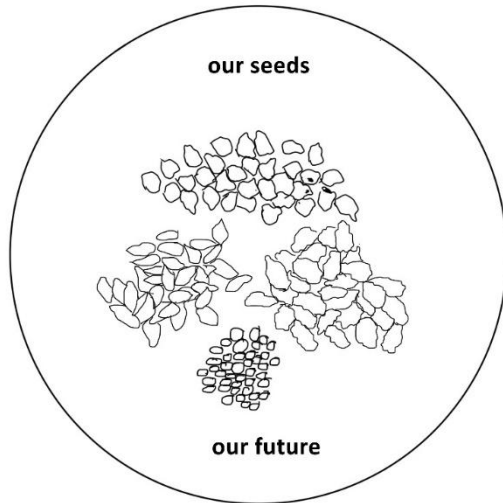


**EXPLORING
THE WORLD
OF SEEDS**



by

Priya Vincent

1. WHAT ARE SEEDS?

Seeds are what the majority of plants grow so they can reproduce. As such, they play a crucial role in the life cycle of plants.

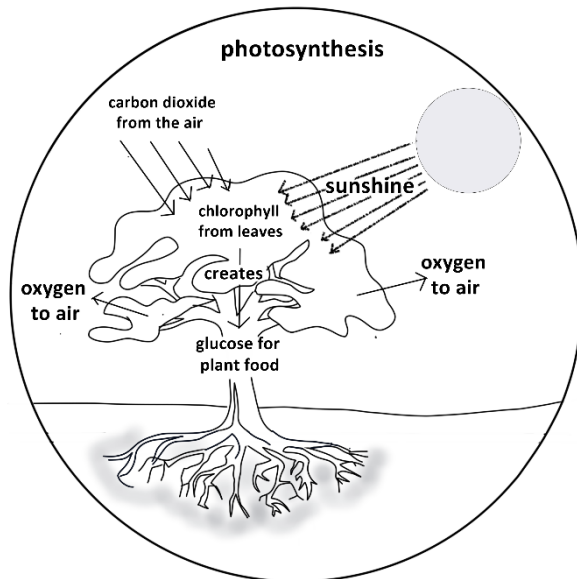
Seeds are what we plant when we want to grow food. The quality and accessibility of the seeds that we grow for food is of great importance to our present and future food security.

To understand seeds we have to explore the plants from which they come.

2. PLANTS AND SEEDS

a) What are plants?

Plants are living organisms that are characterized by their ability to photosynthesize, which means 'put together with light'. Plants produce their own food using energy from sunlight, carbon dioxide and water. This process generates oxygen which is essential to the survival of the Earth.



There are about 380000 known species of plants with majority of them producing seeds. They are extremely diverse and range from single cell plants like algae to the huge trees of the tropical rain forest.

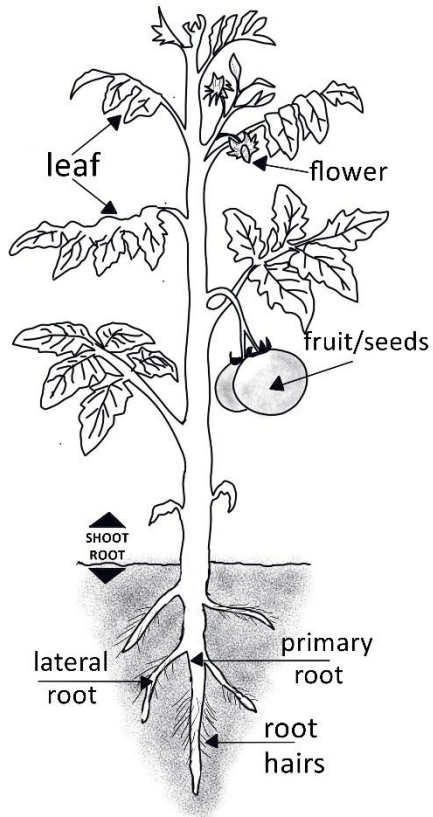
As well as being crucial for the ecosystem, plants provide food for animals and humans through all parts of their foliage, roots and seeds. Seeds are particularly significant for animals and humans as a food source. They form the basis of many staple foods such as grains, nuts and legumes and are often used to produce oils and other important food products.

**Without plants there would be no food for
anyone
including humans.**

b) PLANT STRUCTURE The basic parts of a plant are:

The Root: this is the portion of the plant beneath the soil. As well as being used to absorb water and food from the soil the root also helps to anchor the plant into the ground. It can act as a storage place for food for the plant. Whenever you eat a potato, carrot or radish you are taking advantage of the plant's ability to do this.

The Shoot: includes all parts of the plant structure above the soil. This includes stems, leaves, flowers and fruits.



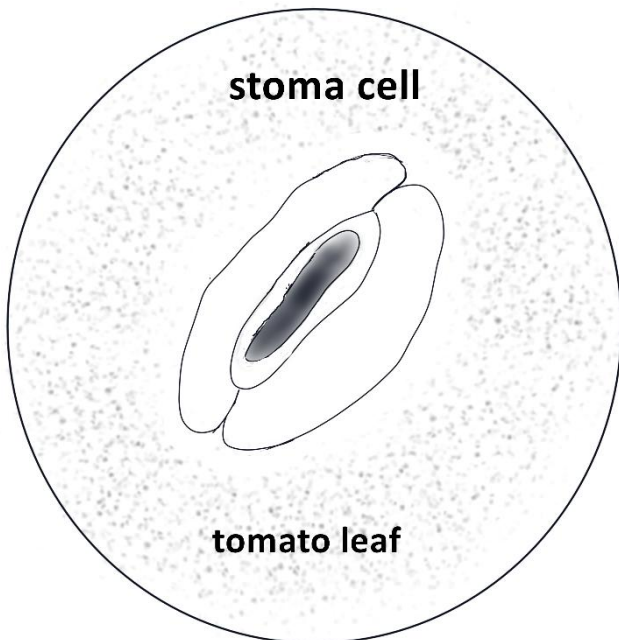
c) Plant cells: the different sorts of tissue found in the roots, stems, leaves and flowers of plants are each composed of different types of plant cells. The basic characteristic of plant cells are as follows:

- Plant cell walls are composed of varieties of cellulose and sometimes other materials which provide the structure for each cell. Depending on their shape and other characteristics these cells form the various sorts of tissue and organs of the plant.
- During growth the cell wall is flexible and has small pores (holes) that allow exchange of nutrients and hormones between the cells thus providing a form of cell to cell communication.
- Many types of plant cells contain a large fluid filled membrane known as a vacuole. This is very important for the plant as it is used for a number of critical functions. These include controlling the movement of fluid throughout the cell (and therefore the plant), storing useful material such as phosphorus and nitrogen as well as digesting various forms of waste. Together with a strong flexible cell wall outside the cell membrane, vacuoles enable the plant is to quickly absorb large amounts of water needed for plant growth.
- Plant cells contain a variety of what are called organelles which can be thought of as like the organs of a body (hence the name organelle). One of the most important of these are

chloroplasts which contain the green pigment chlorophyll which is crucial to the process of photosynthesis which is a major plant characteristic.

