CONFERENCE PAPER

Tree crops for every micro climate*

or Sustainable land use in Todd's Valley, Nelson or Multiple land use for steep gorse hills

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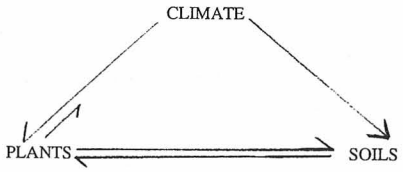
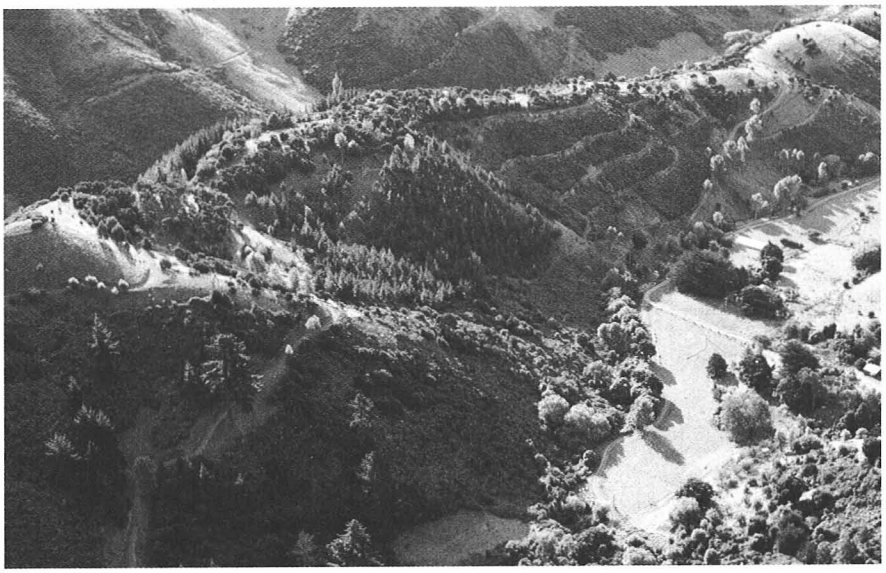
Whatever title is more appropriate, the application of Ecological Principles is paramount. Successful planning for tree crops, particularly if the aim is to find a suitable tree crop for every micro-climate, requires a basic understanding of climate, soil and vegetation. How these factors interact is, of course, the study of Ecology. Only by observing and applying these ecological principles can we maintain or improve our fragile environment.





An aerial view of the Roberts property, Todd's Valley, Nelson. ©G.R. ("Dick") Roberts, Documentary Photographs, Todd's Valley, Nelson.

New Zealand has a maritime climate. There is no agricultural land having a cold winter or hot summer, compared with continental countries in similar latitudes. The average temperature of the coldest month of the year in Central Otago is still well above freezing point. We should try to obtain new plant material from regions with similar climates whenever possible.

a) Islands in similar latitudes whose climates are not greatly influenced by nearby continents, e.g. Vancouver Island, Southern England. (Japan is greatly influenced by the Asian continent.)
b) Western sea margins of continents, e.g. West Coast of USA. It is no accident that *Pinus radiata* and *Cupressus macrocarpa* have done so well in New Zealand. They are native to the Central N. Coast of California and, in fact, are there called Monterey Pine and Monterey Cypress. Further north in coastal Oregon, Washington and British Columbia the rainfall increases and supports Coastal Redwood, Douglas Fir, Western Red Cedar and other trees which thrive in the wetter parts of New Zealand.
c) High mountain valleys in the Tropical Andes and Central America. At these high altitudes, some aspects of the climate, such as cool nights, bright sunlight, rain all the year round, resemble the NZ climate. Potatoes, tomatoes, avocados, tamarillos have long since reached the Western world. Others such as babaco, lucuma, casimiroa, casana, and a subtropical evergreen walnut have arrived more recently.

NZ wood pigeon – enjoying the flowers and leaves of tagasaste. ©G.R. ("Dick") Roberts, Documentary Photographs, Todd's Valley, Nelson.

