Blueberry Production

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BLUEBERRY PRODUCTION

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CONTENTS

Page

Blueberries, A Crop For The Future
D.J. Davies 1

Blueberry Cultivars
D.J. Davies 11

Observations On The Performance Of Different Cultivars In U.S.A. Europe And New Zealand
A.L. Firmin 20

Blueberry Micropropagation - A Rapid Method To Increase New Cultivars
D. Cohen 31

A Basic Approach To Land Preparation
A.L. Firmin 35

Blueberries - Planting, Management & Harvesting
E.M. Gray 41

Pruning
A.L. Firmin 51

Irrigation Of Blueberries
L.H. Weston 59

Climatic And Soil Factors In Blueberry Production
T.H. Webb 62

Mycorrhizal Inoculation For Blueberries
Conway Powell 66

Blueberry Diseases
E.H.C. McKenzie & P.R. Johnston 70

Pests of Blueberries In New Zealand, Especially Canterbury
W.P. Thomas 76

Suggested Spray Programme : Blueberries
Advisory Services Division, M.A.F.... 84

The Cooperative Concept of Blueberry Growing
E.M. Gray 86

A Summary of Blueberry Culture
J. Try 92

BLUEBERRIES - A CROP OF THE FUTURE

D.J. Davies,
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INTRODUCTION

The blueberry is a member of the heath family (Ericaceae) and is native to North America and East Asia.

There are three main types of blue-berries - Highbush, *Vaccinium corymbosum;* Lowbush, *Vaccinium angustifolium, V. myrtilloides, V. lamarkii* and *V. vacillans* and Rabbiteye, *Vaccinium ashei* Reade.

In the Northern Hemisphere *Vaccinium australe* is an important species for southern regions and may be of value for the northern regions of New Zealand. However for most areas of this country Highbush *V. corymbosum* is the species that is attracting considerable interest amongst horticulturists.

Blueberry cultivars were first introduced into New Zealand by (Elliott 1950) in an attempt to find a suitable crop for the large areas of peatlands in the Waikato. Some of the progeny of the original six cultivars are at present being evaluated at the DSIR Lincoln Research Centre. Further improved North American selections were imported into this country by the Ministry of Agriculture and Fisheries during 1973.

CLIMATE

Within these Highbush and Rabbiteye species are a large number of cultivars with a wide maturity range from November through to March. Both require a warm growing season and

adequate chilling for optimum fruit production. Shoemaker (1975) maintains that 650-850 hours of temperatures below 7°C are necessary but Toleman (1976) considers that for Waikato conditions 500 hrs produces satisfactory crops. Blueberries can tolerate temperatures as low as -5°C when in blossom and frosts of this magnitude are not common for the flowering period September-October.

In New Zealand Todd (1975) recommends maintaining adequate moisture, but warns against excessive irrigation to avoid leaching nutrients. Our experience with unusually high water table conditions during 1977-78 seasons at Lincoln confirms that blueberries will not tolerate prolonged exposure to wet soils.

SOIL REQUIREMENTS

Blueberries are very exacting in their soil requirements and this is particularly true for Highbush cultivars. They require a well drained acid soil that has a fairly high content of organic matter. Peatlands are the preferred soils as they are composed almost completely of organic matter and have the desirable pH level (acidity) of from *4.5* to *4.8*. Mineral soils that are less acid but have other correct physical attributes can be made more acid with ground sulphur or continued use of ammonium sulphate. Any soil with pH above 5 must be corrected at least six to twelve months before planting. Constant soil moisture that is moist rather than wet must be maintained at all times and a well drained soil is essential to achieve this situation. Where it is necessary to lower the pH the following table gives a guide as to the amount of sulphur that will be required:

	Kg sulphur required/9 m^2 (100 sq ft)	
To change pH from	Sandy soil	Loamy soil
6.5 to 4.5	0.68	2.1
6.0 to 4.5	0.54	1.6
5.5 to 4.5	0.36	1.08
5.0 to 4.5	0.18	1.54

(Adapted from Rukuhia Research Station Circular 1976).

Mulching with sawdust, straw, peat or pine bark has certain advantages as follows: -

* weed suppression
* maintains cooler soil temperature
* retains soil moisture near surface
* improves soil structure
* assists in reducing and stabilising pH
* prevents frost heave during winter
* avoids erosion and soil compaction

The use of sawdust lowers the nitrogen available for plant growth and additional nitrogen fertiliser should be used.

