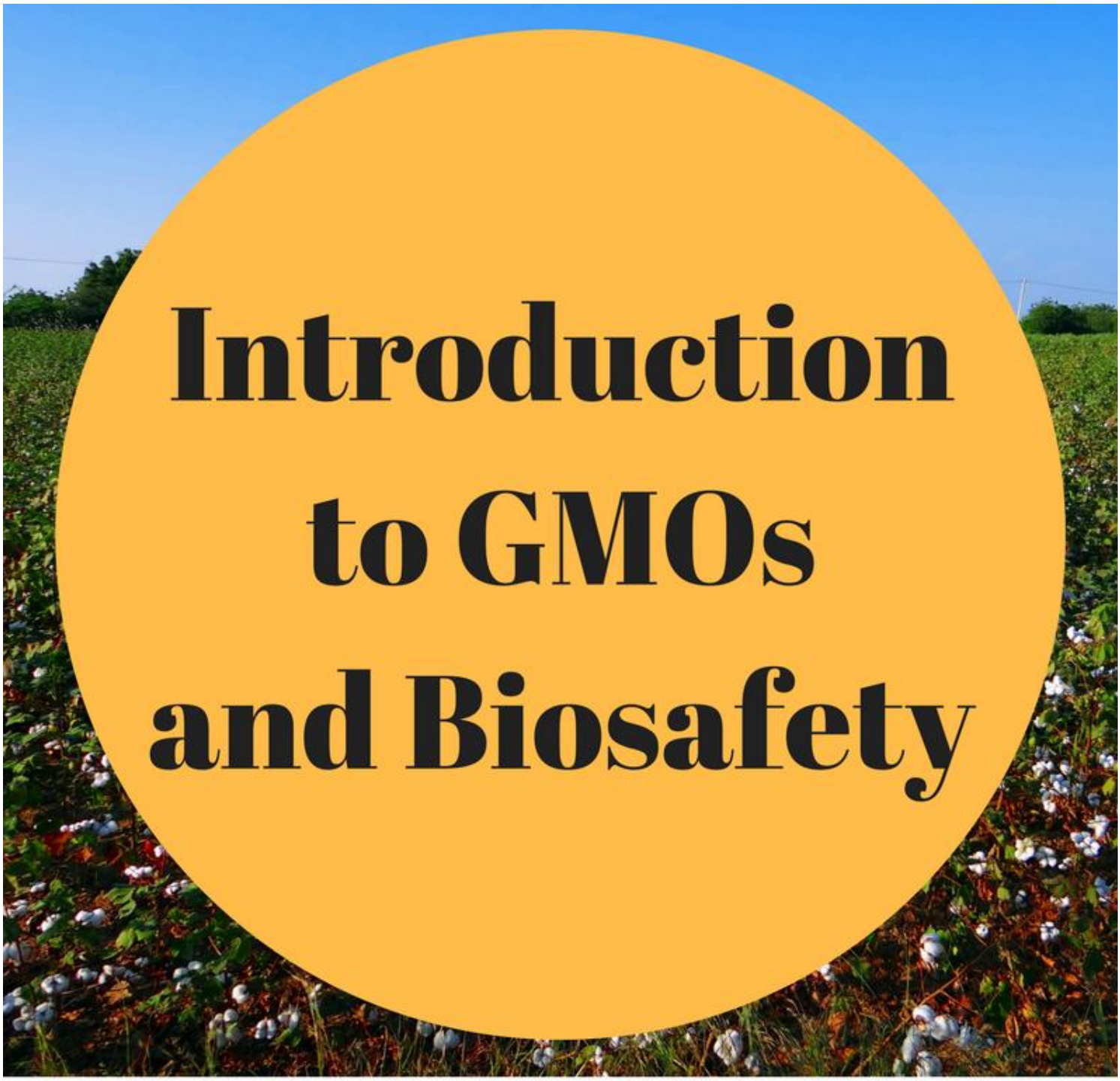


Introduction to GMOs and Biosafety

PELUM ASSOCIATION

SWAZILAND

Supporting ecological land use management in Swaziland

Table of Contents

1. Introduction

GMOs are a relatively new science and their long-term effects on environment and human health have increasingly been revealed to be negative. That is why they pose such a serious threat to small scale farmers livelihoods across the globe as well as human health and the environment we rely on to sustain life.

This Training Manual is aimed at PELUM Member organizations that work with small-scale farmers across the country as well as Policy makers and legislators. This manual can be used by PELUM member organizations to train their staff as well as the farmers that they work with in the field.

Swaziland is currently under pressure to introduce GMOs into the country because a majority of people have got very little or inaccurate information about GMOs' benefits to improve the country's food production. The farmers who are not aware of the dangers of GMOs are pushing for the adoption of GMO cotton in the country in the hopes that these GMOs will give them greater yield while reducing costs of production. However, the truth is that GMOs do not work in feeding the hungry world; instead they divert money and resources that would otherwise be spent on more safe, reliable, and appropriate technologies.

2. What is a GMO?

A GMO is a genetically modified organism. It can be a plant, animal, microorganism or other organism whose genetic makeup has been modified in a laboratory using genetic engineering. Most GMOs have so far been made by extracting a gene from one organism and then inserting it into the genes of the target organisms. This relatively new science creates unstable combinations of plant, animal, bacterial and viral genes that do not occur in nature.

Even newer techniques, that evolved just very recently, such as 'Genome Editing' are also now being employed. They do not necessarily take genes from one organism and put them into another, but instead involve smaller alterations of the genetic material of an organism through the use of biotechnology. This process could occur naturally through natural spontaneous mutation but this process could take thousands of years naturally. The challenge with these new GMOs is that there can often be a lot of unwanted and unpredictable off- target effects.

Four GM crops account for 99% of worldwide GM crop hectarage. These are soy (50%), maize (30%), cotton (14%), canola(5%) and

2.1 The difference between traditional and modern biotechnology

People have been breeding animals and new varieties of plants for hundreds of years to develop or avoid certain qualities, for example roses that are farmed to give us a wider range of colours and to make them more resistant to disease.

People all over the world have also been preparing products, such as beverages, sour milk, cheese, vinegar, wine and bread since the beginning of recorded history of mankind without knowing that microorganisms were involved in these processes. For centuries, yeasts, moulds, and lactic acid bacteria have been used to preserve milk, fruits and vegetables, and to enhance the quality of life with the resultant products.