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Still more remain to be discovered in these numerous isolated mountain valleys. I have been given and asked to keep records, by Invermay Research Station, of some new tree crops from South America.

Climate and micro-climate are not the only factors to take into account when deciding which tree crop to plant or what land use to practise. Topography will limit the use of machinery on hilly country. Soil erosion is a major world problem, even on relatively flat prairie lands. Accelerated erosion occurs on steep land when soil and vegetation are disturbed. In Todds Valley I have made a somewhat arbitrary decision to use very steep slopes for forestry. It can be argued that most timber trees will grow faster on the more fertile damper valley floors. This is true, not only for trees but for most farm and horticultural crops, as long as other factors, such as frost or waterlogging, are not limiting factors. The best land is always at a premium: the test for a practical ecologist or a good farmer comes when one has to decide what to grow in less favourable environments such as steep, rocky, dry, clay, or waterlogged sites. In the past the world's most successful farmers and peasants were those who carefully observed and made use of what we now call ecological principles. Today with the aid of machinery, fertilisers and chemicals we can conquer nature! Or can we? – a short-term illusion, gradually undermined as top soil is lost and pests and parasites develop resistance to chemicals.

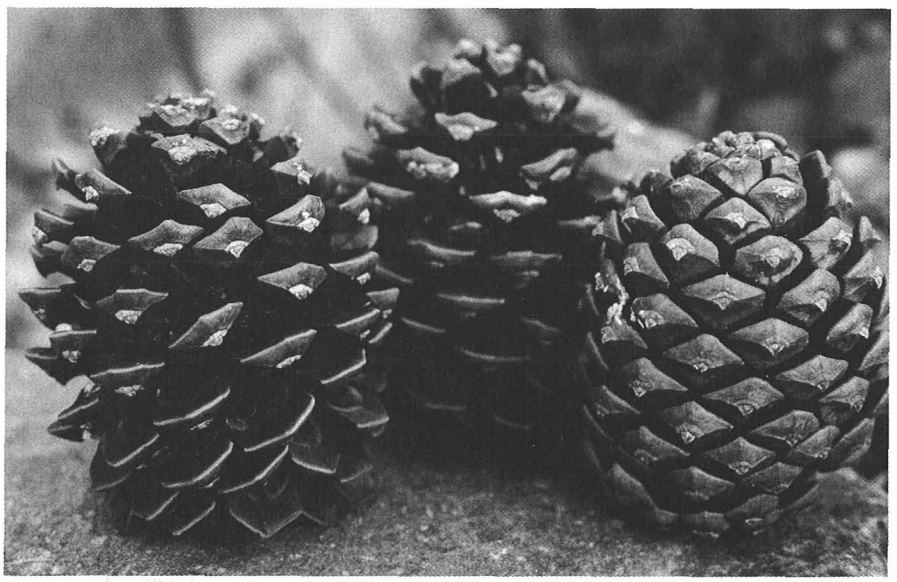
I classify micro-climate sites under three categories, according to frost tolerance. A separate paper could be given at this conference on suitable land use of tree crops for each micro-climate. The best I can do in the time available is to summarise a number of micro-climates and then spend just a few minutes on just one of these less favourable environments.

Widely-spaced eight-year-old *P. radiata* planted on less utilised hill slopes – Brann's farm, Bay of Plenty, ©G.R. ("Dick") Roberts, Documentary Photographs, Todd's Valley, Nelson.

TREE CROPS FOR HOT DRY NORTH FACING SLOPES

Carobs

After 20 years I am now convinced that carobs could be a viable commercial venture on north-facing slopes in Nelson and Marlborough, and probably elsewhere. I have 50 trees, most grown from seed obtained from California. Some aged 15 years are seven metres tall and equally spreading. I am told they live for 200 years or more. Unfortunately for us, carobs are dioecious (separate male and female trees) and non-grafted trees do not flower until about 11-15 years old; even then, males usually outnumber females. I am therefore grafting females on to comparatively useless male trees! Carobs produce inconspicuous flower spikes in the autumn. The pods ripen in the following autumn. Carob powder is produced by grinding the whole pod, which is thick and heavy. The four or five seeds inside each pod are relatively small and surprisingly consistent in size, no matter the size of the pod. For this reason they were used for centuries in The Middle East as standards of weight; hence the term carat. Carobs are attractive evergreen legumes. They provide food for humans and fodder for domestic animals; they enrich the soil with nitrogen and grow on dry rocky soils on windy sites where few other tree crops will grow.



