Selection and breeding

by Frank van Steensel

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Part 1. Action required?

Genetically 'modified' organisms! To me the old name genetically manipulated organism is still more appropriate. Within our current world view we are taught that we can control and manipulate everything in the name of progress. But history, ecology and thermodynamics prove us wrong. I should of course first mention various religions and metaphysics but since they are not scientific we do not take them seriously.

We act like little children running around and waving sharp knives, not knowing that we can harm ourselves or others. Knives are very useful if you know how to use them; as responsible parents we do not allow young children to play with them. The point being: we do not know enough about genetic modification to act responsibly. It is still a big experiment that could go terribly wrong.

The introduction of genetically modified plants into our environment will have huge implications for organic, ecological and biodynamic production systems especially those using the open and cross pollinating plant varieties. Already one of England's largest organic grower is under threat of losing his certification because the neighbours are growing genetically modified maize. He can lose his certification because the maize might pollinate his crop. This is only one of the many issues facing organic farmers if we do not accept genetic modification.

In many places of the world it looks as if certified organic or biodynamic produce is going to be the only way to buy produce free from genetic modification[1]. How do we keep it that way? It is my view that we have to make it very clear – especially to the government – why we do not want it, and *what we (and our customers) do want* instead. Every person involved in the organic industry needs to be able to answer those questions clearly so that we are being understood and respected in the community. I feel our position (the New Zealand organic industry) is very fragile, nationally as well as internationally, since we have not yet expressed a vision or even started to produce plant and animal selection and breeding programs in line with our philosophy.

So what do we want?

We all require seed to grow crops and at the moment we seem to be pleased if it is not treated. Most of the time we buy untreated seed from the major seed suppliers in New Zealand such as Wrightsons and the like. Even though we are all being encourage by Bio-Gro New Zealand and the Bio Dynamic Farming and Gardening Association to buy certified organic seeds or to select our own, the standards allow us to take the easy way out. Herein lies a big danger. I know that except for some small companies there is no commercial quantity of organic certified or selected seed stock available. The truth is that eventually untreated seed will no longer be acceptable. The plants coming from conventional breeding programs are not ideal for ecological or organic farming and many of them will be ruled out for organic certified production systems due to genetic modification. In the European Union all input material used in certified organic plant production systems should be of organic origin by the year 2000 (EU regulation 291/92). This means using certified seed. We see similar developments in the United States, although on regional basis. For New Zealand, not being on the third country list[2] of the EU regulation 2091/92 this could mean an increasing disadvantage for exporters to Europe and other parts of the world. But this article is not about marketing although it is a good mechanism to activate a Kiwi.

Back to the heart of the matter. Organic, ecological and biodynamic farming are based on various principles and a key principle is diversity (even Agenda 21 stresses the importance of bio-diversity). This is a scientifically established key principle for a self-regulating agro-ecosystem. It means that different regional farms requirea broad variety of plant species and varieties (the farm as an individuality, the farm as an organism). An important factor within this concept is cultural diversity. More breeders involved in plant breeding and selection increase the diversity. Actions in the past ("the green revolution") have led to concentration and merging between large breeding firms and multinationals (like Monsanto, Sandoz). They use technologies (genetic modification, plant patents and cytoplasmatic male sterility) that prohibit the free exchange of genetic material. This is the direct opposite of the development of genetic diversity that is so badly needed for stable agro-ecosystems. These developments require immediate action from our side.[3]

It is not only important to produce commercial quantities of certified organic seed but we have to cross breed and select

[1] NZ is ideally located since we are surrounded by sea – if only we could stop the introduction of .....: *Nuclear free and free of GMO's.* In Europe they would kill for a market slogan like that.

2 In EU countries other member states are "second" countries and outsiders like New Zealand are "third" countries. Getting New Zealand on the third country list for the right to export organic produce requires New Zealand government involvement.

new varieties that can function in an ever developing ecological production unit. We do want progress!