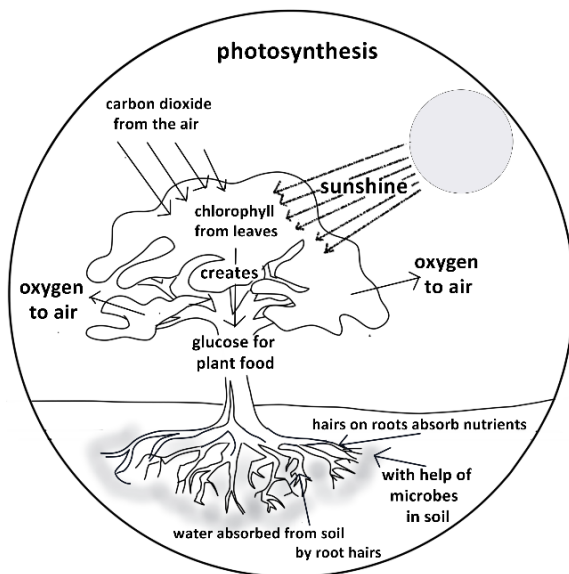
d) PLANT FUNCTIONS

BREATHING: Like humans, plants take in oxygen and give out carbon dioxide. All parts of the plant can do this using special cells called stomata. There are more stomata on the leaves than on other parts of the plant.



The roots of a plant also need oxygen which they get from the air spaces in the soil. Plants such as rice which grow in wet soil have air spaces in their roots. If a plant is given too much water or gets flooded the roots drown and the plant dies.

EATING: During the day leaves make food (glucose) for the plant from photosynthesis. Some of this glucose is exuded by the plant roots to encourage soil bacteria to come close to the root hairs. The activity of the bacteria on the glucose releases soil nutrients which the plant absorbs through the root hairs which also absorb water.



3. PLANT CLASSIFICATION

Plants are classified into different types according to their growth habit. This being the way the plant develops or changes in height, shape and the kind of growth it undergoes.

Herbs – have stems that do not contain woody tissue. Most of them are short plants that complete their life cycle within one or two seasons. Generally, they have few branches or are branchless and can be easily uprooted from the soil. Many of the plants we plant for food such as vegetables (like Tomato and brinjal) or grains such as wheat and paddy are classified as herbs. Grass and bananas are two perhaps more surprising examples of herbs.

Shrubs: are medium-sized, woody plants usually taller than herbs and shorter than a tree. Their features include bushy, hard, and woody stems, each of which have many branches. Although the stems are hard/woody, they are also flexible but not fragile. The lifespan of these plants usually depends on the species. Rose, jasmine, hibiscus, tulsi, and henna are some of common shrubs.

Trees: Trees are big and tall plants with generally one very thick, woody and hard stem called the trunk. This

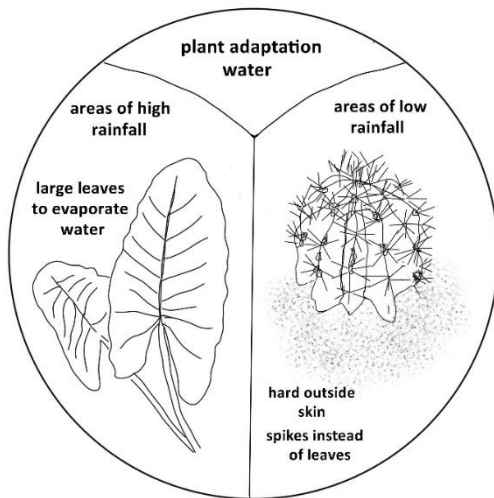
single main stem or the trunk gives rise to many branches that bear leaves, flowers and fruits. The lifespan of a tree is usually counted in years and can be very long. Banyan, mango, neem, cashew, teak and oak are some examples of trees. Coconut trees and many palm trees are branchless with only one main stem from which grow the leaves, flowers, and fruit of the tree.

Climbers have a very thin, long and weak stem which cannot stand upright on its own. They therefore have to use some kind of external support to grow vertically and carry their weight. These types of plants use special structures called tendrils to climb. Pea plant, grapevine, sweet gourd, ivy, runner beans and green peas are all examples of climbing plants.

Creepers, as the name suggests, are plants that creep on the ground. They have very fragile, long, thin stems that can neither stand erect nor support all their weight. Examples include watermelon, pumpkin, sweet potatoes, bassella and water spinach.

4. PLANT ADAPTATION: Unlike animals, plants cannot move and go looking for better conditions to grow. They survive by adapting in many different ways to the surroundings in which they live. Their growth habit, based on their genetic factors and interaction with the environment have the function of enabling the plant to adapt to various habitats such as:

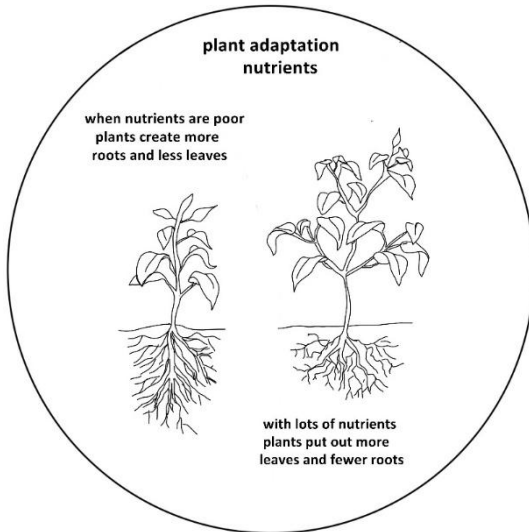
MORE OR LESS WATER: Plants that live in areas of high



rainfall, such as the tropical rain forest, often have huge leaves because they need to get rid of large amounts of water through evaporation.

Plants that live in dry areas have small leaves to preserve as much moisture within the plant as possible. In very dry places like deserts they have spikes, like a cactus, instead of leaves.

MORE OR LESS NUTRIENTS: Roots also adapt according to the nutrients and water available. They may be long and thin to get water and nutrients from difficult soils. Or



they may spread along just under the soil to get as much water as possible from the surface of the soil.

When there are enough nutrients, plants create more leaves and fewer roots and when nutrients are poor, plants create more roots and fewer leaves.

4. SEASONS: PLANT GROWTH AND SEEDS

A season is a division of the year marked by changes in weather, ecology and the amount of daylight. This resulting from the constant orbit of the Earth around the Sun.

In temperate and polar regions the seasons are defined by large changes in the intensity of sunlight that reaches the Earth's surface. At different times of the year days can be very long or very short. In tropical and sub tropical areas there is less change in the length of days and intensity of sunlight. Here the seasons may be defined more by certain types of weather such as monsoon rain or hot dry periods.

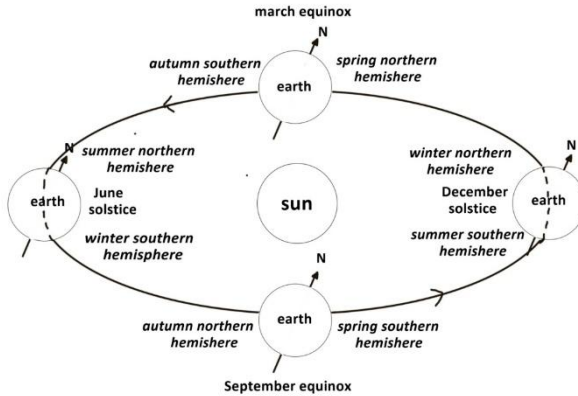
Environmentally speaking a season is a period of the year when only certain types of plant grow and certain animal events happen. This is determined by the temperature, light and general weather conditions at the time. Everywhere certain plants grow better in some seasons and some animals will only reproduce at particular times of the year. Local conditions such as height above sea level or closeness to the ocean will also determine how the different seasons are experienced. Most places have an annual cycle of four seasons, but in India, traditionally there were six seasons and some indigenous communities have even more.

We need to understand seasonal variations in the place where we are growing our seeds. Plants that grow in certain seasons are adapted to those seasons and are known as 'seasonal plants'. When grown in season they do not need extra food or water or suffer too much from pests and diseases. Either they have learnt to repel the pests that cause problems during that season or the pests that might attack them are not very plentiful at that time. For these reasons these are good and easy plants to grow for food and need fewer inputs, thus using less of the Earth's resources.

Humans also adapt to the seasons and seasonal foods have always been thought to be good for them. There may be a fruit or vegetable that will reduce the worst of the seasons' effects like extreme heat or cold. Or a food may bolster the immune system against seasonal diseases. For this reason, many believe that it is best for humans to eat seasonal local food. This is the food best adapted to help their bodies deal with the conditions where they live.

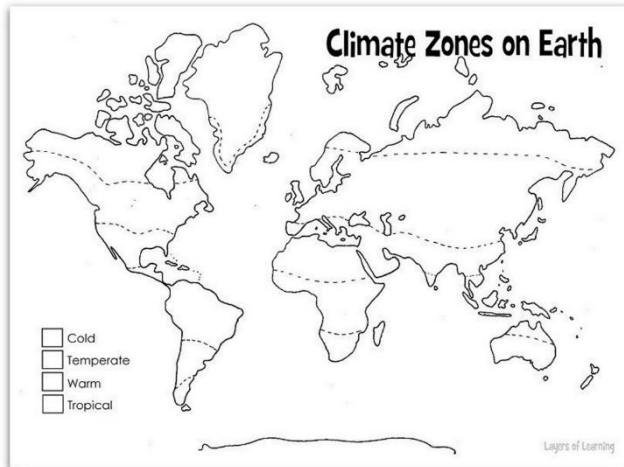
WORKING WITH THE SEASONS

Earth's seasons come from the Earth's orbit around the sun



POLAR AND TEMPERATE AREAS
seasons have large changes in
day length and sunlight intensity

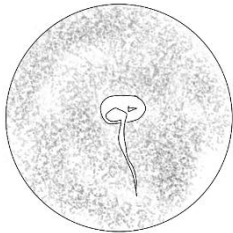
TROPICAL AND SUB TROPICAL AREAS
less change in day length and sunlight
more seasonal changes in weather



3. HOW DO PLANTS PRODUCE SEED?

Seeds are produced as part of, usually the end, of the plant growth cycle. The various stages of plant growth consist of:

a) **Germination** takes place when a new plant starts to grow from a seed. In Buddha Garden all our plants, apart



from white radish and some varieties of spinach, start life in the nursery where they can be looked after in a protected environment.

Here they are sheltered from cats and dogs, various pests, as well as

the extremes of the weather. The protection seeds require to germinate depends on the climate (especially extremes of heat and cold and heavy rain), as well as local conditions like what animals/insects are around.

For different plants, different conditions are necessary for germination. Maybe a particular temperature is needed or a certain soil moisture content is required. Lettuce, for instance, will not germinate well above 23C, so if we want to grow it in conditions above that temperature we have to cool the soil and if possible the place where they are planted. In Buddha Garden we do this by watering the soil and the seeds with iced water.

Since they germinate within six hours, this is enough to get most of the seeds to germinate when temperatures are higher. It is important to understand the specific germination requirements of the seeds you want to grow so that you give them the best chance of germinating successfully. Generally, all seeds like to be kept damp until they germinate, and seeds generally enjoy being watered little and frequently. Too much water can make them rot or invite fungus on them.

It is important that a good mixture of soil and compost is used to germinate the seeds. In many places it is possible to buy various sorts of compost specially developed for germinating and growing small seedlings. In Buddha Garden we make our own so called 'nursery mixture' which consists of:

- Compost to help the seed grow. Often this is sieved to create a good texture.
- Sieved soil which creates a mixture with a good texture that is loose enough so that the roots can obtain oxygen. This also stops the mixture from being too rich, as this makes the seedlings grow too quickly. When this happens, they find it hard to survive when planted into ordinary soil.
- Coconut fibre or any other material that holds water and stops the nursery mixture from drying out too quickly. The coconut fibre that we use is the waste left

over from making coconut fibre string. It used to be extremely cheap, but since coconut fibre is now being imported in many European countries as a substitute for peat, it is much more expensive.

Very small seeds, such as those of tomato, chillies, brinjal, lettuce and basil, are first planted in flat trays. Seeds are sprinkled thinly over the top of the soil, and then covered with a small layer of nursery mixture. When the plants have grown 2–3 leaves they are carefully transplanted into small pots in trays, disturbing the roots as little as possible.

Larger seeds like beans and ladies finger we plant straight into the pots filled with the nursery mixture. In many places it is possible to buy ready-made cubes of material into which seeds can be sown and left until they grow. The advantage of these is that the cubes can be put straight into the growing bed with no disturbance to the roots.

We plant very few seeds straight into the soil as our experience is that they do not germinate well and consequently there can be large gaps on the beds. We have much more success growing seedlings in the nursery and then planting these out on the beds when they are large enough to deal with the sometimes extreme conditions. Some vegetables, however, such as radish and various sorts of spinach, do not transplant well and the seeds have to be sown directly onto the bed. When we are short

of nursery space we sometimes plant bean seeds straight into the bed, but make sure that we also plant a few in the nursery as well at the same time. Then if any of the seeds do not grow we can plant these seedlings into the spaces.

- b) Seedling;** eventually the seed grows into a small seedling. Once the seedlings are large enough – which varies depending on the plant – they can be replanted onto beds to grow to adult plants.



- c) Growing from seedling to adult plant:** To grow well, all plants need to be planted in a fertile soil with enough air, light, water, at the right temperature. Seedlings need to be replanted into beds in a way that disturbs the root system as little as possible, in a situation with plenty of good soil and water that allows them the best possible start to grow into productive plants. As soon as the plants are replanted they need to be watered so that soil is washed onto their roots. In extremely hot weather the holes into which the plants are planted needs to be watered first before planting the seedlings.

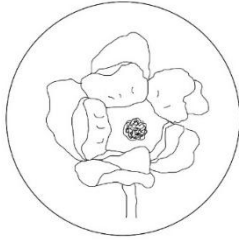


Depending on conditions, growing plants may have to initially be grown under nets to protect them from insect pests and sometimes animals and birds which eat either the small seedlings or the eventual fruit/vegetables.

During the period of growth from seedlings to adult plants the main work is to keep the weeds down, so the plants have space to grow. Covering the soil with some sort of mulch keeps out the light from the weeds, which inhibits their growth, as well as helping to retain moisture and bacterial activity in the soil. Removing weeds manually just as the seedlings start to grow makes the weeding job easier. At this stage the weeds are small and as the vegetable plants grow bigger shading the bed this also helps to inhibit weed growth. In some places it is possible to purchase a weed mat that is certified organic, and over time (usually quite a long time) eventually composts itself into the soil. Often black plastic is used in the same way, but it heats up the soil and there is a problem with disposing of the plastic when its job is finished.

As they grow some plants are regularly watered with compost tea or liquid manure to feed them while growing. This works particularly well with leafy plants like spinach.

d) **Flowering:** The flowers come when the plant is ready to reproduce. If conditions are poor, the plant may



either not produce flowers or produce flowers very quickly, so that seeds are produced quickly before conditions deteriorate. If plants flower early this can be because of unexpected climate

conditions or an indication that the plants are weak and need more nutrition.

Pollination of the flower: Flowers produce male cells called pollen and female cells called ovules (eggs). The pollen has to get to the ovules for the plant to produce

seeds from which new plants will grow.

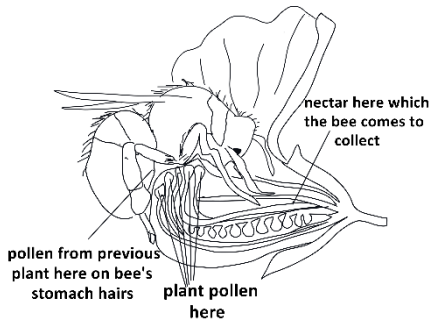
Plants have evolved in ways that allow them to live in symbiosis (cooperation) with

insects and the wind, which act as the main pollinators. In some plants that need

insects for pollination, the flowers have

colourful petals and sweet-smelling nectar to attract them. The plant's pollen then sticks to the insects and they carry it to the next plant they visit. Bees are the main

how a bee pollinates a plant

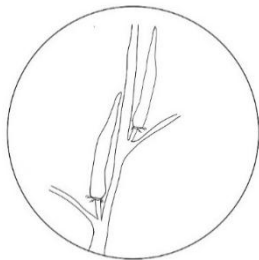


insects that pollinate flowers in this way. Some plants are pollinated by the wind. These plants have small petals and stamens (the centre of the flower which contain the female ovule) outside their petals so that the pollen can easily be blown off by the wind. Wind-pollinated plants often produce large amounts of light pollen that can be carried for long distances.

Fertilisation occurs when the pollen and ovule fuse together and eventually produce a seed.