***Pinus radiata* (stone pine) cones produce edible seeds, and the tree tolerates dry sites. ©G.R. ("Dick") Roberts, Documentary Photographs, Todd's Valley, Nelson.**

Olives

Like carobs, they thrive in "Mediterranean" climate with hot dry summers and mild wet winters. Olives are somewhat more cold tolerant than carobs. Fortunately, unlike carobs, olives are monoecious (male and female parts on every tree) and can be grown from cuttings. Contrary to popular belief in NZ all varieties of olives change colour from green to purple-black if summers are sufficiently long and warm. They are harvested for oil while still green. Our warmest summer micro-climates in NZ are considerably cooler than those of traditional olive and carob growing sites in Mediterranean countries. Therefore it behoves us to select varieties better adapted to our cooler summers. An excellent article on Olives by Gidon Blumenfeld was published in the April 1990 issue of NZ Tree Crops journal

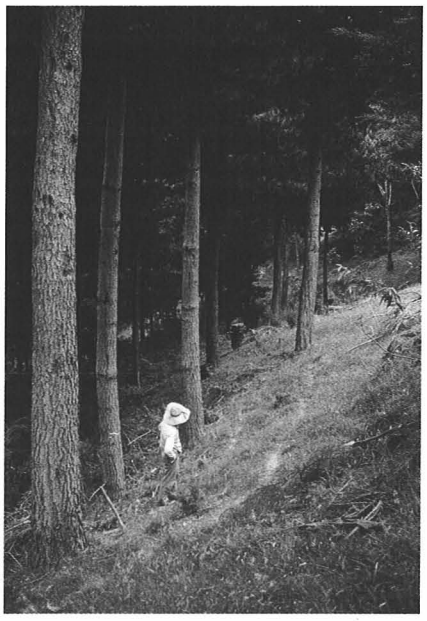
"Growing Today". It refers specifically to a new commercial olive venture near Blenheim where about 50 different varieties have been planted, not on dry hillsides but on alluvial river flats with the help of irrigation. This illustrated my earlier point, that most drought-adapted plants will fare better if provided with water and fertiliser. However, beware of plant nurseries selling drought-resistant plants. Some, like feijoa and honey locust, will survive a drought but will grow very little during that period.

Pines for Pines Nuts

Most of the world's 80 species of pines are more or less drought-adapted. As we learn from school biology, a pine needle is a remarkable structure for minimising transpiration. Being a rolled cylindrical leaf, the surface area is greatly reduced; sunken stomata and a waxy cuticle also reduce water loss. In early summer pines and other conifers of the Taiga zones, e.g. Siberia, suffer from physiological drought: warm sunny days arrive suddenly; the needles evaporate water but the soil is still frozen; "water, water everywhere but not a drop to drink!" *Pinus pinea*, the stone pine or umbrella pine, produces the pine nut of commerce in Europe, especially in Italy and Spain. It does well in New Zealand. I have a few 10-year-old trees producing about 200 cones annually. The seeds are almost 2 cm long and rich in oil and protein. Incidentally, it does not follow that pine species with large cones contain large seeds – quite the contrary in some cases. It is quite likely that other pine species will, in the future, produce comparable or better returns than the stone pine. The native Indians of North America ate the seeds of at least 15 pine species, the best known being *Pinus cembroides* or Pinion Pine, a very variable species of small pine tree. *Pinus torreyana,* the Soledad or Torrey Pine, is confined to a small part of the California Coast, having a climate somewhat similar to ours. Other pines worth trying for nuts are *Pinus ponderosa* from The Rockies, *P. gerardiana* from Afganistan; *P. almondia* from China. *P. lambertiana* or sugar pine might suit the high country.

Tree legumes

Many tree legumes are drought-resistant. They often produce foliage, pods and seeds, all rich in proteins, for human and stock consumption, as well as nectar for bees and birds. Most are good firewoods and some produce high-value timber, e.g. *Acacia melanoxylon*, Australian Blackwood. They invariably enrich the soil with nitrogen. Most Australian acacias (wattles) are drought-resistant. Robinia (black locust) produces ground-durable timber and high yields of honey – ideal for Central Otago and the high country when we have selected suitable cultivars. *Chamaecytisus palmensis* used to be called tree lucerne but Tagasaste, its original name in the Canary Islands, is now preferred. It is not as drought-resistant as carob and olive. Except where severe frost and prolonged wet soils are experienced it is, in my opinion, the outstanding fodder tree for most parts of New Zealand. Its range may be extended if we can find genetically cold resistant seed from higher altitudes in the Canary Islands. Incidentally, at these elevations the climate may resemble New Zealand's more than any other place on this planet. Tagasaste is fast growing and very palatable and nutritious. Branches can be lopped, either during a summer drought, or in winter when clovers may be dormant and pregnant ewes are short of protein. On my farm the two main pests are native pigeons and cicadas. Planting more tagasaste may divert pigeons away from damaging various blossoms and eating nine-tenths of the leaves on almond trees – to mention only two of their sins. It could also be argued that more tagasaste will support more pigeons. At the risk of putting the cat among the pigeons, are we justified in culling pigeons!?



A 14-year-old *P. radiata* plantation on a slope. ©G.R. ("Dick") Roberts, Documentary Photographs, Todd's Valley, Nelson.

Some other tree crops for hot dry slopes

Quercus suber
The Mediterranean Cork Oak. A good specimen grows in front of the Nelson court house. Increasing wine production will result in a world shortage of cork.

Vitis vinifera
Some varieties of grapes require more heat than others. Good rainfall and fertile soils do not produce the best-quality grapes.

Prunus amygdalus
The almond is moderately drought-resistant. Because it flowers early in August, sites subject to spring frost should be avoided.

Zizyphus jujube
The jujube or Chinese red date belongs to the Rhamnaceae – Buckthorn family. It is frost hardy and tolerant of a wide range of dry soils. It needs a warm summer.

Simmondsia chinensis
The jojoba is native to drier parts of Southern California. It is believed that oil from its seeds will replace sperm whale oil.

Pistacia vera
Pistachio nuts require hot summers. Pistacia species give spectacular autumn colours. I am not certain, but I believe that no part of New Zealand has summers hot enough to produce jojoba seeds or pistachio nuts. Both plants are growing in Todds Valley but not fruiting. Jujubes, on the other hand, have fruited.

TIMBER TREES FOR STEEP HOT DRY SLOPES

Exotics

Since this information is readily available from MOF and the NZ Farm Forestry Association, I will be brief. Most eucalypts and acacias are moderately or very drought-adapted. Nevertheless some species such as *Eucalyptus regnans* will do well only on sites having at least 900 mm rain. Others such as *E. saligna* do well on mild coastal sites with moderate rainfall. *E. obliqua* and *Acacia melanoxylon* tolerate a wide range of climate and soils. Most pines and cupressus species, e.g. *Cupressus macrocarpa,* are suitable for dry sites.

Natives

Totara is a drought- and stock-resistant native podocarp. Most other native trees are difficult to establish on north-facing slopes in Todds Valley near Nelson. Kanuka and manuka will colonise but without a succession of above average wet summers the broad-leaved evergreens will not follow. On the other hand, on south-

facing slopes and in damp gullies, native forest will regenerate if grazing animals and possums are excluded. If such sites are already gorse covered, colonisation by native trees is a natural process. When the gorse is six to 10 years old (the old man gorse stage) the canopy opens up. Seeds are dispersed by birds and native seedlings such as *Melicytus* and *Coprosma* species emerge through gaps in the gorse canopy. This natural sequence of revegetation can be encouraged by minimal cutting of competing vegetation. In doing so you will automatically create pathways through the gorse. Make sure you prevent sheep access by blocking your tracks with cut gorse. Depending on micro-climate, it will take from 15 to 50 years for the tree canopy to close. Gorse, being a light-demanding plant, will die away surprisingly quickly as the canopy closes. On the other hand, blackberry, which is shade-tolerant, may replace gorse if the owner is not vigilant. Fire is always a danger where gorse and bracken fern are present. A grazed firebreak surrounding a forest block is helpful.