The goal, as I see it, should be to sustainably manage our cultivars by using responsible breeding and selection techniques and criteria. This means increasing agrobiodivesity and selection for quality concerning plant health and nutritional values. We urgently need to discuss these criteria and techniques with all interested parties. Maybe we need to add more to the discussion but we definitely need a vision. Who is going to do what? What are the views of Bio-Gro New Zealand and the Bio Dynamic Farming and Gardening Association? Do we leave the responsibility with them? Is there a need for a "platform"?

A platform's task could be:
Developing a vision and strategy for responsible breeding and selection for ecological production units
Stimulating, initiating and coordinating breeding and selection activities for the professional organic or ecological grower with improved social-economic structures
Developing, stimulating and maintaining national and international relevant contacts and cooperatives
Fundraising
Promoting, by means of publications, seminars, courses and workshops for growers, marketers, consumers and scientists.

There is probably more but I see this merely as a starting point. What is important now is responses and action!

Part 2. Lessons from Nature and History (phenomenology)

In the last issue of *Harvests* (winter 1998) I introduced Table 1. This time I want to include a few more comparisons. I discussed soil development and ecological succession. That involved the development of ecosystems or landscapes under the influence of the physical environment – climate, soil, topography, and so on – over a long period of time. I mentioned that over time the flora and fauna will change under the influence of climate, soil and the interaction between the biological organisms (plants, insects and animals) in that landscape or system.

The study of ecological succession has led to the discovery that ecosystems go through different developmental phases. Although there is a huge variation between landscapes or ecosystems there is great similarity in their development. There is an underlying principle at work that causes a newly formed landscape to go through different developmental phases. If they do not 'die a premature death' they all go from a juvenile or pioneering stage to a mature or climax stage. Under normal conditions it would be reasonable to expect a juvenile-pioneering stage to develop into a mature-climax stage.
This then can be seen as the 'goal' (ecology), 'purpose', 'formative force' (R.Sheldrake) or the 'will' (Goethean science) of Nature.

Comparing the two stages shows that they have very different characteristics.

So far ecology, or Nature.

Now for agricultural history. Agriculture has gone through

Table 1 - Juvenile and mature stages of soils and ecosystems compared

	Juvenile	Mature
Plant species	one or few	Many
Number of individuals per spp.	Many	few
Plant types	Annual or biannual herbs	one-, two - and more year herbs, shrubs, trees, mosses, ferns, etc
Animal species	few	many
Relationships	simple	complex; specialisation
Biomass	growth; increasing annually	growth and decay in balance
Environment	extreme;	regulating
(fluctuations)	'plant unfriendly'	
Mineral cycles	Open	Semi-closed
Stability (resistance to external perturbations)	Poor	Good
Production	Quantity	Quality
Entropy	High	Low
Soil	mineral, unripened	ripened, with organic matter and humus
	high inorganic P	high organic P
	high pH	neutral pH
	low CEC	high CEC

[3] So this is the time for me to salute all the Kay Baxters (Koanga Nursery), Dave Treadwells (Organically Yours) Dieter Proebsts (Tree Dimensional Nursery) and Chris Hulls (BD Seedbank) in New Zealand. They are the pioneers in NZ. They have made sure that we still have a broad diversity of genetic material to work with.

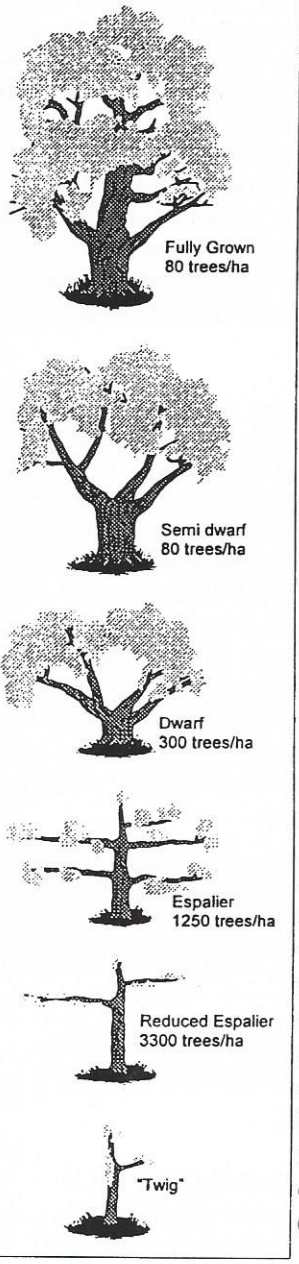
different stages. The first human communities were hunters and gatherers. The next development was the domestication of certain animals (nomadic societies). Following that came the domestication and selection of plant crops. The system evolved from a simple towards a more complex, diverse one with an increasing number of interactions. During the Christian era mixed farming developed – the farming of crops (cereals, vegetables and fruit) and animals in a landscape with wetlands, forests and shelter and hedge rows, was the main concept.