Recent work at Rukuhia, Toleman (1978), suggest that the plastic mulch as used for strawberries combines most of the above advantages. Farmyard manure of any form should not be used.

UTILISATION

In the U.S.A. it is estimated that up to 40% of the fresh berries are used for culinary purposes and the remainder are eaten fresh. Of the total harvest in 1976 45% were sold in the fresh or chilled state and the remaining 55% were processed immediately after harvest.

Blueberries have many uses and of course the famous pie which many of you have tasted at this course is considered by many to be unsurpassed.

G. Strachan (1978) lists the following forms of preservation:

Canning	Freezing
In syrups (30-60%)	Free flow institutional packs 11.25 kg

In Water (bulk packs)	Free flow consumer packs 2.25 kg
As juice, both clear and cloudy	Syrup packs 0.4 - 0.9 kg
As pie filling (with starch fillers)	

Also used for jam, jelly, preserves (less than 55% fruit), yoghurt toppings, wine and syrups.

PROPAGATION

Blueberries must be propagated vegetatively from hardwood or softwood cuttings.

Hardwood cuttings may be taken from May through August, and vigorous growth, pencil thickness or greater, should be chosen. The shoot tips are removed and placed in an outdoor propagating frame with a sawdust base over which is placed 15 cm of a peat/sand or peat/pumice mixture. Cuttings 10 cm long are inserted at least 2/3 of their length either vertically or at an angle of 45°. Cuttings are spaced at 5 cm x 5 cm centres.

During the first three months the temperature in cold frames must not rise above 7°C and the humidity must be high. Heavy shading and restricted ventilation can give this effect. The beds must not be allowed to dry out and once plants start to grow they will benefit from fortnightly applications of a general liquid fertiliser containing the nitrogen in the form of Ammonium sulphate.

Cuttings can be considered to have established when late buds or secondary shoots start to develop. After nearly a year in the beds the rooted cuttings are lifted and transferred to nursery beds spaced at 25 cm in the row and 45 cm between rows. They remain in the nursery bed for one year before planting out in the field.

Softwood cuttings require more expensive facilities for

propagation but under ideal conditions rooting takes place in five to six weeks.

Cuttings are taken as laterals when the terminal growing point has set usually from late November through January. About 7 cm in length with lower leaves removed, they should be dipped in rooting hormone No 1 or 2 depending on firmness of cutting.

Older cuttings or semi softwood should be wounded to promote callousing, dipped in appropriate fungicide and placed firmly in prepared peat/pumice or peat/sand (beds about 12 cm in depth). When summer temperatures are high they may be propagated in a shade house (70% light exclusion) cover the beds with white polythene film on wire supports and use black polythene under beds and perforate for drainage. Covers should be removed periodically for watering, ventilation and control of fungus disease. This is most important as many failures are due to the high humidity conditions which favour fungus pathogens' development. Similar results can be obtained using bottom heat and mist systems inside a glasshouse but once again hygiene is of paramount importance.

After a period of 10 weeks cuttings may be gently removed and placed in containers containing peat/sand or peat/pumice at a ration of 2:1 and water with a general liquid fertiliser. Obtain maximum growth in shade house and allow to harden off before transplanting to nursery bed in the early spring. If necessary, plants may be retained in containers and grown on under shade before pruning back preparatory to field planting.

PLANTING AND WEED CONTROL

Planting-out should be carried out in the early spring (August) to allow plants to establish before the commencement of hot weather. Nursery plants should be lifted with as large a mat of roots as possible and top growth should be pruned back to compensate for any root damage and watered in if soil dry. A field planting of from 1.2 - 1.5 m x 3 m is most commonly

used. Closer planting, 3360/ha, if mechanical harvesting is envisaged and wider, 2150/ha, where manual harvesting is preferred. For the first season in the field all flowers should be removed to encourage plants to quickly reach maximum size.

Weed control may be achieved in several ways either using clean cultivation with Sinazine or if rows are mulched with plastic or other suitable material the interval between rows may be grassed and mown. It is advisable to delay grassing down until bushes are well established. Further research is required for the most economic method of establishment for mineral soils and to this end DSIR Lincoln will be evaluating low, medium, and high cost methods with trickle irrigation over the next few years.

PRUNING

Because they bear their fruit on one-year-old wood blueberries can be pruned in a similar way as for black-currants. An annual supply of one-year-old wood must be maintained by judicious thinning the centre of the bush, by removing all weak spindly growth and dead wood, both within the bush and close to the ground. When the plants are mature 4th-5th year pruning to reduce the fruiting area will increase size of fruit. Any plants lacking vigour should also be pruned hard. There are two main types of growth habit with blueberries - upright and spreading. Generally upright cultivars require centre pruning while spreading cultivars need low branch removal.

General guides for pruning - Shutak and Marucc (1966).

* Remove all diseased or damaged canes
* Remove or cut back the old or least vigorous canes
* Remove low branches and softwood
* Thin out and tip fruiting wood. This includes removing bushy or twiggy growth and rub off smaller shoots.

HARVESTING

In New Zealand cultivars will eventually be available that will extend the harvest period from mid-December until February, as the mature blueberries change from green to red and then to blue. They are normally ready for harvest about one week after the last colour change. Since only a few berries will be ripe in each cluster at any one time it will mean up to three or four pickings at six day intervals for most cultivars.

Manual harvesting is best for high quality fresh market fruit and it is most important for growers of blueberries to provide top quality fruit. If they are picked early they will reach the maximum size and sweetness, while over mature fruit quickly deteriorates, attracts birds and often falls to the ground.

Blueberries can be machine harvested but many North American growers employ both manual and mechanical methods. As the scale of operation develops in New Zealand, mechanisation will become increasingly necessary to reduce labour costs. With mechanical harvesting some form of grading fruit would be required to sort out the different stages of maturity of the fruit. As an alternative to the vibrating mechanisms of the 'down the row' or 'straddle harvesters' hand held vibrating fingers are available that shake the ripe fruit from the bush on to a portable canvas catching frame. The fruit is placed in a container and sent on to a cleaning unit for sorting and trash removal. Machines have been developed overseas that can be adapted to harvest both blackcurrants and blueberries and the growing of these two crops in combination has merit and would increase the usefulness of such a high cost machine.

CULTIVARS

Only six Highbush selections have been under test in the South Island and at least twenty more remain to be evaluated. Of these Atlantic, Burlington, Dixi Jersey and Stanley have performed satisfactorily. The cultivars Berkeley Blueray,

Darrow, Herbert, Ivanhoe and Rubel are still under test in the North Island (Rukuhia Research Station) and should be available for testing under field conditions in the next year or two. *See* appendix for varietal description. Growing of seedling plants is not generally recommended as all plants will not come 'true to type' resulting in plants with quite distinct differences in shape, maturity, fruit size and flavour. However for the home gardener interested in testing soils for suitability on a small scale, this would be a cheap way to select and raise your own plants.

PESTS AND DISEASES

The major problem and an expensive one to overcome is protection from birds that are attracted to the small plantings in particular. Until chemical sprays such as 'Mesurol' have been proven as effective for New Zealand, potential growers would be wise to budget for use of either galvanised netting enclosures, or use of the lighter polypropylene nets. Netted enclosures are being tested at Lincoln and the birds have been seen crawling through soft mud to gain entry to this delectable fruit.

Leaf rollers, scales, mites, black vine weevils botrytis could be troublesome from time to time and will need to be sprayed with the appropriate compound for effective control. While many diseases are prevalent overseas, thanks largely to an efficient system of disease and quarantine control we have remained virtually free of the more troublesome virus diseases in North America.

CONCLUSIONS

The potential for growing blueberries is rated very high by many experienced marketing authorities for export to North America and Europe where large developing markets exist, particularly in the northern hemisphere winter. Blueberrries grown on a large scale would generate processing of a high proportion of the crop and unless this was mechanised throughout it is considered doubtful that processed products could compete on world markets. However in the early

years of producing hand picked top quality fruit there is every reason to believe that fresh fruit could be delivered by air and possibly by refrigerated containers to the west coast of North America.

Our limited experience suggests that the crop can be grown and of course many people from Southland to Tauranga have shown that fruit of quality can be grown. Indeed, several have tested the market and received very satisfactory prices.

Because blueberries have very specific growth requirements particularly in relation to soil composition, it will mean inevitably that the crop will be grown where these conditions can be met and maintained at relatively low cost. Nearness to airports which link easily with international flights will also be an important consideration. It is my view that this country will develop a worthwhile industry, but a lot more work remains to be done on a co-ordinated basis both at home and in the market place if we are to achieve a similar reputation as to that won by 'kiwi fruit' growers and exporters over a fairly long period of time.

REFERENCES

SPACKMAN, G.S. and JACKSON, D.I.: Culture of blueberries and cranberries. Lincoln College Department of Horticulture. Bulletin 23.

TODD, J.S. 1973: Blueberries. Information Service Min. Agric. & Fisheries.

STRACHAN, G. 1978: Blueberry Processing, Plant Diseases Division DSIR. Report for Research Advisory Committee.

TOLEMAN, E. 1976: Blueberries - a crop with potential for N.Z. N.Z. J.A. 132: 26-30.

DAVIES, D.J.: Blueberries in Canterbury. MAF. Mid-Canty Fed. Farmers Horticultural Seminar October 1978.

ECK, P & CHILDERS, N.F. Blueberry Culture. Rutgers University Press. New Brunswick, New Jersey No. 66-18880.

APPENDIX

BLUEBERRY VARIETIES (after Shoemaker, 1975)

Cultivar	Season	Vigour	Yield	Berry size	Cluster Formation	Quality	Other Comments
Atlantic	Mid (early Jan)	Mod.	High	Mod.	Open	Fair	Poor handling
Berkeley	Mid	High	High	Large	Open	Med.	Very light blue
Blueray	Early Mid season	High	High	Very large	Tight	High	Firm, sweet
Burlington	Late (Jan-Feb)	High	High	Small	Tight	Fair	Dense growth req. thinning
Darrow	Late	High	High	Large	?	High	Light blue
Dixi	Mid-Late	High	High	Large	Large & open	High	Ripening not uniform
Herbert	Late	High	High	Large	?	High	Fruit rate dark
Ivanhoe	Early	High	High	Large	Tight	High	Harder to propagate
Jersey	Mid	Mod.	Mod.	Mod.	Loose	High	Uniform ripening
Rubel	Late	High	Mod.	Small	Very loose	Mod.	Excellent process machine harvest.
Stanley	Early (Mid-late Dec.)	Mod.	Fair	Mod.	Open	High	Erect growth a problem under netting

BLUEBERRY CULTIVARS

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The selections of named Highbush cultivars currently being evaluated by Government Research Workers and co-operating farmers throughout the temperate regions of New Zealand, were first imported to the Waikato region by the Ministry of Agriculture and Fisheries in 1950. Importations have continued over the past two decades as new cultivars have been released by plant breeding station in North America.

In 1911 Dr F.V. Goville of the U.S.D.A. began a series of crosses among six native selections of three Vaccinium species (V. australe, V. corymbosum and V. angustifoliam). This work led to the release of the first named cultivar Pioneer in 1920. One wild selection Rubel and at least 55 other improved cultivars have been propagated by various experimental stations and private breeders for release to growers up until 1960 and comprise most of the cultivars currently under test in New Zealand.

Since 1960 and up to 1977 a further 15 Highbush Blueberry cultivars, have been released to the USA industry by various public agencies and no doubt this process of crop improvement by breeding and selection will be a permanent feature of this country's fledgling industry.

In North America some of the older blueberry cultivars were not distributed widely and disappeared soon after being introduced, but others such as Jersey, Weymouth, Rubel and Rancocas have remained in production.

Blueberries have a wide range of climate adaptability from Northern Florida to British Columbia (North West) to Nova Scotia in the North East of the continent, cultivars are being developed to meet the specific requirements of many different environments. To a lesser extent the same will apply to New Zealand from sub-tropical conditions in Northland to the very cool temperate climate of the far South Island.

In other words a range of cultivars will be found that suit a particular set of soils and climates. The question of what is the best Blueberry cultivar to grow need never be asked, but some guidance can be given for some districts now, in response to the question. What are currently the superior cultivars

for export, or for local production or both? The choice of selecting a range of blueberry cultivars to grow will depend on a combination of the following factors:

Disease resistance	Fruit quality	Chilling requirement for bud initiation
Plant vigour	Ripening season	Tolerance to heat
Growth habit	Firmness of fruit	Soil requirements
High yield	Winter hardiness	Availabity of nursery stock

Because of the high investment costs associated with establishing one hectare of Blueberries, most growers will naturally tend to concentrate on the export market.

For the home market or garden situation almost any of the proven cultivars currently in production in this country can be grown.

Export fruit is entirely another matter. Of paramount importance is the ability of the fruit to remain firm for as long a period as possible in order to arrive at the market place in excellent condition.

In general a grower has approximately a period of 10-14 days to pick, package and dispatch the fruit from international airports including distribution to the market and eventually to the consumer.

1. (a) Highbush cultivars in New Zealand (1980)

Early		Mid Season		Late	
Cv.	Year Released	Cv.	Year Released	Cv.	Year Released
Collins	1971	Berkeley	?	Atlantic	1950
Earliblue	1971	Bluejay	1980	Burlington	1950
June	1970	Bluecrop	1971	Coville	1971
Weymouth	1970	Blueray	1971	Darrow	1971
		Concord	1971	Dixi	1950
		Ivanhoe	1971	Elliott	1980
		Rancocas	1972	Herbert	1971
		Spartan	1980	Jersey	1950
		Stanley	1950	Rubel	1971

(b) Cultivars landed and held in post-entry quarantine: Bluehaven, Cabot, Harrison, Late Blue, Northland, Patriot and Trophat

(c) Permits issued for: Avonblue, Bluetta, Croatan, Flordablue, Meader, Murphy and Sharpblue

2. Highbush Cultivars Commercially Grown in North America (A.D. Draper 1979)

Florida	Nth Carolina	New Jersey	Michigan	Washington	Oregon	Arkansas	Brit. Columbia
Flordablue	Croatan	*Bluecrop	*Jersey	*Bluecrop	*Bluecrop	Blueray	*Rancocas
Sharpblue	Wolcott	*Coville	*Rubel	Blueray	*Collins	*Collins	*Bluecrop
Avonblue	Murphy	Concord	*Bluecrop	Bluetta	Washington	*Coville	*Dixi
	Morrow	*Berkeley	Bluehaven	*Collins	Olympia	*Bluecrop	*Jersey
	*Jersey	Blueray	Northland	*Rancocas	Bluetta		*Weymouth
	Blueray	June	*Spartan	*Pemberton	Earliblue		*Rubel
	Harrison	*Weymouth	*Elliott	*Berkeley	*Burlington		*Pemberton
	Bluechip	Earliblue	*Bluejay	*Dixi	*Jersey		June
		Bluetta		*Jersey	*Rubel		Concord
		*Collins		*Rubel	Laniera		Stanley
		*Jersey		*1613-A	N51G		Northland
		*Burlington		Patriot	*1613A		*Spartan
				*Spartan			*Bluejay
				*Elliott			
				Bluehaven			

* Highbush Cultivars suitable for mechanical harvesting

In general the cultivars that have continued to be planted in the U.S.A. are those that are productive, produce high quality fruit and that can be either hand or machine harvested.

3. Rabbiteye cultivars in U.S.A. (1980) (Vaccinium ashei Reade) M.E. Austin

The rabbiteye is a hexaploid species that is characterised by its excessive height when mature (2-5m) long flowering to fruit ripening period, more conspicuous seeds, and tolerant of wider range of climate and soil pH (acidity).

Desirable features include vigour, productiveness, drought resistance low chilling requirement, good flavoured fruit, large size, small scar and good shipping qualities.

CV Name	Year of Release in USA	Cross	Agency Agen
Callaway	1950	Myers x Black Giant	U.S.D.A.
Coastal	1950	Myers x Black Giant	U.S.D.A.
Homebell	1955	Myers x Black Giant	Georgia Exp. Stn
Menditoo	1958	Myers x Black Giant	Nth Carolina Exp. Stn
Garden Blue	1958	Myers x Clara	Nth Carolina Exp. Stn
*Tif Blue	1955	Ethel x Clara	Dr W.T. Brightwell Georgia
Woodard	1960	Ethel x Callaway	Dr W.T. Brightwell Georgia
Briteblue	1969	Ethel x Callaway	U.S.D.A.
Delite	1969	Ethel x Garden Blue	U.S.D.A.
Southland	1969	Ethel x Garden Blue	U.S.D.A.
Bluegem	1970	Ethel x Callaway O.P.	Florida Exp. Stn
Bluebelle	1974	Callaway x Ethel	Georgia Exp. Stn
*Climax	1974	Ethel x Callaway	Georgia Exp. Stn
Premier	1978	Tifblue x Homebell	Nth Carolina Exp. Stn
Powderblue	1978	Tifblue x Menditoo	Nth Carolina Exp. Stn
Centurion	1978	W-4 x Callaway	Nth Carolina Exp. Stn
Beckyblue	1978	Fla 6-138 x E96	Florida Exp. Stn
Aliceblue	1978	(Beckyblue O.P.)	Florida Exp. Stn

* Developed for machine harvest

4. Rabbiteye cultivars in New Zealand and year of release from quarantine

Calloway 1950	Menditoo 1972	Garden Blue 1972	Woodard 1972
Delite 1973	Myers 1950	*Tif Blue 1972	Southland 1973
Clara 1950	Walker 1950	Bluebelle 1980	Powder Blue PEQ**
*Climax 1980	Centurion PEQ**	Briteblue 1980	Premier PEQ**
		Beckyblue PI***	
		Abieblue PI***	
		Bluegem PI***	
		Homebelle PI***	

* Rabbiteye cultivars suitable for machine harvest

** Post Entry Quarantine

*** Permits Issued

Commercial production of rabbiteye blueberries began in the early 1890's from selected plants grown in the wild from N.W. Florida. The first commercial enterprise using plants from the breeding programmes in Georgia was planted in 1955 and the Georgia Blueberry Association was organised in 1970.

Growers that intend to market their rabbiteye fruit locally or export, need to produce large firm fruit, that are light blue in colour and have a dry stem scar.

Growers planning to eventually machine harvest for processing require to grow cultivars where the fruit clusters ripen uniformly and berries are small and firm.

Growers for a U-pick system, need upright plants that ripen large fruit over a long period of time. Several cultivars with different maturing times will be an advantage for extending the harvest season.

5. Rating System for Blueberry Cultivars

A rating system has been developed to express the relative value between cultivars using a scale of 10 for the best and 1 for the harvest.

In North America a rating of less than 6 is considered unsatisfactory for commercial use. Such a system makes it possible to compare the qualities of different cultivars maturing at the same season.

TABLE I

Ratings for some Highbush Blueberry Characteristics (Darrow & Moore 1962)

Cv	Maturity	Size	Colour	Scar	Flavour	Remarks
Morrow	10	8	7	6	6	Very early
Angola	10	8	5	7	6	Very fine bush
Wolcott	9	8	6	9	6	Very fine bush
*Croatan	9	8	7	8	6	Very fine bush
*Weymouth	9	8	5	6	5	Poor bush, productive, poor flavour
*Earliblue	9	9	8	7	7	Fine bush, good machine harvest
*Collins	8	9	8	7	8	Fine bush, good machine harvest
*Murphy	8	8	6	6	7	Spreading bush
*Cabot	8	5	7	6	5	Spreading bush, berries crack
*June	8	5	6	5	6	Bush usually weak
*Rancocas	7	6	7	6	6	Berries crack
*Ivanhoe	7	9	7	9	10	Buds not hardy, difficult to propagate
*Stanley	7	6	7	4	9	Easy to prune, berry size variable
*Blueray	7	10	8	7	9	Bush hardy, easy to propagate
*Bluecrop	6	9	9	9	7	Drought resistant, hardy, fine colour
*Concord	6	7	7	6	8	Fine cluster size
Pioneer	6	6	6	6	9	Berries crack
Scammell	6	7	6	6	7	Sets too large clusters
*Berkley	5	10	10	8	7	Berries drop, light blue
*Atlantic	4	8	7	7	8	Berries drop
Pemberton	4	8	6	4	7	Bush very vigorous, most productive
*Rubel	4	6	7	7	6	Bush hardy - difficult to prune
*Jersey	4	7	7	7	6	Bush hardy - long picking season
*Dixi	4	10	6	5	9	Berries crack, berry size variable
*Herbert	3	10	7	7	10	Bush hardy, berries tender

*Darrow	3	10	8	8	9	Bush erect, vigorous, berries do not drop
Wareham	2	6	6	7	10	Berries tender, bad mildew
*Burlington	2	7	7	10	6	Bush hardy, berries store well
*Coville	2	10	7	6	9	Berries won't drop, fine processed.

Note: Maturity 1 = late
10 = early

Colour 1 = dark
10 = light

* Available in New Zealand

These ratings are not absolute, for all cultivars mature earlier when heavily pruned, compared with little or no pruning and some respond more than others. The amount of pruning also can greatly affect berry size. