CHAPTER 5

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Namibian Organic Association
Enabling Sustainable Organic Agriculture

IFOAM SOUTHERN AFRICAN NETWORK

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ORGANIC SEED AND PLANT PRODUCTION

5.1. Varieties characteristics

5.1.1. The importance of the correct varieties

The correct choice of seed varieties is essential to successful organic farming. Many of the modern cultivars are a result of breeding programmes that rely on high levels of inputs, especially water, synthetic water soluble fertilisers, synthetic pesticides, fungicides and herbicides. Consequently, their performance is not always optimal in organic systems.

On the other hand, varieties that cope with organic growing conditions can give higher yields and better quality crops under lower input organic conditions.

One of the world leading authorities on this, Professor Bernd Horneburg, wrote: "In paired organic/conventional selection experiments with wheat *(Murphy et al., 2007; Reid et al., 2011)* and maize *(Burger et al., 2008)* it has been demonstrated that the best genotypes for organic cropping are selected within the organic system.

Murphy et al. (2007) have demonstrated that the top yielding soft white winter wheat breeding lines in organic management did not correlate to the top yielding ones in conventional management in four out of five paired trials.

In the words of *Murphy et al. (2007)* 'With crop cultivars bred in and adapted to the unique conditions inherent in organic systems, organic agriculture will be better able to realise its full potential as a high-yielding alternative to conventional agriculture'. *(Horneburg 2011).*

One of the keys to obtaining good yields in organic agriculture is selecting the best performing varieties. This can be done by trialling many varieties and selecting from those that perform the best.

One should look for the following characteristics when selecting the best varieties:

- High yields
- Weed suppression
- Weed resistance
- Pest and disease resistance
- Low input
- Acceptable to the market
- Multiple varieties to extend the season

These characteristics will be covered in more detail in 5.3.

5.1.2. Understanding hybrids, open pollinated and genetically modified varieties

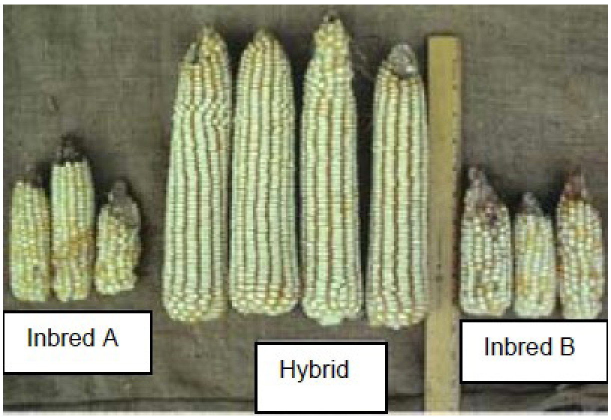
There is currently a debate in organic agriculture about whether to use hybrid or open pollinated varieties. IFOAM accepts the uses of hybrid seeds; however "IFOAM's position on development of organic seed production is to stimulate the importance of seed supply from the open pollinated varieties, traditional sources, home gardens and on farm seed, as diverse populations that have evolved in response to local pressures."

5.1.2.1. Hybrid seeds

Hybrids are created when two different varieties or accessions of plants are crossed and they create offspring with some characteristics of both parents. This occurs naturally all the time and is why they are allowed in organic agriculture.

Plant breeders have been hybridising new varieties for thousands of years. Since the beginning of agriculture, 10 000 years ago, farmers have selected natural hybrids for their improved characteristics and this has been one of the reasons for the continuous improvement and development of locally adapted varieties.

A very important critical reason why first generation (F1) hybrids are commonly used is due to a phenomenon known as hybrid vigour. The first generation tends to be more productive than either of the parents.



Parental inbred lines A and B and the hybrid AxB

The down-side is that when the seeds of the F1 hybrids are saved and planted, their offspring, the 2nd generation (F2), are highly variable and do not give consistent results. The best performing varieties of the F2 generation have to be selected and then self-pollinated (the variety is crossed with itself) to produce a 3rd generation (F3) that starts to stabilise. It might require further generations of self-crossing to make a truly stable line that reproduces consistently from seed.

5.1.2.2. Open pollinated

Open pollinated varieties are stable lines of accessions that come "true to type" (i.e. plants are the same type as their parent, which is often not the case for hybrids) from seed when they are pollinated by the same accession. These are preferred by many organic farmers as they can save the seeds and grow consistent crops from them.

Open-pollinated maize varieties

Open pollinated varieties can naturally hybridise with other varieties due to pollen drift if they are too close together in space and time.

5.1.2.3. Traditional varieties, land races and farmers' varieties

Traditional varieties or land races are those plants that have been developed by farmers and used traditionally for long periods.

These have been passed down through the generations from parent to child.

These varieties tend to be well adapted to the local conditions and are generally more resilient to climate extremes, weed pressure and low input farming systems.

Traditional seed saving

They tend to perform very well in good organic management systems.

Research by the Institute of Sustainable Development (ISD) in Ethiopia has shown more than 100% increases in yield when compost is applied to fields where the traditional varieties are grown. The composted yields were higher than when chemical fertilisers were applied *(Edwards, 2011).*

Unfortunately due to the introduction of improved hybrid varieties, thousands of these traditional varieties along with their tremendous genetic potentials are going extinct.

The loss of these varieties is the greatest of all the extinction events that is occurring around the world at the moment.

Equally critical is the loss of the knowledge about the specific characteristics and performances of these famers' varieties. Traditionally farmers would have a range of varieties that they knew would perform better in different soil types, different seasons and were resistant to various pests and diseases.

Fortunately, there are numerous groups around the world that are doing their best to conserve these valuable high bio-diversity accessions.

Organic farmers have always been actively involved in conserving traditional varieties of agricultural plants and animals. Many more varieties tend to be cultivated in organic systems than conventional systems due to its roots being based in traditional agriculture and the need for diverse rotation systems.

The advent of industrial agriculture has seen a massive decline in on-farm bio-diversity as these commercial systems focus on fewer and fewer varieties, to concentrate on uniformity in production to supply supermarket chains and brand lines.

Research by Pat Mooney and colleagues at the ETC group has identified this continuous decline in the bio-diversity used in our industrial farming systems. *"The industrial food chain focuses on far fewer than 100 breeds of five livestock species. Corporate plant breeders work with 150 crops but focus on barely a dozen. Of the 80 000 commercial plant varieties in the market today, well over ½ are ornamentals. What remains of our declining fish stocks comes from 336 species accounting for almost ⅔ of the aquatic species we consume" (ETC Group, 2009).*

The majority of the world farmers are involved in traditional farming systems, which clearly fit within the organic umbrella. These farming communities are responsible for conserving an enormous amount of unique farm-based bio-diversity.

When the ETC group researched the traditional systems that fit within the organic paradigm, they found that: "Peasants breed and nurture 40 livestock species and almost 8 000 breeds. Peasants also breed 5 000 domesticated crops and have donated more than 1.9 million plant varieties to the world's gene banks. Peasant fishers harvest and protect more than 15 000 fresh water species" *(ETC Group, 2009)*.

All farmers should be encouraged to trial and preserve as many of these accessions as possible.

5.1.2.4. Genetically modified organisms

Introduction to GMOs

Why are GMO seeds so different to what we know?

What are genes?
The smallest part of an organism is a cell. Microorganisms, such as bacteria, have only one cell whilst larger plants and animals have many cells that are combined together to make up their tissues, organs or structures.

Inside every cell we find DNA, which carries the full 'information' for how the organism will look, grow, function and reproduce. The DNA is inherited from the organism's parents. Genes are small sections that make up the DNA containing the codes for specific proteins. For example, a dog's DNA will ensure the dog looks like and behaves like a dog but a specific gene in the DNA will make the dog have white hair or brown hair.

What is genetic modification (GM)?
Genetically modified (GM) seeds have been created in a laboratory. The process of creating them is completely new and does not happen in nature. Since farming began, people have worked with nature to breed plants and animals to suit human needs. Usually, this breeding can only happen within the same "species" or family. For example, we breed a tomato with a tomato but we cannot breed a tomato with maize or with a pig.

In the last 30 years, scientists have used genetic engineering (GE) techniques, also known as genetic modification, to create plants and animals with novel (new and unique) characteristics. In genetic engineering, the 'genes' responsible for a specific characteristic (called traits) are taken from one organism and forced into the DNA of another organism. In this way, the characteristics of one species can be unnaturally bred into a completely unrelated one – across the boundaries between species and even plant and animal kingdoms. The resulting new species is called a genetically modified organism (GMO).

Genetic modification allows scientists to mix the genes of unrelated species.

The traditional foods that we know were developed by farmers over the last 10 000 years. We know that these foods are safe and which ones are likely to cause allergies because humans have been eating them for such a long time. These natural foods are part of our culture of eating and our bodies are adapted to them. The same is not true of GMOs. Scientists are not sure what impacts these new crops might have on our bodies or on the environment over time. It is just too soon to tell as the science is too new and not enough independent research is being done.

Once GMOs are sown and thus released into the environment they are impossible to control as they reproduce and spread. The pollen from plants drifts in the wind or are carried by insects to other plants. Seeds fall in fields and GM seeds spill from trucks and begin to grow on sidewalks. We often hear about products that have design faults, which must be returned to the factory because they do not work or are dangerous. However, if we find there are problems with GMOs, these cannot be returned to the lab. GMOs continue to spread and we are not able to undo the damage that is caused.

GM seeds are patented

Because scientists have inserted novel genes into the GMO, they argue that they have "created" something new. When a farmer plants GM seed they are doing this by permission of the company that owns the patent, such as with Monsanto. This 'permission' is gained by signing a contract and paying a higher cost for the seed. Farmers are not allowed to save the seed to replant because it belongs to the company. In the case of some crops like soya, where the seed is saved and replanted, the farmer must pay a license fee to the company or face being sued. This is the reason that GMOs are even more expensive than hybrid seed and why multinational corporations try by any means to get farmers to switch to GM crops.

What you should know about GM crops:

"Myths are based on false promises and deception, against actual reality and genuine concerns."

The biotechnology industry has spread a lot of myths about what GMOs can do. These are not based on fact and have been shown to be false in reality. The myths we often hear are that:

- GMOs will solve the hunger crisis in the world and in Africa
- GM crops have massively increased yield potential
- GMOs decrease pesticide use
- GM foods are safe because they have been thoroughly tested
- GM foods are the same as those that are produced through conventional breeding
- GMOs are more nutritious, longer-lasting and better-tasting
- GM and non-GM crops can co-exist without contamination
- GM technology will boost farmer income and profitability

These statements are simply not true. Here are the facts about GMOs:

Which countries grow the most GMOs?

GM Crops are not the norm! Less than 3% of global agricultural land is planted with GM crops, with the majority being grown in the United States, Brazil and Argentina. Together, these three countries grew 77% of the 160 million hectares of GM crops grown in 2011. South Africa is the 8th largest producer of GMOs in the world, having cultivated about 2.1 million hectares in 2011*(James, 2011)*.

What are the health risks?

GMOs go through very little testing for health and safety. When a new drug comes onto the market it must go through the following experiments:

- three month tests on three mammal species,
- one year tests on one mammal species, and a further
- two years on another mammal

This is the procedure to test for a drug that will only be given to sick people who can be monitored by a doctor. It is strange that the same is not done for new GMOs, which will be used as food for everyone, is often not labelled, and is not being monitored for health effects. It is quite normal for a GMO to be tested for just 90 days on rats. That is all. Even with this minimal testing, scientists are finding early warning signals that GMOs may not be safe in the long-term.

Animal tests have shown worrying health impacts including:

- Effects on gastro-intestinal tract: Inflammations, ulcerations and excessive growth of stomach and gut lining
- Disturbance of liver, pancreas and kidney function
- Disturbance of testes function (male function)
- Alterations in haematology (blood composition)
- Altered body weight
- Allergic reactions and immune responses
- Impacts on second generation

Nutritional changes:

- Altered level of existing, or presence of new toxins
- Altered level of existing, or presence of new allergens
- Altered level of existing, or presence of new anti-nutrients (these stop nutrients from being absorbed by the body)
- Altered level of existing nutrients (e.g. vitamins)[1]

What about the effect of the chemicals that are sprayed onto GM crops? Herbicide tolerant GMOs increase the amount of toxic chemicals that come into direct contact with the crop. This means that more chemicals are found on, and within the foods that we buy. New studies are coming out about one of the most common chemicals used in herbicides, called glyphosate.

What environmental risks have been identified?

GMOs can disrupt the entire food web, impact on aquatic systems as well as create new weeds, secondary pests and resistant pests.[2]

Disrupting the food web

GMOs can have a negative impact on pollinating insects, such as bees, when they feed on GM crops. There are also many insects that are 'farmer's friends', such as ladybirds and lacewings. These can be killed by pest resistant GMOs, which disturb the balance of pests and predators in the field. Negative impacts have also been found on moths and butterflies.

It has also been found that *Bt* genes from GM crops disrupt the food web in the soil. Ecological health begins in the soil as it is the most vital source of nutrients for plants.

Insect resistance, secondary pests and super-weeds

Farmers buy GM technology to make management of their crops easier. But this has turned into a nightmare for many farmers because in the long run, GM crops have created new problems on top of the old ones. In South Africa it has been found that insects are becoming resistant to the poison that GM *Bt* plants make. This is a problem for farmers because they do not get the crop protection that they paid for. These pests then become harder to deal with and often, farmers have to resort to spraying pesticides.

In some cases the GM crop takes care of the pests that it is being targeted by, but farmers suddenly have to deal with pests that have not been a problem before. For example, in South Africa farmers found new pests in their GM cotton fields such as stinkbugs *(Pschorn - Strauss, 2005)*. In Pakistan and India GM cotton farmers had to deal with the mealy bug, which was not common before *(Wan-Ho, 2010)*. These 'secondary' pests become a problem because they no longer need to compete with the pests that the *Bt* toxin is killing.

One of the most expensive and serious problems created by GM technology is the appearance of weeds that develop a tolerance to the herbicides. In other words, they do not die when the GMOs are sprayed with the herbicide. This occurs because the same herbicide is used over and over, which encourages the weeds to develop a tolerance to the herbicides. The widespread use of Roundup Ready crops has led to farmers over-using herbicide made from glyphosate, resulting in a speedy increase in glyphosate resistant weeds where GM crops are grown. These weeds are choking farmer's fields and causing farmers to use more, of the older and stronger herbicides. This is also an environmental catastrophe because so much more poison must now be used on these crops.

It is a myth that GMOs reduce the need for agro-chemicals, in fact GMOs cause an increase in chemical use. In the USA, farmers used 10 times more glyphosate on their crops in 2007 than they did in 1993[3].

Laws governing GMO's

Introduction

Genetic engineering (GE), also called genetic modification (GM), is not just a modern version of the natural breeding that we know and have practised for many thousands of years. It is a new and totally artificial way of creating living organisms that can never occur in nature. These genetically modified organisms (GMOs) have a life of their own; once released, they will spread and multiply and cannot be recalled. Many scientists believe that the way of producing these GM foods is so new that we cannot be sure of the long term impacts on our health and the environment. We do not yet fully understand the potential risks of growing and eating these GM foods. However, scientists have already begun to see early warning signals of serious health and environmental problems. Therefore, special laws are required to regulate GMOs.

International law

The Cartagena Protocol on Biosafety (CPB), a United Nations (UN) treaty is the main international agreement that deals with GMOs. This agreement was negotiated by many countries in the world, over a period of eight years. The "mother" agreement of the CPB is called the 'Convention on Biological Diversity'. The CPB governs how GMOs move across borders, what safety measures must be taken and how governments should make decisions on whether or not to allow them into their countries. Most African states are among the 163 countries that are "Parties" to the CPB[4], including Namibia.

A Party to the CPB refers to a country that has agreed to adopt the measures of the CPB in its domestic laws. Parties may develop stricter laws than those set out in the CPB in their own countries, but may not develop weaker laws. The CPB sets the lowest standards of biosafety because every country at the negotiating table must agree on every clause before it is finalised. This consensus leads to a lot of compromise and a watered down protocol.

South Africa became a Party to the CPB in 2003. The overall authority in the South African government responsible for matters relating to the CPB is the Directorate of Bio-diversity and Heritage of the Department of Environmental Affairs and Tourism.

In Namibia, the National Commission on Research Science and Technology (NCRST) is the competent authority on GMO matters. The Biosafety Act (Act No. 7 of 2006) provides for measures to regulate activities involving the research, development, production, marketing, transport, application and other uses of Genetically Modified Organisms and specified products derived from genetically modified organisms. The Regulations to the Biosafety Act are currently being drafted and is expected to be gazetted in 2015.

The need for caution

The CPB allows Parties to take a "prevention is better than cure" attitude toward GMOs - if there is reason to believe that a GMO could cause harm, a government can decide not to allow it into the country based on the 'Precautionary Principle' (PP). This was one of the greatest battles in the negotiation of the CPB. It was a great victory that the Precautionary Principle was included. The GM industry claims that it is unreasonable to reject GMOs without sound scientific proof that they cause harm. However, the PP allows Parties to refuse to approve the use of a GMO where there is scientific uncertainty as to the harm that the GMO may cause to bio-diversity and human health.

The World Trade Organisation is opposed to the Precautionary Principle

The World Trade Organisation (WTO) is an international body that has laid down rules to promote free trade between member countries. The WTO has a lot more control over whether or not its members abide by its trade rules than the United Nations has over countries that sign treaties. Countries that break the WTO rules may be punished through trade sanctions or other forms of financial punishment. This is a great advantage for more wealthy countries.

The WTO approaches GMOs as a trade issue rather than a safety one. It turns the PP on its head. The WTO Agreement on Sanitary and Phytosanitary Measures (SPS) says decisions must be based on risk assessments that use the most current science. According to this, GMOs must not be rejected without hard scientific backing. Rejecting GMOs without scientific proof of harm could also be punishable under the WTO's agreement on Technical Barriers to Trade. This says that countries should not restrict trade from other countries without sound reasons[5]. The USA, Canada and Argentina used the SPS to bring a WTO case against the European Union (EU) because some countries in the EU had banned particular GMOs they thought were unsafe. The WTO ruled that there was not enough scientific evidence of harm to justify the bans.

GMOs can impact on so many aspects of our life. Unfortunately international and national laws often only focus on what can be tested by science while the other important issues are ignored.

Sharing information with the public

Parties to the CPB are required to publish all their decisions on GMOs, on an international website called the Biosafety Clearing House (BCH). They must also publish summaries of the scientific safety studies carried out on these GMOs. This information is very important – as it should inform citizens, governments and industry about decision making on GMOs. It also assists in building scientific knowledge about the risks and performance of GMOs. Other important information that governments must post on the BCH includes the various laws that are related to GMOs in their country, as well as contact details of the relevant authorities and experts. Each country is responsible for ensuring that its country profile is kept up-to-date. The BCH can be accessed at *www.cbd.int*

Public Participation and Awareness

The CPB is very clear that the public must understand what GMOs are and must be actively encouraged to participate in decision making processes. This goes hand in hand with ensuring that information is available for public scrutiny. Promoting education on GMOs can also be a double edged sword – whose version of the GMO debate will be promoted through education materials?

International law and when GMOs cause harm

Another great battle in the negotiation of the Cartagena Protocol was agreeing on how to deal with harm caused by GMOs. In 2010, after 10 years of negotiation on this issue, an international agreement has finally been made, called the Nagoya – Kuala Lumpur Supplementary Protocol on Liability and Redress.

This law is much weaker than most developing countries had hoped for; they were pushing for strict rules to hold the developers of GMOs directly liable (responsible) for the damages their technology causes. Instead, national governments are left with the responsibility to fix any damages and try to get payment and assistance from those who caused the damage.

Types of GMO's

Getting to know about seeds

Seeds can be categorised into three groups: those that are farmers' varieties have been selected and bred naturally over time; hybrid seeds that are specially bred and GMOs that are artificially made in laboratories using genetic engineering techniques.

	Farmers' varieties	Hybrid	GMO
Breeding process	Developed through farmer observation, cultivation, experimentation, selection and sharing. Knowledge passed down from generation to generation	Developed by breeding two "distinct varieties", e.g. drought tolerant and high yielding	Developed in a laboratory by inserting genes from another species into a crop. e.g. insecticide from soil bacteria. The parent crop is usually a hybrid
Seed saving	Seed can be freely selected, saved and planted year after year	Performs well for one growing season only. Seed has to be bought fresh every year	Performs well for one growing season only. Seed has to be bought every year
Who is it for?	Suited to local conditions, taste and cultural needs	Commercial varieties, used by commercial farmers often for export or large markets	Commercial varieties, used by commercial farmers often for export or large markets
Type of Agricultural system	Fits into diverse cropping systems, agro-ecology, traditional agriculture	Usually developed to work within mono-crop systems supported by irrigation, fertilisers, herbicides and pesticides	Usually developed to work within mono-crop systems supported by irrigation, fertilisers, herbicides and pesticides
Intellectual property	No legal ownership rights. Seed is enriched and developed through sharing	These are corporate owned seeds and are usually protected by Plant Breeder Rights which does not allow farmers to exchange seed	These are corporate owned seed and protected by patents. Farmers can be sued for sharing or saving seed from their harvest

What types of GMOs are on the market?
There are just three types of GMOs available on the market – pest resistant, herbicide tolerant and a mixture of the two, called 'stacked' varieties.

Pest resistant or "*Bt*"
Bt stands for *"Bacillus thuringiensis"*. This is a little bacterium that lives in the soil. It is poisonous to certain types of insects. The genes that create this poison have been engineered into various crops so that the crop also becomes poisonous to certain insects.

Herbicide Tolerant
GM herbicide tolerant crops are those that have been engineered to withstand massive doses of a particular herbicide without the GM crop dying. These crops are sprayed with herbicides to kill of surrounding weeds. The most common herbicide tolerant crops grown in the world are called Roundup Ready because they have been engineered to withstand Monsanto's glyphosate called Roundup.

Stacked
These crops contain a mixture of herbicide tolerant and pest resistant genes. Stacked GMOs can contain between two and eight mixtures of genes.

The organic position on GMO's
Organic agriculture uses the precautionary principle when it comes to new technologies, especially those technologies that do not occur naturally. Genetic engineering transfers genes across species and kingdoms in ways that have never occurred in nature.

The organic sector has serious concerns about GMOs based on the published science.

Genetically modified plants and animals are prohibited in organic systems.

5.2. Seed and plant production

IFOAM's position on seeds
"The overall goal is to provide organic farmers with sufficient quantity of excellent starting plant material of a wide range of suitable varieties propagated according to the organic guidelines. Considering the diversity of organic agriculture with respect to farm size, crop rotation, intensification level, as well as the diverse range of markets around the world, different site specific strategies need to be developed to promote the organic propagation of seeds. For example, supermarkets in many countries demand uniform organic products with a long shelf life that are certified for compliance to organic regulations by an independent third party.

On the other hand, consumers of local farmer markets or niche markets are more interested in locally adapted varieties that have a cultural heritage. In addition, not all countries have established organic certification systems that would allow for certified organic propagation.

However, local seed production is essential for an autonomic organic farming and needs to be promoted.

Ideally all plant production should be based on organically bred and organically propagated varieties. Where the number of organically bred varieties is very limited or non-existent for certain crops, conventionally bred varieties can be allowed, except for varieties derived from genetic engineering (GMO crops). However, the seeds of conventionally bred varieties should be propagated under certified organic systems."

5.2.1. Technical aspects

Seedling propagation

Seedlings are usually started in a nursery where seeds are planted into pots, trays or seed beds that use a seedling medium instead of pure soil. The purpose of using a seedling medium is to have a medium that is dense enough to allow the easy movement of shoots and roots while at the same time have large amounts of air, water and nutrients to ensure optimum growth. Heavy soil mixtures make it difficult for the new roots to travel through it and for the leaves to emerge to collect the light.

Mixing seedling medium

Mixtures need to be well drained to stop water-logging, which will cause roots to die from lack of air or from pathogenic diseases that thrive in damp conditions. At the same time it has to hold sufficient water so that the young seedling is not drought stressed from insufficient water.

Seed beds for sowing

These criteria are just as important when preparing seed beds for sowing seeds in the field. Adding good amounts of compost in the planting furrows will ensure a loose soil that is well drained and consistently holds water. It is important to remember that over 95% of a plant's biomass comes from water and air combined by capturing the energy of sunlight through photosynthesis.

Always put concentrated biology and nutrients next to seeds/seedlings at planting to give them a boost.

Crops that germinate quickly and grow rapidly are better at out-competing weeds and tend to produce higher yields.

Research in Australia has found that as little as 50 kilograms of pelleted compost per hectare applied next to the seed at planting gives a significant boost in yield. Similarly pelleted composted chicken, pig and other high nitrogen composted manures applied next to the seed, seedling, sugar cane billet or cutting at planting will make a significant difference. Liquid composts or compost teas have also proven effective.

The simplest and cheapest way to make seedling mixtures is from easily and cheaply available local materials.

A good example is a seedling medium that is ⅓ coarse river sand, ⅓ dark, organic matter-rich loam top soil and ⅓ compost. The compost should be available from the farm and the others should be easy to obtain locally and in many cases freely with transport back to the farm nursery as the major cost.

Seedling medium ingredients

Many commercial nurseries use mixes that are without soil for a number of reasons. One of the main ones is the fear of soil borne diseases. This shows a complete lack of understanding about the concept of healthy soils that are biologically active with beneficial microorganisms.

These types of nurseries tend to feed the plants with water soluble chemical fertilisers in a manner that is close to hydroponics. Consequently these nurseries have to constantly spray the plants with fungicides and pesticides to prevent pests and diseases damaging the nursery plants.

A seedling medium that uses a healthy organic matter rich soil combined with good quality compost should prevent most pests and diseases. Most fungal and damping-off diseases can be controlled by having well drained seedling mediums and regular air movement in the nursery.

Examples of seedling medium components

Vermiculite, zeolites, coir fibre or dust, peat moss, pine bark, peanut shells, rice husks and many other products can be used in seedling mediums. Over time most people experiment with a range of mixtures and settle on the one that works best for them. One of the critical aspects for choosing the input mix is that they are available locally, are clean, cheap and easy to obtain.

Nutrition in the nursery

The nursery plants can be regularly fertilised with liquid seaweed, compost teas, compost, gypsum and other organically allowed nutrients. The same nutrition rules apply for nursery plants as those in the ground. *Chapter 2 explains all of this in detail.*

Farm nursery

It is important to have an area that is the dedicated farm nursery, where all the pots and potting mixes can be stored and the plants can be propagated. The critical reason for the farm nursery is to have an area where the temperature, light, humidity and water can be controlled to ensure optimum success in the propagation of the seedlings.

In areas that have a cooler winter, this is usually a plastic covered green house. These are not as necessary in most tropical areas. The important issue of shade can be solved by finding a suitable area under trees. Water can easily be controlled by regular misting through a hose with a fine nozzle. It is better to regularly mist seedlings than to water them heavily.

One of the advantages of using trees as a cover for a nursery is that the seedlings will receive constant air movement. This will prevent a lot of the fungal and bacterial diseases that cause damping-off and leaf damage.

One of the main mistakes made in green houses is not opening them up enough to allow sufficient air movement to prevent fungal and bacterial diseases.

Hardening-off seedlings

One of the other advantages of shady trees is that seedlings can be progressively moved into full sun to harden them off before planting out. Plants, like humans, can get sunburnt if they have been in the shade for a long period and then exposed to full sun.

This is a major mistake made by many growers, when they take fresh seedlings out of the nursery and plant them straight into the full sun. These plants get stressed out, get burnt and wilt and take days to recover.

Sun hardened plants that are transplanted well, will recover and grow very well and out-compete weeds.

When hardening seedlings always cover the side of the pots with mulch otherwise the heat from the sun will cook the sides of the pots, killing the roots that are close to the sides.

It helps, when hardening plants, to face them in the same direction to the sun as the direction they will be planted in the field. This means that their leaves will be able to take maximum advantage of the sun after transplanting.

Plant seedlings in the late afternoon

Always plant seedlings in the cooler period of the late afternoon rather than in the morning. Planting in the late afternoon reduces the water stress from transplanting. It means that the plants have a night and the next morning to grow new rootlets into the soil to get enough water to cope with the heat of the middle of the day.

When seedlings are planted in the morning they have to cope with the midday and afternoon heat and this causes them to stress and wilt. Seedlings planted in the morning generally have to shut down their metabolic activities and close their stomata to prevent water loss. This will stress them out and slow their growth. The exception can be on wet overcast days. These are some of the best conditions for transplanting seedlings as long as it is not so wet that the soil is damaged by the activity.

Ensure that all the seedlings have good root growth before they are transplanted. The roots are critical to give the plants much needed water when transplanted. The larger the root area, the more water they can take up. Denser root systems mean that less of the seedling medium will fall off when transplanting. Ensuring that seedling medium soil surrounds the roots is critical to establish the plants quickly in the new environment.

Seed production

Many crops are produced specifically for the seed harvest, either for food or for the basis of the next season's crop. In horticulture these seeds are usually for producing the seed stock for future crops rather than for human consumption. There are a good number of seed crops for human consumption such as nuts and seeds that are usually for herbs and spices such as pepper, cardamom, dill, fennel, poppy and sesame.

Each of these will have their specific requirements and these will have to be learnt on an individual basis. *Some of these requirements are covered in section 5.2.3. Quality Standards.*

Seed soaking

Soaking seeds before sowing has also been shown as an effective way to speed up germination, increase vigour and give seeds a head start over weeds. This also results in higher yields. The soaking time ranges from two hours for small seeds (like lettuce, carrots) to overnight for large seed (like beans).

Seed soaking

5.2.2. Quality standards

Certified seeds

Many countries have laws requiring that seed varieties are certified to quality standards. These are usually done in qualified seed testing laboratories.

The following are examples of the types of tests that are needed:

- **Physical purity**
  This test ensures that the sample is free or within the guidelines for impurities such as weed seeds, stones, other varieties of seed, extraneous organic matter and live insects
- **Germination rates**
  This tests the seeds to ensure high germination rates

Germination test

- **Moisture content**
  This test ensures that the seeds have the right moisture content. Too much water can cause seeds to germinate while instorage and too little can dehydrate the embryo causing low germination rates
- **Varietal purity**
  This test grows the seeds to ensure that they are consistent and the correct variety

UPOV Convention

In developed countries and some developing countries most seeds and new varieties are subject to the various laws that enforce the rules of the UPOV Convention or variations of it. UPOV stands for International Union for the Protection of New Varieties of Plants.