The process of establishing native forest using gorse as a nurse crop applies only to south-facing slopes near Nelson: But, on the South Island West Coast and in regions of the North Island where rainfall exceeds 1200 mm this method of revegation would occur on north-facing slopes. It is important to understand in this respect that 1000 mm of rain near Nelson, where evaporation is so great, is no more effective than 600 mm in parts of Southland for example.

IRRIGATED NORTH-FACING SLOPES

By artificially increasing the available soil moisture and improving shelter, a whole new range of subtropical tree crops can be grown in some regions.

I will finish with a few possibly controversial comments, ideas and suggestions.

KEEP NZ CLEAN AND GREEN

I have written enthusiastically about using plants from parts of the world with similar climate. At the same time I am painfully aware of the risk of introducing soil-borne diseases, pests and noxious weeds. The Tree Crops Association has always had a policy of selecting desirable varieties of, say, nut trees, which have already proved their worth under New Zealand conditions. Failing that, only seeds should be introduced, followed by a strict quarantine period. It may already be too late to prevent our native flora from being overwhelmed by plants and animals already introduced. Perhaps most of our first aid should be concentrated on off-shore islands and comparatively small areas where labour is available to control pests and remove or spray noxious weeds at their most vulnerable seedling stage?

KANUKA SHELTER

Strong winds in New Zealand are more of a problem than in similar latitudes in the Northern Hemisphere. If you ask gardeners, farmers and other growers why wind is harmful, they will answer correctly about physical damage, water loss and temperature lowering; but few have considered how only moderate winds can damage soft new stems and leaves, facilitating entry of disease-causing fungi, bacteria, etc. The importance of shelter to improve the micro-climate for most crops is still underestimated. Shelter trees, such as willow and pine, may compete too vigorously with adjacent crops. More attention could be paid to alders and casuarinas, both of which, incidentally, are nitrogen fixing. On hot dry slopes near Nelson I have found kanuka wind-breaks very effective. Manuka seedlings are nibbled by sheep; kanuka are not. Kanuka grow somewhat faster and taller. When young, they must be trimmed; otherwise the lower branches will receive insufficient light, causing leaves to drop, allowing wind to whistle through.

UNEXPECTED REWARDS

When plants are grown near the limit of their climatic range, unexpected benefits may result: some fungal diseases may be absent or modified at lower temperatures. It is well known, for example, that tomatoes grown in Canterbury need less fungicide and insecticide than those grown around Gisborne, where higher rainfall and temperature favour more rapid growth. Some Nelson-Marlborough micro-climates may produce avocados, casanas etc more economically than North Auckland. Also late-ripening fruits may command a higher price.

SUSTAINABILITY

Unless our use of land and sea is **ecologically** sustainable it will not be **economically** sustainable in the long term. Here lies the dilemma. How does one survive on the land during the changeover period? Tree crops, for example, may take 20 to 100 years to produce an economic return. In my case, photography has subsidised tree planting and maintenance. Surely all farmers without a mortgage can plant a few trees every year?

UNDERSTANDING

The better we understand and locate micro-climates, and the more information we collect about the needs of various tree crops, then the more confidently can we make our own decisions about what to plant in a particular site. The more suited a plant is to its environment, the less energy we need to spend on cultivation practices such as removal of competing weeds. A simple guide could be "to live with rather than conquer nature".

EDUCATION

For 40 years I have felt an urgent need to "spread the gospel" according to the laws of Ecology! For this reason, 26 years ago, at the age of 40, I retired from teaching Biology at High School in an attempt to produce a working example of long-term ecologically sustainable land use. At first 99.9% of the locals regarded me as a crazy crank; now only 95% do so – an encouraging exponential rate of change!