

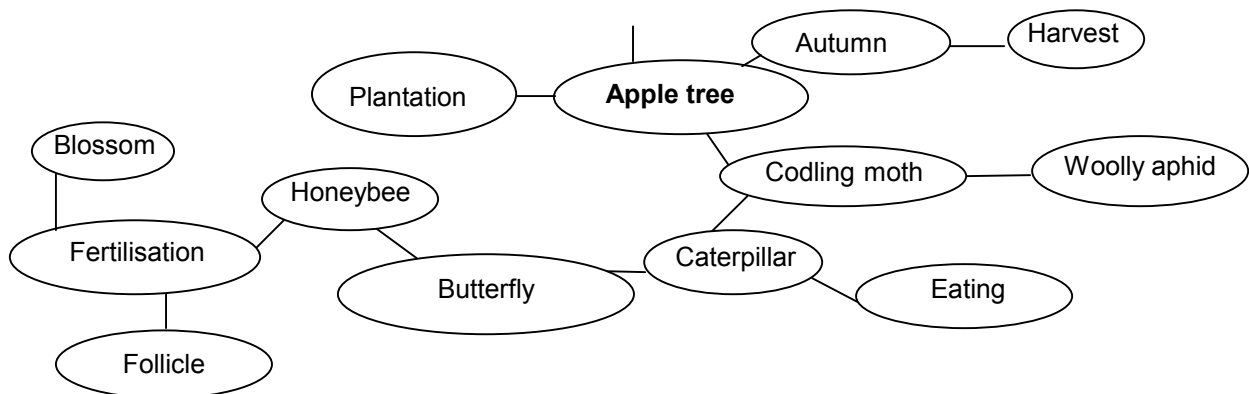
Creativity methods

Brainstorming

Brainstorming works best in groups. Everyone is allowed to say spontaneously whatever a particular topic or concept suggests to them. Nothing is subjected to criticism or comment, nothing is rejected. A minute-keeper writes down all contributions, but not in any imposed order. Sorting and selection comes later. A brainstorming lasts 5 to 10 minutes, depending on the subject, after which time it usually comes to an end automatically.

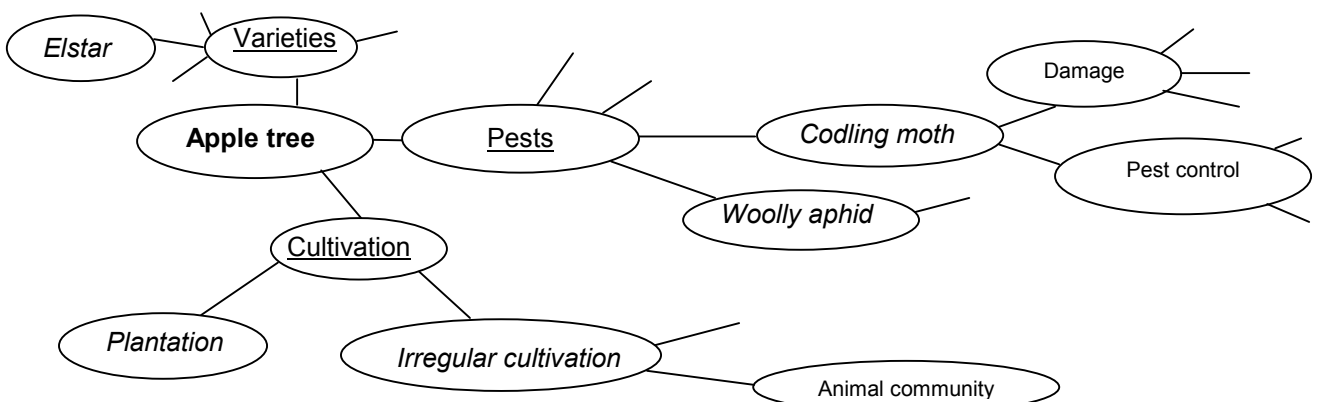
Clustering¹

Clustering was devised by the educationalist Gabriele L. Rico and is a special form of brainstorming for one person. A concept is written in the middle of a piece of paper and a circle is drawn around it. The person gives his or her thoughts free rein and writes down all associations as soon as they come to mind. These ideas, expressions or words now also have circles or ovals drawn round them and are connected by lines or arrows - associations belonging together follow on after one another. During the process it is possible to go back to an earlier concept and thus branch off in different new directions. Nothing is arranged in any order, e.g. more universal or more particular concepts.



Structural diagram (also known as "Mind Mapping"²)

The structural diagram differs from clustering in that the terms are arranged under more universal and more particular concepts, resulting in a hierarchical order. The central concept is linked with main categories and these in turn with relevant sub-points, thus opening up many new lines.



¹ Gabriele L. Rico, 1983

² The terms "Mind Maps" and "Mind Mapping" are proprietary and may be used only by the patentees for advertising or promotion purposes.