This international convention outlines the rules for plant breeding rights. It was first adopted as an international convention in 1961. Currently 65 countries are signatories of this Convention.

IFOAM acknowledges variety protection as long as breeder exemptions and farmers' privilege are guaranteed. IFOAM will strongly advocate against the patenting of living organisms that violate these rights.

- **Plant Breeders' Rights (PBR)**
  Plant Breeders' Rights (PBR), are designed to give the breeder of a new variety the exclusive right to market, license and sell that new variety. These rights will allow a breeder to apply for Plant Variety Rights (PVR) on new varieties. This right will stay in force for a limited number of years – usually around 20 to 25 years.

PBR was advocated as a way to allow breeders a financial return on their years of investment in developingnew varieties. There have been many cases where people have spent years and a lot of money developing a new variety and then not make any money to pay for these costs because other nurseries can simply buy one plant or a few seeds and then easily propagate and sell them at a cheaper cost. This is unfair on the plant breeder and discourages investment in new varieties.

- **Exemptions**
  Some countries allow exemptions to PBRs to allow other breeders access to PVR varieties for the purpose of developing new varieties or for research. This is called Breeder Exemption.

IFOAM advocates for exemptions that allows farmers to save their own seeds for protected varieties and not have to pay a royalty. Saving seeds for personal use is very different from selling the seeds. This is known as Farmers' Privilege.

- **Patents**
  IFOAM opposes plant and gene patenting on the basis that it gives exclusive rights to the patent owner without exemptions.

IFOAM is strongly opposed to the patenting of genes as these have been found naturally and have not been created by the patent owner. The patenting of genes means that the patent owner has rights to charge royalties over any future varieties that have the gene, even when the patent owner has not done any of the breeding development.

5.3. Breeding varieties

Most of the current high yielding varieties that are used in commercial agriculture have been bred under high input, artificial conditions. They tend to require high levels of synthetic chemical fertilisers and water. They also tend to be less resistant to pests and diseases and need regular applications of synthetic pesticides and fungicides to maintain high yields.

Some of these varieties will perform well under organic conditions, however many do not and can give significantly lower yields.

Selecting individual plants

Selecting and breeding varieties that perform well under organic conditions is very important.

A limited number of organisations such as MASIPAG in the Philippines, Michael Field Institute and Seeds of Change in the USA, FiBL in Switzerland and Georg-August-University, Göttingen in Germany have been actively involved in developing organic varieties. However compared to conventionally bred varieties, there are very few organisations breeding specifically for the organic sector.

The bulk of the breeding and development of organic varieties is done informally by farmers selecting their best lines. This is still the preferred method and farmers need to be actively encouraged to trial many varieties and learn how to select the best of these as the basis of breeding programmes for high yield, well adapted varieties for their farms.

5.3.1. Epigenetics

The science of epigenetics is beginning to understand how a range of environmental factors can affect the way genes work in organisms (such as plants) without making fundamental changes to the DNA of the organism. Environmental factors can inhibit genes or cause them to work more actively. This changes the way a plant will grow and produce fruits, seeds, flowers and leaves.

This emerging science of epigenetics is a key to our understanding of how all organisms, including plants and animals adapt to their environmental conditions.

These changes in the way the genes work (express themselves) can be passed down through generations.

This knowledge is very important when breeding for organic conditions. Selecting material that has been bred for generations in climate controlled laboratories and glass houses means that the epigenetic process has modified the genes to adapt to that environment, rather than in farm environments.

This is why participatory breeding on actual farms under the actual growing conditions is critical to get varieties that are optimally adapted to that environment.

5.3.2. Beneficial neglect

Beneficial neglect is the concept where plants that are being trialled for breeding purposes are selected on the basis of how they perform under limited input conditions such as low water, low nutrition inputs, weed pressure and no treatments for pests and diseases.

The best performing seedlings are selected as these will have characteristics that make them more resilient and higher yielding in good practice organic systems.

5.3.3. Always select the best

It is important to always select the best performing plants when selecting the seeds for the next crop or generation. Never select the slow growing runt – unless deliberately breeding for smallness.

An example of this is over-sowing the seedlings and thinning out the runts and stragglers to only keep the strong growers. This is a very good strategy for selecting the best performing plants for the seeds for the next crop.

The characteristics of the best performing plants are usually passed on to the next generation.

5.3.4. Self-improving varieties

There are lines of accessions that are known to be self-improving with every generation. Good plant breeders know these lines and continue to plant out the seeds and select the best of the next generation as new varieties. This is particularly the case with many varieties of lychees and mangoes. The continuous improvement of crops can come from making hybrids; however many of the better varieties have come from planting lots of seeds from each new generation of the self-improving lines and selecting the best new ones.

This is also the case in many crops. By trialling many varieties, particularly the traditional farmers' varieties and landraces and selecting the seeds from best performing plants every season, farmers can progressively develop better performing varieties.

5.3.5. Crucial traits

A farmer based breeding programme needs to select for many crucial traits. There is no point selecting a high yielding variety if the taste or colour characteristics are not acceptable to the market or the shelf life is too short for it to reach the consumer in a good condition.

Bean varieties

The key traits need to be:

- Reliable and consistent high yields
- Colour acceptable or preferred by market
- Taste acceptable or preferred by market
- Able to travel well to the market
- Acceptable shelf life so that the quality is still good after purchase by the consumer
- Adapted to the local climate including the regular extremes of heat, cold, wind and rain
- Able to perform well under good organic nutrient programmes
- Efficient at using water
- Resistant to pests and diseases
- Able to cope well with weeds or suppress weeds
- Easy to reproduce for the next crop via seed or vegetative propagation

Other specific factors may include:

- Salinity tolerance
- Perennial – to reduce the need for replanting
- Copes well with being grazed
- Makes good animal fodder
- Produces a large amount of biomass that can be used for improving soil organic matter levels or for composts etc.
- Higher levels of nutrition

5.3.6. Restrictions imposed by the UPOV convention

The rules set by the UPOV Convention usually means that farmers cannot use protected varieties as the basis of on-farm breeding programmes. This is unfortunate as many of these newer varieties have characteristics such as colour, size, shape and shelf life that are desirable to the markets. However in organic systems they can end up with lower yields due to the increased susceptibility to pests, diseases, weeds and the need for higher levels of water and chemical fertilisers.

Crossing these protected varieties with farmers' landraces with resistant traits has the potential to produce varieties that are high yielding and result in excellent quality in organic systems.

5.3.7. Use farmers' varieties and landraces

There are thousands of accessions of traditional varieties, farmer's varieties and landraces that are not subject to the UPOV Convention, patents and other protective rules and these can be used for breeding.

These collections contain some of the most valuable genetic resources that can be used for farming and should be used as the basis of any on-farm breeding programme.

As well as using these accessions for breeding purposes, farmers should be encouraged to conserve the original accessions to ensure that they are not lost. This is critical to prevent the extinction of this important collection of bio-diversity.

IFOAM's position is that it:

"[…] strongly recommends the maintenance of genetic resources in the form of on farm or in-situ conservation of landraces, farmer's varieties, regional specialities, wild relatives and other accessions to allow for an ongoing process of evolution and adaptation within the plant's habitats. To be able to guarantee sustainable plant production, meeting all kinds of present and future challenges, it is essential to continue the genetic progress of new varieties. The development of improved varieties suitable for organic agriculture requires that a special emphasis must be put on the diverse organic management systems. In addition, breeding strategies and techniques which are in line with organic agriculture need to be defined. Special attention has to be drawn to exclude genetically modified organisms from the organic breeding, propagation and cultivation."

Footnotes

James, C. (2011). Global Status of Commercialized Biotech/GM Crops: 2011. ISAAA Brief No. 43. ISAAA: Ithaca, NY.

1. There are many peer reviewed studies on health effects. Thank you to Dr. Ricarda Steinbrecher for compiling this list.

For example see:

- *Finamore, A et al. (2008) Intestinal and Peripheral Immune Response to MON810 Maize Ingestion in Weaning and Old Mice. Journal of Agricultural and Food Chemistry*
- *Cell structure and function: GM soya fed mice: Malatesta et al. (2002; 2003 and 2004)*
- *Changes in histomorphology: Ostaszewska et al. (2005)*
- *Protein profile: rainbow trout: Martin et al. (2003) in animal feeding trials*
- *Altered hepatic enzymes: gna rice: Poulsen et al. (2007) and in GM maize 1507: MacKenzie et al. (2007)*
- *Increase in triglycerides: Mon863 maize fed female rats: Seralini et al. (2007)*
- *Liver and kidney damage: Bt maize fed rats: Kilic and Akay (2008)*
- *Liver and pancreas of lambs of sheep fed Bt 176 maize: Trabalza-Marinuzzi et al. (2008)*

2. There are many peer reviewed studies on environmental effects. Thank you to Dr. Ricarda Steinbrecher for compiling this list.

For example see:

- *Pollinators e.g. Bees in US: Kaatz (2007)*
- *Beneficial organisms, e.g. lady birds, lacewings: Hilbeck et al. (1998), (2012) vs. Romeis et al. (2006); Loevei & Arpaia (2005)*
- *Soil food web – plant interaction: Castaldini (2005)*

Pschorn-Strauss, E. (2005). Bt cotton in South Africa. The case of the Makhathini Farmers. Seedling. April 2005. ***http://www.grain.org/article/entries/492-bt-cotton-in-south-africa-the-case-of-the-makhathini-farmers***
Accessed 8 August 2012.

Wan-Ho, M. 2010. Mealy bug Bt cotton disaster in Punjab. ***http://www.i-sis.org.uk/mealybugPlaguesBtCotton.php***
Accessed 8 August 2012.

3. US EPA. Pesticide Sales and Usage: Market Information. *See reports for 1998/1999 and 2006/2007. Table 3.6 at* ***www.epa.gov/opp00001/pestsales***

4. Biosafety Clearing House ***http://bch.cbd.int/***
Accessed 18 August 2012.

5. World Trade Organisation. ***http://www.wto.org/english/tratop_e/sps_e/sps_agreement_cbt_e/c8s1p1_e.htm***
Accessed 26 August 2012.