To ensure plants produce seed, it is essential to understand this process and make sure that the right conditions are available for pollination for the plants that you grow. This might require making sure that certain insects are in the vicinity of the plants or that there are sufficient male and female flowers for pollination to take place.

e)Seed growth and formation; once fertilization has taken place the flower withers and the vegetable or fruit is formed. Usually we pick and eat the fruit or vegetables before seeds are formed. If we want to collect seed we often need to leave the vegetable on the plant to give enough time for this last

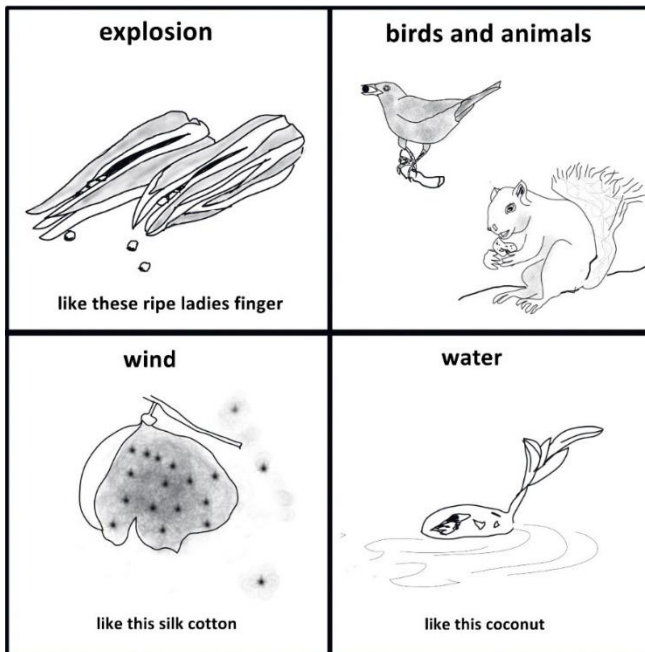


step of seed ripening to occur.

Seed ripening is a the last stage of the seed growing process when the seeds grow and ripen. During this latter process the seed pod will become dry and will

often change colour. In lady's finger, for instance, the pod has to dry and the seed pods turn brown on the plant before they are ready for collection and use. We eat ladies finger before they reach the last stage of the seed producing cycle, so to get our own seed we grow special plants for producing seed in the Seed Garden.

Seed dispersal: To ensure that plants have enough space to grow, seeds must be dispersed away from the parent plant. Since plants cannot move, they must use other methods to make sure the seeds are dispersed. The various methods are:



Explosion. Peas, for instance, have a seedpod that dries and splits, flinging the seeds over a wide area.

Animals eat the fruit and then excrete seeds far away from the parent bush. For some seeds this is a necessary process before the seed germinates. Plants that depend on this method of seed dispersal have fruit that attract the animals by colour or smell.

Wind. Grasses have fine, light seeds with 'whiskers' that are blown long distances by the wind.

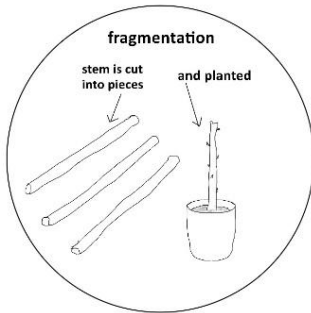
Water. Coconuts have a thick outer coat and are designed to float in water.

Once the seeds have been dispersed they are ready to grow into new plants, and the cycle starts all over again.

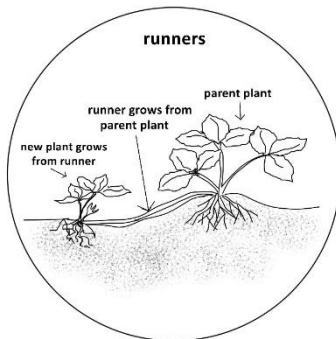
4. OTHER FORMS OF PLANT REPRODUCTION

In addition to producing seeds for (sexual) reproduction many plants also have various forms of what is called vegetative (asexual) reproduction as follows:

- a) **Fragmentation** is a process by which the stem of a plant is cut into pieces and each piece makes roots and can grow into a whole new plant. Bougainvillea is a good example of a plant that can be grown in this way.



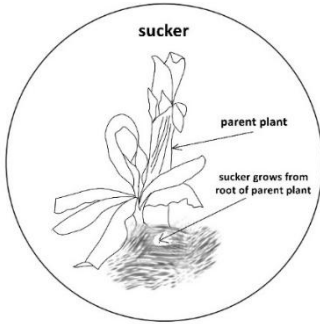
- b) **Runners** are slender horizontal stems that spread outward from the main plant. They arise from the stem of the plant and grow over the soil. New plants can develop from nodes located at intervals on the runners. Each node can give rise to new roots and shoots. Strawberries and many kinds of grasses are good examples of plants that propagate themselves in this way.



c) **Suckers** grow directly from the main root or stem and

then grow into a new plant beside the original plant.

Suckers can be dug up and replanted to grow into a new plant away from the original plant. This is how new bananas are usually propagated.



d) **Tubers** are fleshy underground food storage structures

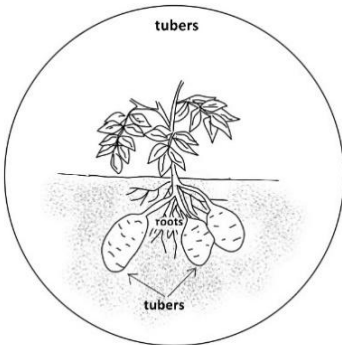
that are derived from modified underground stems.

These modified stems start as so called stolons that grow from the original stem in any direction in the soil together with the roots.

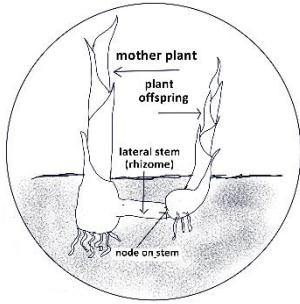
Tubers are basically

enlarged parts of these kind of stems that store nutrients, mainly starch, which will enable to plant to survive through times when growing is not possible.

Buds form on the tuber, each of which can grow into a new plant.

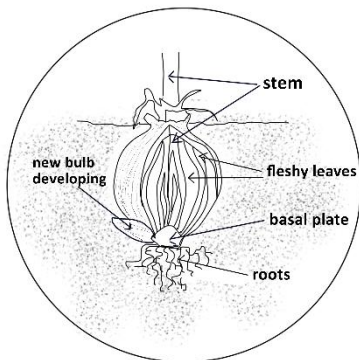


Rhizomes are very similar except that in this case the modified stem grows horizontally just under the surface of the soil. Unlike tubers the rhizome sprouts new plants from nodes on its surface with new shoots sprouting from the top of the underground shoot and rhizomes and roots



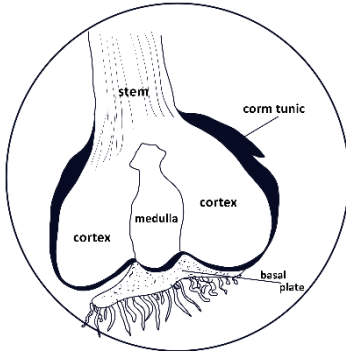
developing along the bottom. Like tubers the rhizomes main purpose is to store nutrients for the plant during times of inactive growth.

Bulbs are rounded underground buds with fleshy leaves extending from their short stem. Each bulb contains several other buds which grow into new bulbs and eventually new plants. Garlic and onions are good examples of bulbs. Like tubers they develop from underground stems but their growth patterns



are different. New bulbs grow from the base of the original bulb while tubers develop buds on their surface and new stems sprout from there. Onions, garlic and hyacinth are all examples of bulbs.

Corms have a swollen underground stem for nutrient storage and like bulbs have a basal plate from which the root grows. Unlike bulbs they are not composed of leaves but consist of a swollen stem in which nutrients are stored in special cells. The outside of the corm is protected by



old leaf petioles which are the remnants of leaves produced in previous years. They act as a covering, protecting the corm from insects, digging animals, flooding, and water loss. The tunics of some species are thin, dry, and papery, but in others the tunic of a mature corm can be formidable protection. Plants with corms generally can be propagated by cutting the corms into sections around a bud and replanting. Each section can usually generate a new corm and then a new plant

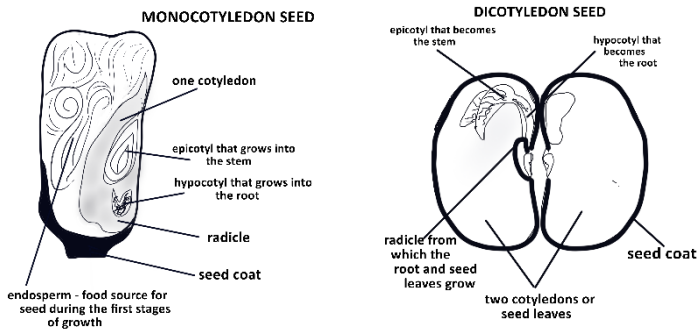
4. WHAT'S IN A SEED?

a) A seed consists of the embryo of a future plant together with a food source, called an endosperm, to use during its early stages of growth. Providing food for the initial growth of the plant is one of the most important functions of seeds, allowing the seed to grow as fast as possible.

The seed is covered with a protective coat called a testa which provides protection for the embryo and enables the seed to be effectively dispersed. It also protects the embryo from unfavorable conditions. The seed coat helps protect the embryo from mechanical injury, predators and drying out. In some cases the seed coat needs a certain type of treatment (maybe going through the digestive system of a bird or animal) before it can germinate.

On one side of the seed under the testa there is a small white root-like structure called a radicle from which the future root of the plant will grow. On the end of the radicle are one or two tiny white leaves which are the first true leaves of the plant. On the inside of the seed is either one cotyledon or 'seed leaf' (so called monocotyledon seeds) or two cotyledons (so called dicotyledon seeds) that take up the bulk of the space inside the seed.

Diagram of a mono and dicotyledon seed



When the seed sprouts these cotyledons turn green and look like leaves (hence their alternate name of seed leaves) but at this stage of the seed's growth they are not photosynthesizing. Instead they are using the stored starches, fats and proteins within their form (dicotyledons) or the endosperm (monocotyledons) to supply energy to the developing plant embryo during the early stages of its growth.

Once the embryo has used up the food stored in the cotyledon (s) the plant will start to make its own food through photosynthesis which will happen through both the true leaves that come after the seed leaves which at this point will also start to photosynthesize. Once that starts happening the plant will go on to grow into a new plant.

In flowering plants the ovary of the flower ripens into a fruit which contains the seed. There are a range of



variations and sometimes it is difficult to distinguish the seed coat from the flesh of the fruit. Peach seeds, for instance, have what appears to be a hard seed coat which is in fact a hardened fruit layer. Cashew nuts are an interesting variation in that the nut (seed) does not develop inside the fruit but at the bottom of the fruit once it has reached a certain maturity. Hence the fruit of the cashews are known as 'false fruit' which grow to maturity after the nut.

Seeds are very diverse both in size, shape, colour and appearance this often relating to the adaptations the plants have made to the climate in which they grow and to ensure that the seeds disperse and find somewhere to grow. Plants that produce smaller seeds may generate many more seeds per flower, while plants with larger seeds usually invest more energy per seed and fewer seeds. Smaller seeds are easier to disperse than larger seeds so many annual plants produce large quantities of smaller seeds which helps to ensure that at least a few of them will end up in a place that is suitable for growth. Larger seeds may have a tough seed coat that enables the seed to survive for longer until the plant comes into the right conditions. Many of the seeds of plants in the tropical rain forest are able to remain dormant for long periods of time and only germinate when the conditions are right – such as if there is more sunlight when a nearby tree falls down.

Overall seeds serve several functions for the plants that produce them. Key among these are nourishment of the

plant embryo after germination until it grows roots and dispersion to a new location. Most seeds are the product of sexual reproduction which produces a mixing of genetic material and phenotype (observable traits) variability on which natural selection acts. Plant seeds also hold micro organisms that often protect against disease.

b) HYBRID SEEDS – WHAT ARE THEY?

To understand the characteristics of hybrid seeds it is important to understand how plant features, like size, type of fruit etc., are passed down from one generation to the next.

A gene is considered to be the basic unit of inheritance and these are passed from the parent plants, through the seeds, to the offspring. Genes, through their substance of DNA which forms chromosomes, contain the information needed to specify physical and biological characteristics of the plant as passed down from the parents. The genome is the complete set of genetic information in the plant that provides all the information the plant needs to grow and function. Plant cells are made from proteins. It is the genes that translate to the growing plant the information for how those proteins should be made. The way they do this can be quite complex especially when affected by things in the environment.

When a plant is fertilised the male and female genes combine and are carried in the seed. Traditionally crops

were 'open pollinated', which meant that the pollen could come from a large number of different plants in the surrounding area, so that it was not always easy to predict how plants would produce from year to year. If the climate was very variable, however, plants with varying characteristics were an asset. Whatever the weather, probably at least some of them would have characteristics that would enable them to survive and there would be something to eat.

Over the last fifty years or so various methods have been used to manipulate plant genes to change crop characteristics so that they grow and produce in more predictable ways. One method is to create a hybrid seed, which is a cross between two varieties of the same plant. This happens from time to time in nature, but in 1920 the first human plant hybrid was created using maize. It is carried out in the following ways:

Two 'inbred' lines of the two varieties are produced. This is done by pollinating the flowers by hand from the same plant.

Once the two inbred lines are established, the two varieties are cross-pollinated to produce what is known as a first generation or 'F1' hybrid seed.

Seeds produced in this way have the following advantages:

1. They have what is known as 'hybrid vigour', which means that they produce more and uniform crops, all at the same time.

2. The hybrid process can also be manipulated to create plants that produce crops of a particular type – extra red tomatoes or papayas of a certain size. Hybrid plants with predictable characteristics can be very useful for farmers. Plants that all grow the same and produce at the same time make it much easier for farmers to do the necessary farm work, like weeding and harvesting, with machines. Supermarkets also often prefer vegetables and fruit that all the look the same and have been bred with characteristics like having a long shelf life. For this reason hybrid plants are very popular and in some places it is more or less impossible to obtain non hybrid seed.

In the long term, however, hybrid plants do have disadvantages as follows:

1. As more and more farmers use hybrid seeds the irony is that they have a tendency to eliminate the varieties from which they have been derived. Hybrid varieties yield better than the varieties from which they are derived, and very often displace them in farmers' fields. Once a displaced variety is no longer planted, its genes are lost to future generations unless it is conserved, usually in a seed bank collection or as an heirloom variety. Many of these heirloom varieties taste better, cook better, or possess other unique characteristics that make them good for a particular environment, but they lack the productivity that mechanized farming demands in modern agriculture.

2. The in-breeding – which happens when both the male and female pollen comes from the same plant –

intensifies any weakness in the plant. Initially hybrid seeds may be more vigorous, but if there is a build-up of susceptibility to disease in the two inbred lines from which they are derived, this can have serious consequences. A particular weakness in the genetic stock of maize used to produce hybrid seeds in America made the plants susceptible to a fungus disease. During a damp 1970 summer, the disease spread widely in America with disastrous results for farmers who saw all their corn rotting in the field. Eventually new hybrid strains without this genetic weakness were bred, but not before many farmers had gone bankrupt.

3. If seeds of hybrid plants are saved they will not have the same characteristics as the parent plants. The two different varieties combined in the F1 hybrid seeds segregate out in the offspring. In other words, the superior qualities of the F1 hybrid disappear in the next generation of plants, which 'revert to type' or go back to the original two varieties.

The development and creation of hybrid seed is done almost exclusively by seed companies for the practical reason that they have the expertise for the work, and the means to maintain appropriate in-bred lines in an economical way. Hybrid seed production has prevented farmers from saving and replanting seeds, making it necessary for them to purchase seeds every season. They have become dependent on the seed companies for their seed.

4. While hybrid seeds were an important part of the 'green revolution' in India and are credited with averting famine, there were some disastrous long term consequences for the environment. In order to get the best from these high yielding hybrid seeds farmers mechanized and used chemical fertilisers, pesticides and weed-killers. Over time this led to soil damage (from the overuse of fertilizers) together with water pollution (from both fertilizers and pesticides) as well as lowering of the water table. More worryingly it has been found that the initial productivity gains from this type of industrial type farming are tapering off with more and more fertilizers needed to keep the same level of production.

c) GENETICALLY MODIFIED SEEDS

Genetically modified seeds are created by inserting specific DNA into a plant's genome (its original gene profile) to give it new characteristics. This can include a wide range of characteristics such as:

- Improved crop yields even when conditions are poor, such as poor soil or lack of water. i.e. plants are created that can grow with very little or in contaminated water.
- Increased resistance to pests and diseases which reduces the need for pesticides and other chemicals. Bt corn, for instance, produces a toxin that kills certain pests that would otherwise have to be killed with large amounts of pesticides.

- Improved nutritional value such as so called 'golden rice' which has been modified to produce vitamin A.

There is no consensus as to whether genetically modified seeds are overall a good or bad thing. Environmental concerns include:

- **Environmental risks;** if GM crops contaminate non-GM crops or wild plants this could potentially cause environmental harm. Such as if the so called 'terminator gene' (which stops GM crops producing seed) were to lead to the extermination of certain plants.
- **Food safety;** despite tests showing that GM crops are safe to consume, since this is a very recent development the long term effects of consuming these crops cannot be known. Are the plants that produce toxins to deter pests safe to eat in the long term?
- **Patent issues;** and the high price charged by seed companies limits access to the seed for small scale farmers and poorer countries.
- **GM seeds,** even more than hybrid seeds, create seeds with the same genetic profile. This means that if there are unexpected weather events with which the plants cannot cope, the whole crop will fail with potentially disastrous results for the farmer.

5. SEED SAVING

a) WHY SAVE OUR OWN SEED?

Before the days of seed companies, which wasn't so very long ago, farmers saved seed from their crops, often taking them from their best plants to use the following year. Compared to today there was a very wide diversity of food crops most of which were adapted to (often very) local conditions.

Increasingly, however, the global food supply has become dependent, both on a small number of species of food plants and a smaller number of varieties within that species. Now a mere 24 food plants account for 75% of all plant calories and 90% of arable land cultivated. This list includes six grasses – rice, wheat, corn, barley, oats and sorghum; four legumes – soybeans, peanuts, common beans and peas; two sugar crops – sugarcane and sugar beets; two tropical tree crops – bananas and coconuts; four starchy roots – potatoes, sweet potatoes, cassava and yams; five fruits – tomatoes, grapes, apples, oranges and mangoes; and two vegetables – cabbages and onions.

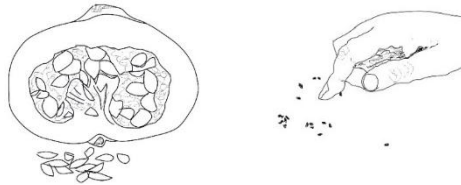
There are many reasons for this loss of biodiversity, but one is the increasing use of hybrid and genetically modified (GM) seeds. This has happened because of changes to the practice of farming which requires more uniform seeds that are grown in large quantities using mechanized equipment.

b) Growing and collecting your own seed will enable you to grow plants that eventually become adapted to your place. Over time they not only adapt to the soil and other conditions but to the pests so that they are able to resist them. To become completely adapted the plant needs to be grown for at least six generations. Plants grown from your own seeds will have more diversity/variety. If you experience unexpected bad weather at least some of your plants will survive and you are much more likely to have something to eat.

- Over several generations seed grown in a particular place adapt to survive in that particular place. This means evolving ways to deal with the soil, water and pests that occur there.
- Open pollinated seeds have much more diversity than hybrid or GM seeds so in these days of climate change and unexpected weather events the plants are more resilient. Some plants will grow and provide something, whatever the weather or extreme weather event, rather than the whole crop being destroyed.
- Seed saving enables local/heirloom varieties of food to continue to be grown and eaten which helps preserve a diverse farm ecology.

SAVING YOUR OWN SEEDS BRINGS FREEDOM!

AND BRINGS BACK DIVERSITY



Your seeds adapt to your place and grow well

Your seeds produce diverse plants

**Whatever the weather you will more likely have
something to eat.**

b) GROWING SEEDS FOR SEED SAVING

Growing vegetable or fruit seeds to collect and save is generally (but not always) a separate process from growing vegetables and fruit to eat. When fruit or vegetables are ready to eat, the seed within them at this point may not be ripe and therefore cannot be collected for saving.

If you want to save your own seed it is therefore important to understand not only the general reproductive cycle of the plant that produces the seed. But how the seed ripens and needs to be saved if it is to

grow into a new plant. It all depends on the vegetable/plant.

- Take seeds from the plant when the vegetable or fruit is ripe but before it disperses naturally. Some seeds need to ripen completely on the plant, others need to start ripening on the plant but will continue to ripen off the plant once they have been picked.
- Grow some plants just for their seeds. All the energy of the plant then goes into creating the seeds.
- Seeds need to be processed in different ways. Some will need to be soaked/fermented and washed. Others will need to be dried over a long period.
- To preserve their vitality seeds need to be stored properly. They must be properly dry and kept away from insects that might eat them. Keeping them in the fridge is a good way of doing this.

c) COLLECTING AND PROCESSING SEEDS FOR SEED SAVING

This section is in part based on the experience of saving our seeds in Buddha Garden.

Amaranth: These seeds are small and will fall off the plant as they ripen. Best way to catch them is to put a paper bag over the seeds (which grow at the top of the stem) and bend the stem over so the seeds fall into the bag as they ripen. Collecting these seeds when rain is around is difficult if not impossible so the best time to do this is during dry periods. Or plants for seeds can be grown in places like a nursery that is/can be protected from rain, although this means the plants will have to be watered manually while they are growing.

Beans; the best way of growing bean seeds is to allow two or three of your bean plants (depending on how many seeds you want) to just grow bean seeds and for none of the vegetables to be picked. This means that all the energy of the plant will then go into the growing the seed rather than in growing the vegetables. It is best if the beans can be allowed to ripen completely on the plant and then picked when the seed pods are brown and dry. This may not be possible, however, if there are animals around that like eating the seeds or if there is rain that might stop the seed drying out and lead to seeds becoming unusable because of fungus. In this case the beans can be picked when the beans are ripe but the pods not completely dried out. Or the pods can be covered in something so that the animals cannot get to them. Further drying out can be carried out in a protected place in the hot sun. It is important that the seeds are properly dry as the first stage of the bean

germination process is for the seed to absorb water and the dryer the seeds are the more water they can absorb.

Bitter gourd; the gourds need to be left on the plant until they change colour (most varieties turn yellow as they ripen) which shows that the seeds have started to ripen. They will not be fully ripe, however, until the inside of the gourd turns red which can usually be seen when the ends of the gourd open. To save the seed split the gourd open, wash all the red material from the seeds which then need to be dried.

Brinjal (aubergine, egg plant); the vegetable should not be picked until it is ripe which generally means that it will need to change colour. In Buddha Garden the variety that we have turns yellow when it is ripe but there are many different varieties of brinjal and you will have to watch to see how the colour changes as it ripens on your plants. A ripe brinjal is full of seed and is not therefore good to eat. There are two ways of dealing with the seed:

1. The seed can be scraped out with a knife and then soaked for 24 hours. If the seeds start fermenting this is supposed to be good for their germination. After that the seeds need to be washed and then dried in the sun as quickly as possible so that fungus does not grow on them.
2. Another way of collecting the seed is to slice the brinjal in half and then leave them to dry in the sun. This takes some time, however, so it is

something we tend to do in the hot season when there isn't any rain as it takes some time for everything to dry out so the seed can be scraped out of the vegetable. Once that is done the seeds are usually clean enough to be bagged up.

Ladies finger: the pods need to be left on the plant until they are brown and completely dried out, which can take some time. Eventually the pod opens which shows that the seeds are completely ripe and ready to be collected.

Pumpkin: seeds need to be scraped out of the middle of the pumpkin when it is ripe. One advantage of pumpkins is that they do not have to be left on the plant to ripen completely but can be picked as soon as they start to ripen. They can be left to ripen in a store room and once ripe they are ready both to eat and for the seeds to be cleaned and dried and stored.

Tomatoes: this is one of the few vegetables where the seeds are ripe and ready to be collected when it is ready to eat. To be absolutely sure the tomato seeds are ripe you can allow the tomato to go a bit squishy. To collect the seeds scrape them away from the flesh and then soak them for 24 hours. After which wash them well and dry as quickly as possible in the sun.

d) SAVING SEEDS

1. Once the seeds have been dried they need to be put into bags/containers and saved. It is very important that the seeds are labelled properly with details of variety and when and where they were collected.
2. For long term saving most seeds are refrigerated as they deteriorate less quickly and therefore last longer – usually several years. Some varieties of seed last much longer than others and it is important to know which last longer so that those that last for only a short time are replaced regularly. If a fridge is unavailable the seeds can be kept in a cool dry place (like a store room). In this case it is important that the seed containers are insect and animal proof. To make absolutely sure seeds can be mixed with ash to protect them both from insects and diseases like fungus.
3. It is also important to keep an ongoing list of seeds that are used so that when certain seed stocks are low efforts can be made to grow some more as soon as possible.



HOW TO KEEP
IN TOUCH
WITH OUR DAILY
FOOD GROWING
PRACTICE

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