Botanical classification of the apple-tree:

The apple is a member of the rose family. The alternate leaves of rose species almost always have a paired appendage at the leaf base, called a "stipule", and are often pinnate. The flowers show a radial structure, mostly with five separate petals, and a corona consisting usually of a large number of stamens (5 or 2-4 times as many as the number of petals), and a clearly distinguishable style in the middle. The narrow lobes of the sepals are often clearly visible between the petals. The carpels are not fused together, the petals are usually shaped to a cup-like form. The flowers are either solitary or clustered together in an inflorescence. The fruits are aggregate nut fruits (nutlets), though they may also be capsules, stones or follicles.

The apple is an aggregate follicle. Follicles consist of a single carpel. The follicles form the central casing, or core, and the carpels turn parchment-like. The pulp surrounding the core is derived from the growing flower stalk.

Conventional breeding of apple-trees and breeding by means of biotechnology:

Breeding of apple-trees or apples is carried out with a view to improved quality and storage characteristics, resistance to apple scab and powdery mildew, and higher yield safety. Some of the most familiar cultivars of apple were discovered by chance (random seedlings) and then deliberately multiplied (selective breeding). Examples of these are Golden Delicious, McIntosh, Red Delicious and Granny Smith, which all originated in the nineteenth century. Other cultivars came about as a result of cross-breeding, e.g. Elstar from Golden Delicious and Ingrid Marie, or Jonagold from Golden Delicious and Jonathan.

Apple-trees need several years to grow from seed to first fruit, and several generations are necessary for successful breeding. This means that about twenty years will go past before a new "cultivar" (*cultivated variety*) is ready for market. To make it easier and quicker to select suitable candidates for the breeding process, scientists search the apple genome for so-called "markers" which indicate the genes for certain characteristics. For this purpose they must localise relevant genes - e.g. those for disease resistances - on the genome of the apple. What are known as DNA-markers are used to detect these genes reliably in the genome of the new seedlings. If the DNA extracted from the leaves of young seedlings is found to possess certain markers (which can be confirmed by DNA analysis), it will also possess the related genes, e.g. resistance genes. It has already proved possible, for example, to detect a scab resistance gene in this way.

This takes very much longer by conventional selection methods, and sometimes not until the trees are several years old - as, for example, in the case of resistance to powdery mildew. Molecular diagnosis can also show whether a trait is pure-bred (homozygous) or of mixed ancestry (heterozygous), or whether one or several genes are responsible for a characteristic (e.g. a resistance) in a particular plant. Information of this kind makes selection easier and helps in the search for suitable crossing partners.

Resistances due to crossing occur naturally in existing apple cultivars, since crosses only work between related plants. There are other characteristics, however, which cannot be obtained so easily by crossing, or for which genes have not (yet) been found in apples. For this reason gene technology is also being used in efforts to bestow particular characteristics on apple-trees. Of particular interest

here are resistances to fungi and bacteria, or to particular insect pests. The usual method used to achieve resistances to bacteria or fungi is to introduce genes for substances which break down cell walls, such as chitinase or lysozyme. But modifications in the blossoming time or in certain quality characteristics are also on the agenda. Transgenic apple-trees have already been released in Europe, North America, Australia and New Zealand, but no transgenic apples have yet been placed on the market.

Grafting:

If trees were grown only from seed, every tree would have its own specific genome, which means that every tree would also have different fruits. This is the reason why trees are grafted in tree nurseries: the fruit-bearing parts of the selected cultivars are grafted on to what is known as an “understock”, consisting of the roots and stem base. The understock may have been grown from sexual propagation (seed) or asexual propagation (root formation by shoots), the advantage of the latter method being that all shoots have the same characteristics as the parent plant. The understock influences growth, fertility, and resistance to frost and diseases.

A distinction is drawn between cleft grafting and bark grafting. Cleft grafting is carried out very early in the year. The understock is cut straight across the middle and then split to a depth of a few centimetres. The graft is sharpened at the bottom to a point and inserted into the cleft until cambium contacts cambium. The site is smeared with grafting wax and wrapped with canvas and bast.

Bark grafting is carried out later than cleft grafting, i.e. when the sap is rising. A scion of the selected plant is placed in a gap between the wood and a loosened flap of bark. This is obviously a gentler method.

Other methods are splice grafting and bud grafting. For splice grafting a sharp diagonal cut is made through a small stem, and on this is placed the end of a scion with exactly the same kind of cut.

Budding means the insertion of a piece of wood carrying a single bud. This “budwood” from one plant is inserted into a slit, shaped like a T or a cross, which has been cut into the bark of the other plant.

This method is used mainly for roses.

Cultivation:

The trees are cultivated either irregularly on meadowland, or in plantations. Irregular meadowland cultivation means that fruit trees of various species and cultivars stand together, but not in regular rows, as in plantations. Irregular cultivation provides a biotope for many different wild species, but they are of lesser economic importance than plantations. The trees grow higher than in plantations, where care is taken to ensure that the fruit can be plucked more easily.

Apple-trees prefer very loamy sandy soils enriched with humus. They are planted during the resting period from autumn to spring, though when the trees are planted in autumn they take root better and sprout more strongly.

The tree is planted in such a way that the grafting site is at least a hand’s breadth above the soil. If the hole is too deep, this will destroy the capillary effect which conducts water from to the tree from deeper soil layers. (The capillary effect can be demonstrated, for example, with ink and glass capillaries. For

comparison, a solid, dry lump of soil can be placed in a dish with a small amount of water - the water will moisturise the soil right through to the top.)

A prop is hammered into the soil to a depth of about half a metre in the direction of the prevailing wind. A mesh can be laid in the pit to protect against mice. To ensure that the mice really have no chance, care must be taken that the mesh at the end is laid flush around the base of the stem to a height of about 30 cm. Once the pit has been filled, it is covered over with compost or chipped bark. This improves not only the nutrient status but also the water balance of the soil.

Pests and diseases of apple-trees:

The simplest thing for the fruit farmers, of course, would be if the fruit trees themselves possessed sufficient resistance to pests and diseases, without any of the extra work needed for solving the problems. This is the reason why resistances are one of the constant aims of breeders (see above). But breeding by these methods is laborious, time-consuming and not always successful, which means that conventional methods for the control of pests and diseases will continue to play an important role for a long time to come.

Apple scab is one of the most prevalent plant diseases in fruit-growing. The fungus overwinters in the fallen leaves on the soil, where the fruiting bodies develop. The spores of the fungus germinate and make their way into the leaves.

After a time the infected leaves show scab patches. These patches are where the conidia are stored and where during the course of the summer enormous quantities of summer spores are generated, which then trigger off the secondary infection. The conditions necessary for the development of infection by the winter or summer spores of the fungi can be identified with the aid of various instruments. It is possible, for example, to calculate the time point when the trees should be sprayed with fungicides.

Powdery mildew is a fungal disease which affects leaves, shoots, flowers and flower buds. The fungus overwinters on the shoots and in the buds, and for this reason it is very important to prune off the infected shoots. Primary infection takes place at shooting. Fungicides are sprayed before shooting, and again after shooting.

There are also a number of other diseases prevalent in fruit-growing which can be caused by viruses or bacteria. The pathogens and control methods mentioned here can only be taken as examples since there are very many different pests and diseases of fruit-trees.

The caterpillars of the apple ermine moth live in large collective webs and damage the trees by eating the leaves. They can be controlled if cut away early enough.

The apple leaf sucker, or apple psyllid, is a winged plant louse which mostly infests apple-trees. As a result of its sucking activities and honeydew excretions the leaves turn patchy and often start to curl, the flower buds frequently fail to develop and dry off on the tree. They are controlled by plant protection products.

The larvae of the apple blossom weevil eat the blossoms. They are controlled by plant protection products applied before blossoming.

The apple sawfly goes to work directly on the apples, in which it produces a system of tunnels and cavities. It can be controlled with suitable chemical or biological products. Infested fruits are collected and destroyed.

The summer fruit tortrix moth is a small species whose larvae cause great damage by eating the fruit. It can be controlled by predatory wasps or plant protection products.

The apple capsid bug sucks on the leaves, shoots and fruits. It can be controlled by plant protection products, for example by certain plant extracts.

The codling moth is a small species whose larvae bore into the fruit at the blossom or calyx end of the fruit and eat their way to the core. Many different techniques are helpful against the codling moth.

Control measures can be carried out, for example, in the form of repeated spraying of plant protection products at the time of egg-laying, i.e. at the end of May to beginning of June. A biological control method is also possible with the aid of egg parasites. Two different predatory wasp species are used for this purpose.

The woolly apple aphid infests mainly apple-trees. More seriously infested patches can be cut out or brushed off. An intact beneficial fauna, as found in irregularly cultivated areas, can often make it unnecessary to carry out control measures. Useful beneficials here are ladybirds, earwigs, the larvae of hoverflies or lacewings, and woolly aphid parasite wasps.

It is a general rule in plant protection that the use of resistant, hardy cultivars is a very economic and environmentally friendly approach. For this reason great efforts are being made by breeders to obtain cultivars of this kind by conventional and/or biotechnological methods.

Links

Pests, diseases, and beneficial organisms:

<http://whalonlab.msu.edu/PestPictures/applepests.htm>

<http://www.rce.rutgers.edu/pubs/pdfs/fs112.pdf>

http://www.agricology.com/pest_guides/appleguide.html

<http://orchard.uvm.edu/uvmapple/pest/BacktoBasics/Diseases.htm>

<http://www.gaipm.org/id/appled.html>

<http://www.verbraucherministerium.de/englisch/pflanzenschutz/risk3-2.htm>

Growing:

<http://www.norfolk-county.com/bigapple/seasons.htm>

<http://www.agric.nsw.gov.au/reader/10691>

Contacts:

<http://www.hdra.org.uk/> Organic growing

<http://www.aprc.org.uk/> Apple and pear research council

<http://www.aftonpark.co.uk/> Nursery and orchard

Facts and more:

<http://www.urbanext.uiuc.edu/apples/>

Future:

<http://www.guardian.co.uk/Print/0,3858,4061323,00.html>