This concept came to an end when our western world-view changed from an overall religious one to a more materialistic-mechanical world view under the influence of 'The sciences' as introduced by Francis Bacon, Rene Descartes, and Isaac Newton. Adam Smith's theory of 'modern' economy underwrites the same world view. Justus von Liebig had the largest influence on agriculture with his 'barrel theory'[1]. The barrel theory led to the introduction of synthetic fertilisers and eventually to pesticides. During this phase the farms changed from mixed farms towards more specialised ones supported by the breeding and selection of a 'few' new crops and animals. This is agriculture as an industry. It was in sharp contrast to the mixed farming system, a system which in itself is already diverse, but also the crops and animals used were different over the regions and countries. There was a broad genetic basis due to the wide variety of regionally selected plants and animals. The plants and animals were adapted to the physical environment, the farm, in which they were selected. The introduction of chemicals and new technologies made it possible for the farmer to improve his control on the physical environment and to increase production. Farmers all over the world are able to create a similar environment for a few 'world varieties' with high production capacity. This has led to a genetic erosion. This development also created opportunities for large multinationals to increase their influence. They now supply all the inputs required by farmers (and take most of the profit) and are the ultimate products of the 'Green Revolution'.

For example: commercial chicken breeding is now under management of five multinationals. The different breeds disappeared, and you can choose to produce either eggs or meat. Breeding and selection used to be regional, now it is mainly global. The original breeds were optimally adapted to the region and farm. Now the farm needs to adapt to the few commercial animals and crop varieties available.

Changes in fruit tree shapes illustrate a similar development. Fully-grown trees have disappeared, as they were replaced by semi-dwarf and dwarf varieties. The development did not stop there. The espalier is introduced and the next step is 'a herbal like twig'. (Fig 1)

Fig 1. Fruit tree shape development



What does this mean in the light of ecology? Due to specialisation most farms create similar landscapes and ecosystems with only a few crops or animal species that become genetically more and more the same. A logical consequence is that farmers need to control the environment with chemicals and technology or else the crops or animals will not deliver. So we buy ever increasing amount of inputs and contribute towards more entropy. Entropy is a term used in thermodynamics. Thermodynamics is both the simplest and at the same time the most impressive scientific conception I know of. It includes the idea that the total energy content of the universe is constant and the total entropy is continually increasing. Every time energy is transformed from one state to another a certain penalty is extracted – there will be less energy to work with in the future. The penalty is called entropy. An entropy increase means a decrease in available energy.

Every time something occurs in the natural or cultural world, a certain amount of energy ends up being unavailable for the future. Part of the unavailable energy is pollution, dissipated energy that accumulates in the environment and poses a threat to the ecosystem. Our current practices are very high in entropy production and will lead to the rapid destruction of our finite resources (like oil, minerals and genetic material) and an increasing amount of pollution like the green house effect. By forcing the landscape into a continuous pioneering phase (Table 1) the outcome will be:

- loss of minerals,
- poor stability,
- emphasis on quantity instead of quality,
- loss of resistance to pest and diseases,
- high entropy,
- loss of (soil) organic matter, and so on.

4 Von Liebig likened soil nutrients to the staves of a barrel broken in half. The shortest stave determines how much water the barrel can hold – similarly, according to von Liebig, the most scarce nutrient determines what plants can use. Ed.

Modern technology has proven to be quite useful, as for instance the increased production shows. It is the way we use modern technologies, out of context, that creates the forementioned disadvantages.

To me it is obvious that the farm (at least an ecological or biodynamic one) should resemble a climax phase with semi closed mineral cycles, more stability, the emphasis on quality, increased internal resistance to pest and diseases, low entropy and a recognition of the importance of recycling dead organic matter. The mature forest as the example! (*see Box , this page*)

A forest as a mature stage, on a mature soil, has a strong and complex story/ layer structure consisting of a moss layer, herb layer, shrub layer and several tree layers. Growing forests with a closed canopy are interrupted by open, grassy areas. Open spots, caused by the felling of an old forest tree, are full of young seedlings from one or a few species. Trees of all ages will be found. The diversity in space is big. The distance between individuals of one species is large. The net growth per area of surface has reached its end. The yearly growth equals yearly decay. There is a balance. Growth is needed to maintain the forest (growth = maintenance). The mature stage has complex relationships. Many specialisations occur in the pollination of flowers and the spreading of seeds. The dependence between plant species (support, shadow, and so on) is high. This is why the people who use phenomenology as a science see the forest as a living organism.

The famous ecologist E. Odum (Science, Vol. 164) sees many parallels between ecological succession and the biology of organisms. According to a biodynamic scientist (T. Baars, Louis Bolk Instituut, 1990) the organism (the forest) can be divided into several organs that are interrelated. Organs have different functions but depend on each other. Mosses for example are the organs for regulating the moisture content, fungi as mycchorriza connecting the roots of all plants under the topsoil are like a nerve system. The skin, the outside of the organism, is formed by the leaf area of the several tree species. They lock together to capture the rain and filter the sunlight. The heart of the forest is the sun and the transformed sun is in the earth as carbon rich humus. The will of Nature can be recognised as a finishing point of organising power. This finishing point or mature stand can be formulated as a living forest organism, in which organs functions are recognisable. It closes itself off more and more from environmental influences

[1] Take away the mosses – an organ – and the humidity in the forest will decrease and thus the organism will suffer. To me causes and consequences are not the issue here – it is not possible to discuss whether the human body created the organs or if the organs created the human body – they both are developed at the same time according to the same law which also is applicable to soil development and ecological succession (the 'will' of Nature). Take an organ away from a human being and the human being will suffer.

The goal becomes to increase diversity on the farm – or in other words develope appropriate organs for the (farm) organism. This makes breeding and selection for local conditions a priority. It is not back to the future, it is using technology in a proper context (the context of the climax phase). There are already successful breeding and selection programs. A logical consequence, if you take action that way, is that you can lower your input requirements. It is obvious that the large, influential multinationals will not appreciate this. Their influence creates an ever increasing controlling grip on the physical environment in which the few varieties and animal species they breed or 'modify' can produce quantity. The landscapes become very similar and require a lot of 'energy' to be stable. It is *fighting the will of Nature.*

Here we have the essence of our current situation: the strongest 'will' forces on this earth, Man and Nature, are wasting energy by trying to control each other. True progress can only come from a symbiotic, co-operative relationship between those two 'will' powers. It is simply not possible to ignore either one of them, they are reality.

With genetic modification we have a powerful tool to speed up the process of creating a uniform, pioneering stage type of farming. Biotechnology is a logical consequence of centralistic, mechanistic thinking. It has led to centralistic DNA thinking. As we have seen the environment used to invite in plants and animals with appropriate DNA. DNA was an expression of that specific environment. Scientific development in genetics changed that concept. No longer is the environment is important but only DNA. The genome is seen as the most important factor in the whole. Environments need to adapt themselves – gene become the dominant force in the environment. It might not be the technology that is a danger (but we do not understand it yet) but the way it is being used, definitely is. *This underlying issue is what deserves more attention*!

References and further reading

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