Microorganisms were, for the first time, used to produce some organic compounds like citric acid after the First World War. Microorganisms were also later used to produce antibiotics. In all these processes only the natural capabilities of the microorganisms and cells were exploited. These activities are now often referred to as old or traditional biotechnology.

Modern biotechnology refers to the application of recently developed skills in microbial and biochemical technology to force the biological systems and processes to happen as humans want them to.

2.2 The difference between GMO and LMO

LMO = Living Modified Organism

GMO = Genetically Modified Organism

In general, the term living modified organism is functionally the same as genetically modified organism.

2.3 The difference between GMO and a hybrid variety

GM variety is an organism with a modified genome through genetic engineering technology inside the lab.

Hybrid variety is an offspring produced by controlled sexual reproduction between two organisms by the breeder. It relies on natural breeding of crops.

Exercise 1

- Give examples of traditional biotechnology in everyday products that you use.
- Name some examples of different GMO products.

3. How is a GMO made?

Step 1: Identifying a trait of interest

To identify a desirable new trait, scientists most often look to nature.

Step 2: Isolating the genetic trait of interest

Comparative analysis is used to decode what part of an organism's genetic makeup contains the trait of interest...

Step 3: Inserting the desired genetic trait into a new genome

Altering the genome of plant seeds is difficult due to their rigid structure. Many biotech companies use 'gene guns' that shoot metal particles coated with DNA into plant tissue.

Step 4: Growing the GMO

After a genetic trait has been successfully inserted into an organism's genome, the modified organism must then be able to grow with its newly engineered genome.

Step 5: Checking

GM plants are checked by growing the whole plants, allowing them to turn to seed, planting the seeds and growing the plant again, while monitoring the gene that has been inserted. This is repeated several times. This is done to be sure that the new genes are working as they should.

4. History of GMOs

In Swaziland, even though GMO crops are not yet cultivated, relying on imported maize has meant that a big part of our food is infiltrated by GMOs. However, it's not difficult to think back to a time when food was simpler and healthier. How did we get to the point of genetically modified organisms infiltrating so much of what we eat?

1935 – DNA Discovered

Russian scientist Andrei Nikolaevitch Belozersky isolates pure DNA.

1973 – Recombinant DNA Created

The idea for man-made DNA, or rDNA, comes from a grad student at Stanford University Medical School. Professor Herbert Boyer and a few of his biologist colleagues run with it.

1975 – Asilomar Conference

A group of biologists get together with a few lawyers and doctors to create guidelines for the safe use of genetically engineered DNA.

1980 – First GMO Patent Issued

A 1980 court case between a genetic engineer at General Electric and the U.S. Patent Office is settled by a 5-to-4 Supreme Court ruling, allowing for the first patent on a living organism. The GMO in question is a bacterium with an appetite for crude oil, ready to gobble up spills.

1982 – FDA Approves First GMO

Humulin, insulin produced by genetically engineered E. coli bacteria appears on the market.

1994 – GMO Hits Grocery Stores

The U.S. Food and Drug Administration approves the Flavr Savr tomato for sale on grocery store shelves. The delayed-ripening tomato has a longer shelf life than conventional tomatoes.

1996 – GMO-Resistant Weeds

Weeds resistant to glyphosate, the herbicide used with many GMO crops, are detected in Australia. Research shows that the super weeds are seven to 11 times more resistant to glyphosate than the standard susceptible population.

1997 – Mandatory Labels

The European Union rules in favor of mandatory labelling on all GMO food products, including animal feed.

1999 – GMO Food Crops Dominate

Over 100 million acres worldwide are planted with genetically engineered seeds. The marketplace begins embracing GMO technology at an alarming rate.

2003 – GMO-Resistant Pests

In 2003, a BT-toxin-resistant caterpillar-cum-moth, Helicoverpa zea, is found feasting on GMO BT cotton crops in the southern United States. In less than a decade, the bugs have adapted to the genetically engineered toxin produced by the modified plants.

2011 – BT Toxin in Humans

Research in eastern Quebec finds BT toxins in the blood of pregnant women and shows evidence that the toxin is passed to foetuses.

2012 – Farmer Wins Court Battle

French farmer Paul Francois sues Monsanto for chemical poisoning. He claims that this was caused by the pesticide Lasso, part of the Roundup Ready line of products from Monsanto. Francois wins and sets a new precedent for future cases.

2014 – GMO Patent Expires

Monsanto’s patent on the Roundup Ready line of genetically engineered seeds will end in two years. In 2009, Monsanto introduced Roundup 2 with a new patent set to make the first-generation seed obsolete.

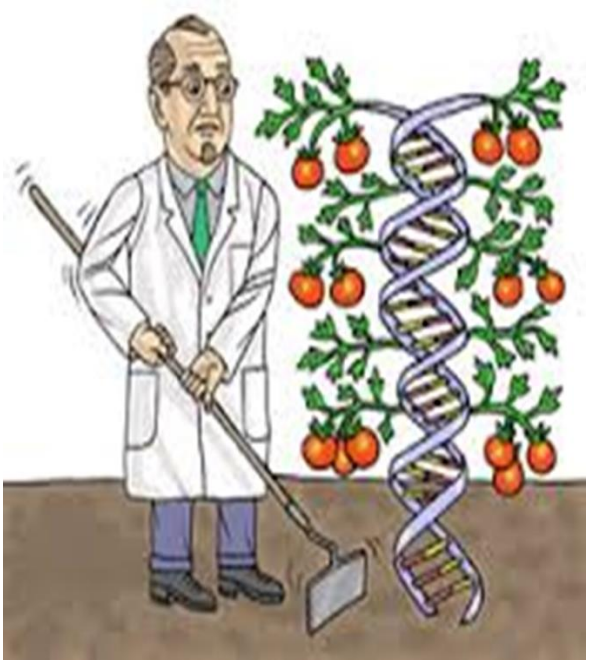
5. Why do we use GMOs?

Scientists are constantly searching for solutions to help feed a hungry planet with an increasing population. Some theories have said that genetically modified crops would enable farmers to produce more food, while at the same time reducing the need to use herbicides and pesticides.

Other reasons for using genetic modification is that traditional methods of breeding animals and plants involve mixing thousands of genes, genetic modification allows just one individual gene to be inserted into a plant or animal to change it as wanted. And the newer techniques allows even smaller alterations of the genetic material of an organism through the use of biotechnology.

In other words, genetic modification in theory, allows us to produce plants, animals and micro-organisms with specific qualities more accurately and efficiently than through traditional methods (some examples are given below). It also allows genes to be transferred from one species to another to develop characteristics that would be very difficult or impossible to achieve through traditional breeding.

- **Pest Resistance**
- **Herbicide Tolerance**
- **Viral Resistance**
- **Drought Resistance**
- **Increased Nutritional Value**
- **Improved Fruit**
- **Altered Ripening**
- **Increased yield**



5.1 Pest resistance

Cotton and maize have been modified to incorporate Bacillus thuringiensis (Bt) genes, producing proteins that are toxic only to larval pests. Farmers had previously applied the toxin directly by spraying the crops. The supposed benefits of the 'Bt cotton' are a reduction in pesticide use, an increase in yields and profits, and health benefits for farm workers who often apply pesticides without protective clothing.

5.2 Herbicide tolerance

Some GM crops have been engineered to be "roundup ready" resistant meaning they can withstand the herbicide glyphosate. Farmers can therefore spray the whole field with glyphosate and all other vegetation except the GM crops will be eradicated. More recently, due to weeds developing resistance to glyphosate, GM crops have been engineered to be tolerant to other herbicides, or even multiple herbicides, including 2,4-D, glufosinate and dicamba.

5.3 Drought tolerance

An example: A gene from a plant which can survive prolonged water stress in desert conditions has been introduced into rice. This allows rice to produce a sugar that protects the plant during dehydration, allowing it to survive periods of drought.

5.4 Increased nutritional value

Another proposed benefit of GMO crops is that they can be engineered in ways that enhance their nutritional content. Some examples of this include soybeans with better fatty acid profiles, golden rice with increased beta-carotene (Vit. A)(Figure 1), and other crops with enhanced levels of iron and zinc. These enhancements were designed to produce healthier products and offer new opportunities to increase nutrition availability in developing countries.

Figure 1: Yellow Rice that has been fortified with Vitamin A.

5.5 Increased yield

Supporters of the technology claim that farmers will enjoy increased productivity and yields in the fields if they grow GM crops. “Crop yields have increased by 21% on average because of GM Technology. This is due to more effective pest control and therefore, lower crop damage. Yield and farmer profit gains are higher in developing countries than in developed countries.” (Klümper & Qaim, 2014, pp. 4-5).

Exercise 2

- What benefits have you heard of with regards to GMOs?
- Where did you get this information?
- What are your thoughts on these benefits?

6. Negative Impacts of GMOs

The use of genetically modified plants and animals has already become commonplace today without many people being aware of it. The lack of consumer consent in the choice to eat genetically modified foods creates an ethical dilemma.

Over the past few years, several countries have completely banned GMOs and the pesticides that go along with them, and they are doing so for a reason.

By mixing genes from totally unrelated species, genetic engineering unleashes unpredictable side effects. Moreover, irrespective of the type of genes that are inserted, the very process of creating a GM plant can result in massive collateral damage that produces new toxins, allergens, carcinogens, and nutritional deficiencies. With regards to the newer techniques such as gene editing, although no two species are involved, the process can still yield unpredictable side effects.

Also, cumulative effects of GMOs are important to take into consideration. Small genetic changes in plants may produce even larger ecological shifts, meaning that there is potential for GMO´s to

become persistent and weedy in agricultural conditions, since they are modified to be resistant to some modern agricultural techniques.

6.1 Failure to yield

Although Monsanto and other multinationals boast that GM seeds increase the yield sizes, the truth of the matter is different. The difference within the development rates of yield sizes in various crops before and after the introduction of GM seeds shows no correlation to such statements. Many GM crops got even lower yields than non-genetically modified counterparts.

In other words, GMOs do not work against feeding the hungry world. On the contrary, GMOs divert money and resources that would otherwise be spent on safer, reliable, and appropriate technologies especially considering that the majority of the world's population is fed by small scale farmers.

6.2 Super pests

Some targets pests have developed resistance to the BT toxin. These new super pests become more and more difficult to kill which has led to stronger and more dangerous toxic pesticides being manufactured. This unnatural cycle cannot last forever though and the day will come when these super pests will prevail.

According to Navdanya International, these insects which have developed resistance to BT toxins used in GM seeds include the diamond black moth, Indian meal moth, and Colorado potato beetle which have all been recorded as resistant to BT toxins.

6.3 Super weeds

Herbicide-resistant weeds, often referred to as "super weeds", are nuisance plants that have developed resistance to one or more herbicides. Glyphosate-resistant weeds have been increasing with force during the last two decades, requiring even deadlier chemicals to be used. Over 30 new glyphosate-resistant weeds have been discovered within 1996-2015.

6.4 Emergence of secondary pests

When looking at the GMO experiences of other countries, it becomes apparent that secondary pests almost always become a major problem in BT fields.

South Africa Makhathini Flats: While target pest was controlled by BT, unexpected secondary pests were experienced by some farmers. Farmers were already dependent on credit but BT made it worse by increasing their exposure and risk.

Uganda: Open field trials on BT cotton in 2009 and herbicide resistant cotton initiated. Trials did not go well. Intensive management required due to secondary pests.

India: Whitefly infestation on BT cotton led to farmers returning to Indian varieties. This infestation combined with unfavourable weather conditions led to farmer suicides.

6.5 Increased use of chemicals

Opposite to what has been advertised, the statistics do not support the claim that the use GM seeds decreases the use of chemicals in agriculture. In fact, in India, pesticides are used even much more than before.

Herbicide and pesticide use in the USA has only increased since the introduction of genetically engineered crops. Resistant weeds and pests are proving out to be critical problems for many farmers relying on genetically engineered crops and, thus, the usage of herbicide and insecticide is projected to increase drastically in the coming years.

6.6 Loss of biodiversity

Monoculture or mono-cropping is the practice of growing the same crop year after year without rotating through other crops. It leads to a loss of different varieties of the crops that are needed for human nutrition. The crops also get more vulnerable to climate change, pests and diseases.

GM crops and monoculture deplete the soil of nutrients and, as a result, destroy biodiversity (in a healthy environment, each plant has unique contributions to the soil that maintain the balance and nourishment).

Glyphosate, the active component in GM crop herbicides, also does not biodegrade, which means it is continually accumulating in the environment without restraint, perpetually altering soil composition and contaminating natural resources. Furthermore, Glyphosate acts as a chelate (chemical structure) and binds a lot of nutrition in the soil and making it unavailable for plants.

6.7 Loss of non-target organism

Pest resistant GMOs (as for example bt-cotton or bt-maize) may be toxic to non-target organisms, for example bees and butterflies. Bees are hugely important in the pollination of many food crops, but are unfortunately extremely endangered by modern agricultural techniques, such as GM crops. In addition to insects, birds are also at risk from pesticides.

In May 1999, it was reported that pollen from Bacillus thuringiensis (BT) insect resistant maize had a negative impact on Monarch butterfly larvae. This report raised concerns and questions about potential risks to Monarchs and perhaps other non-target organisms. After that there has been concern that GMOs may affect non-target insects some of which may be beneficial in the fields.

6.8 Financial impacts

GM technology is actually more costly, especially to small scale farmers and this cost escalates in the long run. GM crops have cost the United States an estimated $12 billion in farm subsidies, lost sales and product recalls due to transgenic contamination.

In India, government regulations were shaped in favour of Monsanto, based on dishonest research data provided by Multinational corporations. Hence, the farmers were unable to purchase traditional seeds and forced to buy the GM seeds which were very expensive: 100 gram of GM seeds cost 15$, while the same price used to gain the farmer 1000 gram of traditional seeds. In addition, the farmers who bought the seeds are not allowed (by a contractual clause) to save the seeds for reuse after the first season. In other words, the farmers are forced to buy new seeds every season. Furthermore, the herbicides that accompany the seeds are also purchased form the same agri companies which means more money for them and more expenses for the farmer.

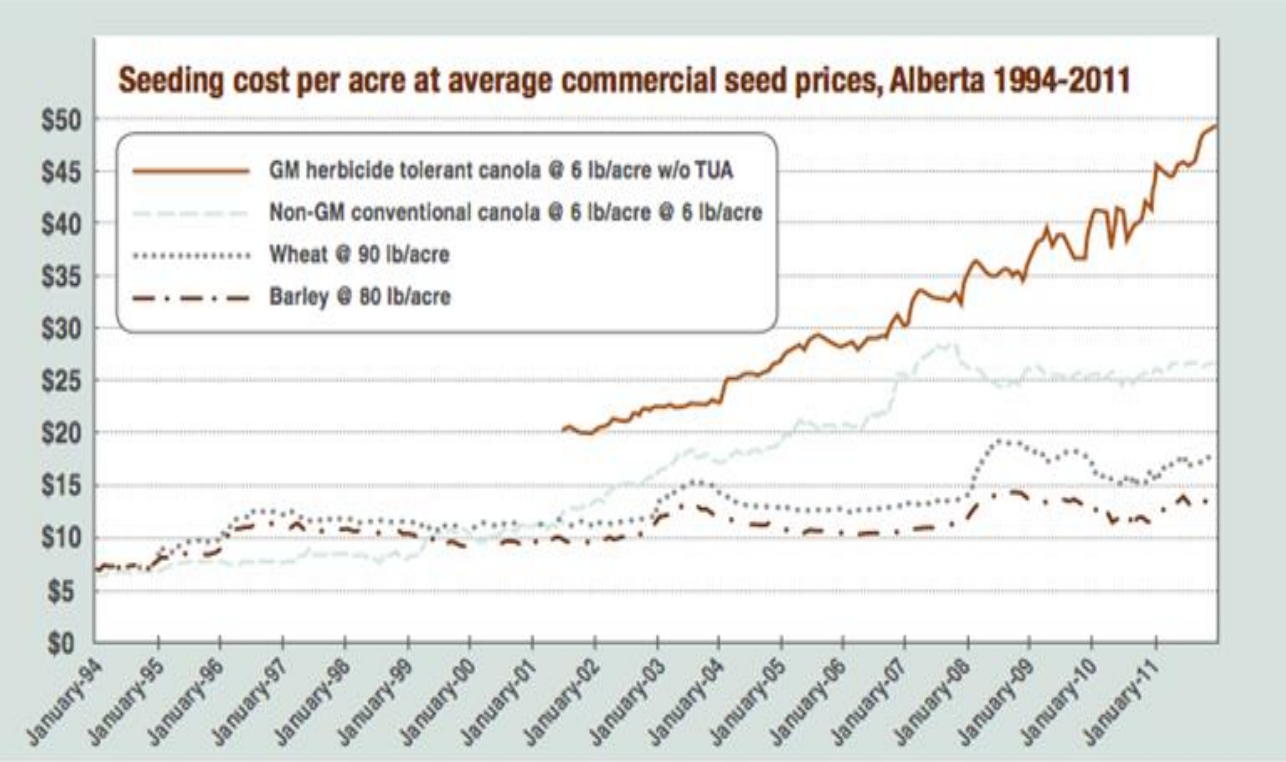


Figure 2: Rising cost of seed prices in Canada (National Farmers Union, 2013)

7. Human health and safety

Emerging research is pointing at GMOs as highly toxic and the chemicals associated with them, carcinogenic. We don't know enough about GMOs to deem them safe for human consumption and the little we do know warrants extreme precaution.

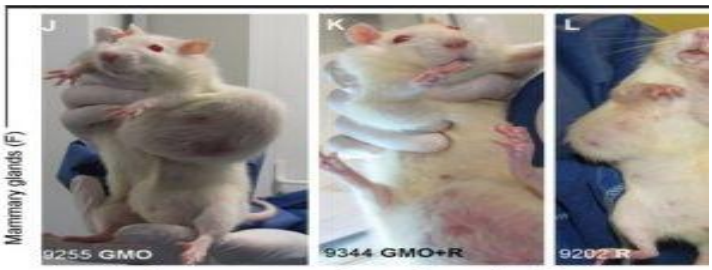
Many countries do not consider GMOs to be safe and have complete bans on the GMOs. So far it has been noted that the increased usage of herbicides and pesticides due to the adoption of GM seeds raise serious health concerns.

For example, herbicides and pesticides have been found in the blood of pregnant women and their foetuses. It has been found that higher exposure to pesticides during pregnancy is linked with the delayed growth of the foetus. Additionally, pesticides have also been linked with miscarriages and preterm deliveries. Some studies have also linked glyphosate to birth defects, Autism, Parkinson's and Alzheimer's.

GMOs are linked to toxic and allergic reactions in people, for example soy allergies rose by 50% after the introduction of GM Soy in the UK. They are also linked to the deaths of sick, sterile livestock, and damage to basically every organ studied in lab animals.

In recent years health professionals have also noticed the increasing number of bacteria that are resistant to antibiotics. Biotechnologists use antibiotic resistance genes as markers when inserting new genes into plants to test if the insertion has been successful. There is a danger that bacteria living in the humans could pick up an antibiotic resistance gene from a GM plant before the DNA becomes completely digested.

7.1 Seralini study



Seralini Rats develop hideous tumors after GMO Corn Diet.

A controversial paper that linked genetically modified maize to the development of tumours and other severe disease in rats, which was published in 2012 and retracted in 2013, has now been published again, by a different journal.

A post-publication review of the paper found that "the data were inconclusive, and therefore the conclusions described in the article were unreliable." However, Food and Chemical Toxicology,

another Journal, found “no evidence of fraud or intentional misrepresentation of the data”, according to the journal's publisher, Elsevier in Amsterdam.

Seralini’s team had found that rats fed for two years with a glyphosate-resistant type of maize (corn) made by Monsanto developed many more tumours and died earlier than the other control animals. It also found that the rats developed tumours easier when Roundup was added to their drinking water.

8. Examples of GMO’s effects on other organisms

Most of the world's GM crops are used as feed. The effects of GM feed on animals have not been adequately studied. According to the regulations, the safety of genetically modified plants must be tested by animal testing before they can be released to the market. As with animal experiments in general, it is also considered about safety tests for GM varieties, whether the experimental arrangements have been made convincingly and whether the results of the animals are reliable to prove the risks to humans. So, the GM feed may affect the health of animals and to the health of humans that eat their products.

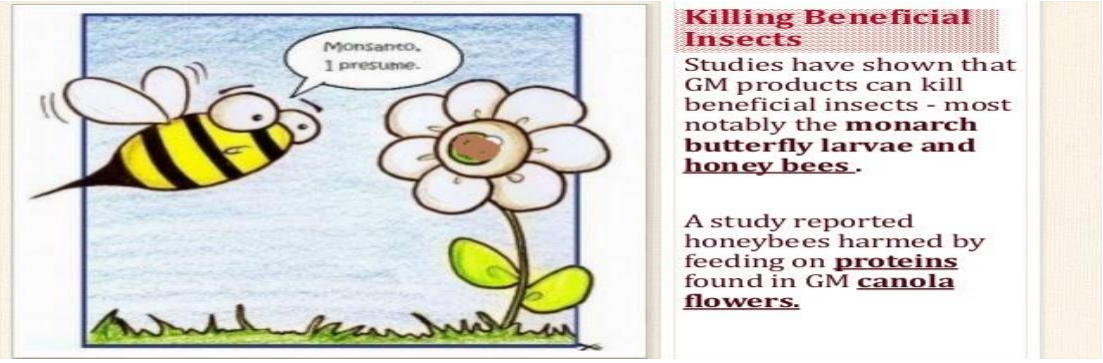
8.1 Cows

According to studies, the genes contained in crops have been detected in end-products of the animal feed system. The GM genes can be detected from the milk if the cow has eaten GM soy or maize.

8.2 Beekeeping

In the EU, there is a debate on how to treat pollen from genetically modified plants in honey products. Does the honey product become a GM product if it contains GM pollen? Bees will go to collecting grounds in the nearby fields, regardless of how they have been cultivated.

In some of the GM plants, cross-breeding of plants with wild plants and other crops has been prevented by making the pollen from GM plants sterile. Bees cannot identify sterile pollen and collect it as food for their larvae as usual. The nutritional value of sterile pollen is poor and because of its low protein content, when the bees eat it, their life spans are reduced and they become susceptible to diseases. (“Geenimuuntelu ja mehiläistenhoito”. GMO-vapaa website. < http://www.gmovapaa.fi > 7.2.2018)



9. Contamination and loss of traditional seeds

Another risk of GMOs is the contamination and eventual loss of traditional seeds. Even if a farmer does not use GMO crops, there is a risk of cross-contamination with GMO seed and it is impossible to fully clean up the contaminated gene pool. Contamination can be a catalyst for dramatic economic losses for farmers who face rejection from export markets that ban GMOs. Organic farmers suffering contamination can lose their organic certification and the premium they earn for their organic crop.

The inability of companies to properly separate GMOs from conventional varieties continues to threaten farmers. Additionally, a UK-based study found out that GM canola had contaminated a non-GM canola fields more than 26 kilometres away. Wind, insects, and even natural occurrences such as floods have been recorded to transport the GM pollen for many kilometres.

In Canada, the local canola seed growers can no longer guarantee that their seeds are GM-free because of GM contamination. Sources estimate that almost all canola grown in the country is now genetically modified. Therefore, the traditional canola seed has been lost in Canada. However, the contamination does not only endanger the existence of traditional seeds but also the livelihood of organic farmers in general.

10. Rights to food and pursuit of scientific truth endangered

Today, people are not given a proper chance to choose whether they want to eat GM food or not due to weak or non-existent labelling of the GMO products.

Additionally, the monopolization of the seed industry as well as the uncontrolled pollution of the GM seeds resulting to the widespread contamination of traditional seeds, are violating the rights of farmers and consumers (Canadian Biotechnology Action Network, 2015).

Additionally, Andrés Carrasco, a well-known professor of embryology in Argentina, found out that glyphosate has a lethal effect on amphibian embryos. He met a storm of opposition by media, politicians, and agribusiness sector but his research was eventually proven right and proper regulations were put in place. However, even with a happy end, this does show how the scientific truth is secondary if it threatens the future of GMOs (Canadian Biotechnology Action Network, 2015).

Fortunately, many scientists and scientific organizations are working against the GMOs and providing knowledge on the dangers of them such as the European Network of European Scientists for Social and Environmental Responsibility and the Union of Concerned Scientists (US-based) are among those organizations (Canadian Biotechnology Action Network, 2015, p. 32).

10.2 Effect on small-scale farmers

Because GMOs are new life forms, biotechnology companies have been able to obtain patents which means that they are the only one's authorized to sell and further develop the resulting products (seeds and herbicides). It is illegal to exchange such type of seed with other farmers or to use it for farmers own breeding. The farmers must buy the products each year thus becoming very dependent on these big multinational companies. These companies that make GMOs now have even the power to sue farmers whose fields are contaminated with GMOs, even when it is the result of inevitable wind transfer from neighbouring fields and through no fault of the farmers.

GMOs therefore pose a serious threat to farmer sovereignty and to the national food security of any country where they are grown. You cannot keep seeds from one harvest to regrow in the next planting season which has major financial implications for the small-scale farmer.

"If we, as a nation, withdraw our resources from plant breeding, then all new seeds will be owned and controlled by global agribusiness corporations. Ultimately, those who control the seeds control most of the food we eat. Do we want to grant that kind of power to Monsanto, Bayer and Dow Chemicals?" — National Farmers Union (of Canada).

Exercise 3

- Imagine what would happen if all agriculture production was in the hands of one multinational corporation eg. Monsanto.
- What kind of world would that be?
- What are your predictions?

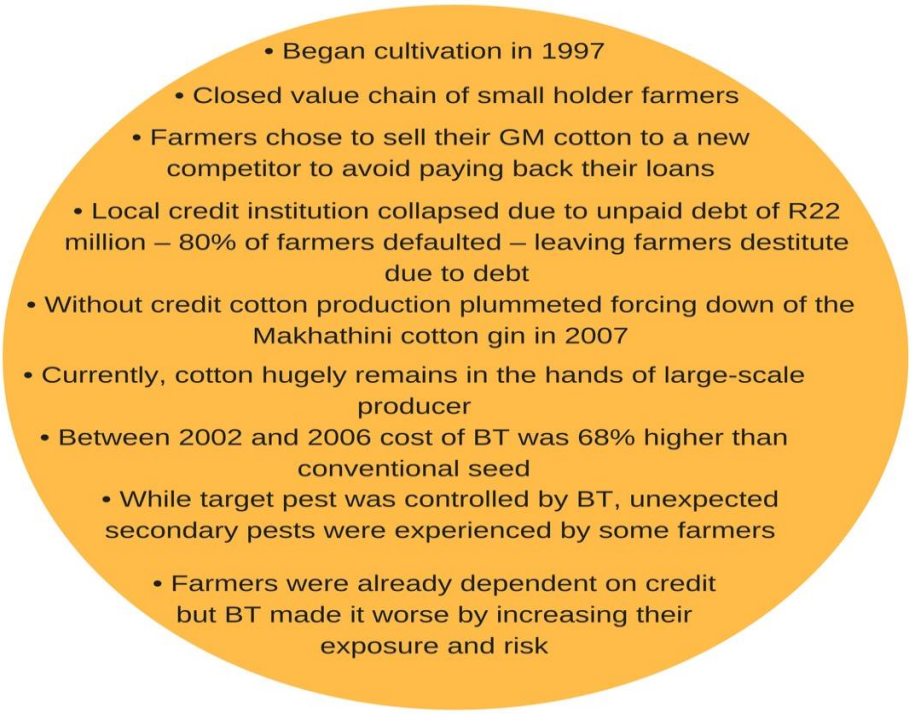
11. Case studies in Africa

South Africa is the largest producer of GM crops in Africa, producing mainly maize. Most of the maize producers are smallholder producers. Four African countries have grown GM cotton on a commercial basis –South Africa in 1997, Burkina Faso in 2008 and Sudan in 2012.

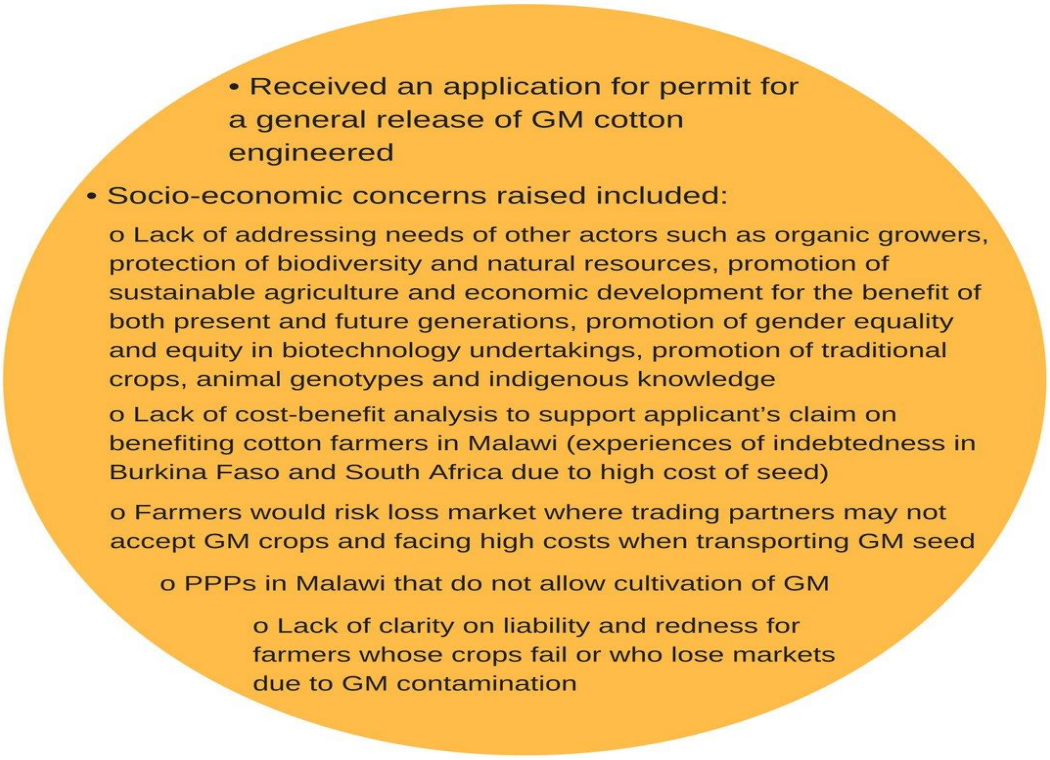
Today Africa's productivity is declining - while global productivity is increasing. Promise of improving productivity and reducing pesticide use through the adoption of GM cotton is compelling and has led to disregarding of alternative pest management mechanisms.

GMO trials have been undertaken in Uganda 2009, Kenya 2012, Cameroon (2012 greenhouse, 2015 open field trials) and in Ghana 2013. There are now ongoing trials in Malawi, Nigeria and Ethiopia.

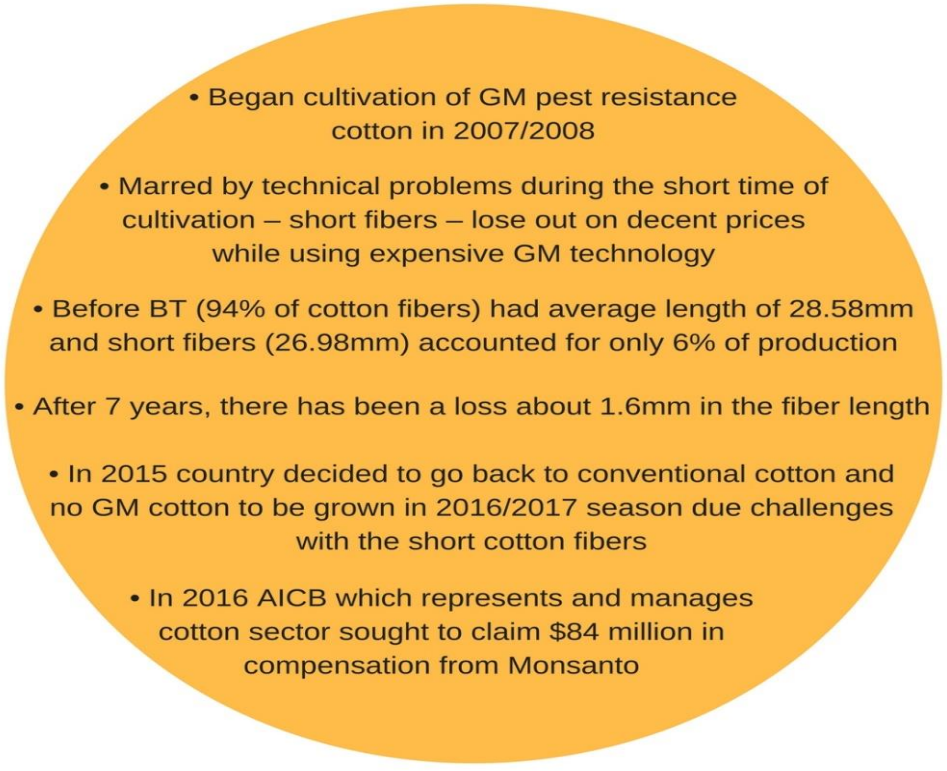
11.1 South Africa – Makhathini Flats



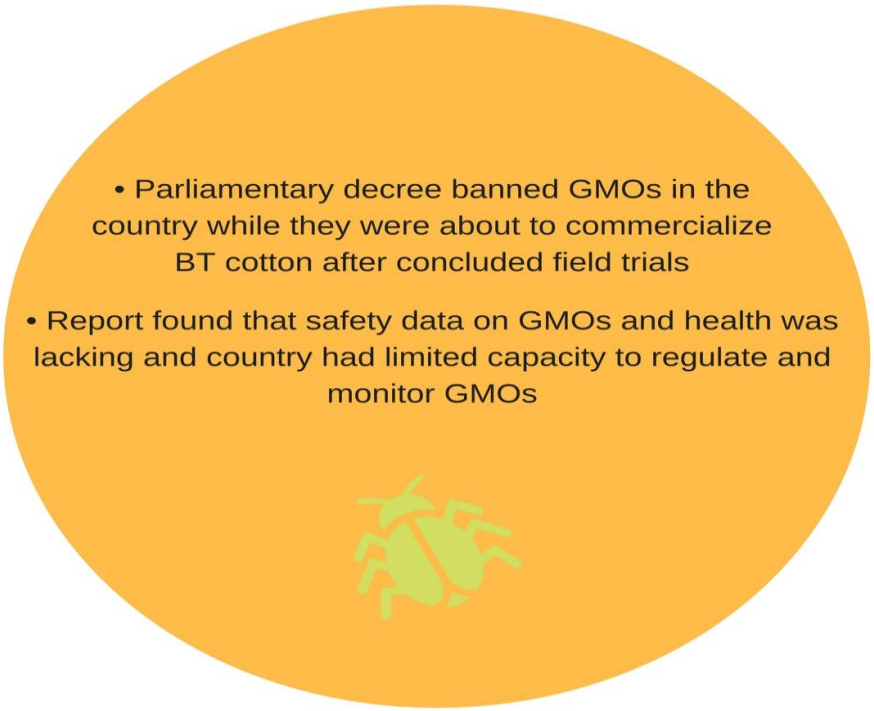
11.2 Malawi



11.3 Burkina Faso



11.4 Kenya



11.5 Uganda

12. India Case Study: GM crops linked to farmer suicides in India

In 1995, Monsanto introduced its BT technology in India through a joint venture with the Indian company Mahyco. In 1997-1998, Monsanto started open field trials of its GMO BT cotton illegally and announced that it would be selling the seeds commercially the following year. India has rules for regulating GMOs since 1989, under the Environment Protection Act. It is mandatory to get approval from the Genetic Engineering Approval Committee under the ministry of environment for GMO trials. The Research Foundation for Science, Technology and Ecology sued Monsanto in the Supreme Court of India and Monsanto could not start the commercial sales of its BT cotton seeds until 2002.

And, after the damning report of India's parliamentary committee on BT crops in August 2012, the panel of technical experts appointed by the Supreme Court recommended a 10-year moratorium on field trials of all GM food and termination of all ongoing trials of transgenic crops.

Monsanto's seed monopolies, the destruction of alternatives, the collection of super profits in the form of royalties, and the increasing vulnerability of monocultures has created a context for debt, suicides and agrarian distress which is driving the farmers' suicide epidemic in India. This systemic control has been intensified with BT cotton. That is why most suicides are in the cotton belt.

The highest acreage of BT cotton is in Maharashtra and this is also where the highest farmer suicides are. Suicides increased after BT cotton was introduced — Monsanto's royalty extraction, and the high costs of seed and chemicals have created a debt trap. According to Government of India data, nearly 75 per cent rural debt is due to purchase inputs. As Monsanto's profits grow, farmers' debt grows. It is in this systemic sense that Monsanto's seeds are seeds of suicide.

Exercise 4

- Can you list some products that you know of that contain GMOs?
- Putting cost aside, would you buy the GMO product or the non-GMO product?
- Why is that?

13. Swaziland and GMOs

Swaziland has a biosafety Act of 2012 to regulate the import, cultivation or use of GMOs and their products. Currently, to import GM products or living GMOs, seeds, a permit needs to be applied for. That is a thorough process that requires evidence of how safe the product or seed is (Risk assessment). Still, some farmers are bringing GM cotton and maize seed into the country illegally from South Africa because they have been informed that it will increase the yield and be much more cost effective.

Furthermore, Swaziland Environment Authority has allowed the Swaziland Cotton Board to conduct Confined Field Trials at several sites in the country where they are growing BT Cotton to test whether it is suitable for release into the environment.

There is also enormous pressure from the industry as well as the Cotton Board to have the farmers growing GMO cotton in the country and have even gone as far as lobbying legislators to support an amendment in our Biosafety Act.

A majority of Swazi's, not aware of the dangers of GMOs, are either pushing for the adoption of GMO cotton in the country in the hopes that these GMOs will give them greater yield while reducing costs of production, or complacent are not putting up sufficient objections to the technology.

14. What are the alternatives?

In Swaziland, what we need is a production system that sustains the health of soils, ecosystems and people. A system relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Ecological Land Use Management (ELUM) combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved in the ecosystem. ELUM seeks to sustain environmental stewardship, economic viability and social responsibility.

"The challenge of the 21st century is not to increase agricultural productivity, but to strengthen the resilience of our food production in the face of ever increasing stress on the system."

14.1 Agroecology

Agroecological farming recognizes the multifunctional dimensions of agriculture, as well as local and Indigenous knowledge and practices. This means farming that not only produces food, jobs and economic well-being, but also creates cultural, social and environmental benefits.

Agroecology also protects and provides ecosystem services like pollination, natural pest control, nutrient and water cycling and erosion control.

Knowledge-intensive & inclusive: Agroecology recognizes the value of formal scientific research and of advanced technological innovation. It also values dialogue and collaboration between researchers, farmers, indigenous communities and historically marginalized groups.

Resilient & adaptive: Agroecology improves the adaptive capacity of agroecosystems and reduces vulnerability to natural disasters, climate change impacts, and new and emerging environmental and economic system stresses and shocks.

14.2 Household food security (HFS)

Household food security exists when all the people living in the household have physical, social and economic access to sufficient, safe and nutritious food at all times that meets their dietary needs and food preferences for an active and healthy life (World Food Summit Declaration, 1996). Over time, it has become evident that increased agricultural production and rural incomes alone do not necessarily translate into stable, sustainable and adequate food consumption at the household level or improved nutritional well-being of individual household members. This is because when people focus entirely on increased production and income, they tend to neglect the environmental aspect hence overtime, the productivity declines due to unsustainable farming practices and ecological degradation.

We must realize that there are no easy solutions to the multifaceted problems and causes of household food insecurity and malnutrition. The goal is rather to develop better and more user-friendly tools and to sensitize staff, collaborators and policy-makers systematically on relevant concepts and practical ways of addressing HFS and nutrition.

14.3 Organic production as profitable enterprise

Organic farming is a method of crop and livestock production that involves much more than choosing not to use pesticides, fertilizers, genetically modified organisms, antibiotics and growth hormones.

Organic production is a holistic system designed to optimize the productivity and fitness of diverse communities within the agroecosystem, including soil organisms, plants, livestock and people. The

principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment.

One of the key benefits of Organic Farming is that it is safer and healthier for the environment and human health. Another major benefit is that there is a huge market for organic products and the profits for the farmers are much higher than in conventional farming. It may appear as though the high inputs in conventional farming lead to high outputs as compared to the low input organic farming which produces a lower output. However, the impact of conventional farming on the environment results in a gradual decline in productivity whereas the inputs used in organic farming are enduring in the soil and ecosystem yielding no adverse effects. Furthermore, organic farming inputs are cheaper for our small scale farmers as they use materials that are readily available on farm.

Exercise 5

- Separate into 2 groups and prepare for a debate. Given all the information that you have received, debate on the pros and cons of the technology.

15. Conclusions

GMOs have many weaknesses and disadvantages as well as critical threats and risks for farmers, consumers, and the whole world in general. At the very least, the situation is very confusing and unclear. In such a situation, it would be better to keep testing the GMOs in safe confinements and make sure that there are no threats to the people or the environment.

Many of the sources (especially pro-GM ones) compared GM farming to the conventional farming. However, the conventional way of farming is not the most effective farming method. The ecological and organic farming method is by far the most effective and, thus, the rightful competitor to the GM method.

16. References

ACB, 2015. Accessing Decision Makers. Presentation made during the African Biosafety workshop in Pretoria.

ACB, 2015. Cottoning on to the lie; the introduction of genetically modified cotton will harm, not help, smallholder farmers

Collective Evolution website. < http://www.collective-evolution.com >. 7.2.2018

Food and Agriculture Organization of the United Nations website. < http://www.fao.org >

GMO-vapaa website. < http://www.gmovapaa.fi >. 7.2.2018.

One Green Planet website. < http://www.onegreenplanet.org > 7.2.2018

Traavik T and Ching L. L . ed 2009, Biosafety First; Holistic Approaches to Risk and Uncertainty in Genetic Engineering and Genetically Modified Organisms. Chapter 34 pg 555. Public Participation in Biosafety Issues.

TWN &ACB 2017. BT Cotton in Burkina Faso; when theory does not match reality. Prepublication report.

Responsible Technology website. < http://www.responsibletechnology.org > 7.2.2018

Published by:

PELUM ASSOCIATION
SWAZILAND
Supporting ecological land use management in Swaziland

Truth support from:

Brot für die Welt

biorespect
Wir hinterfragen Biotechnik

Participatory Ecological Land Use Management (PELUM) Swaziland
c/o ACAT Lilima Swaziland
Mbuluzi Farm, Former Leprosy Settlement
P.O.Box 283 Mbabane Swaziland
E-Mail: coordinator@pelum.org.sz
Tel: +268 2401 1171 / +268 2401 1533
Fax: +268 2401 1709
www.pelum.org.sz
facebook.com/pelum.swaziland
instagram.com/pelumswaziland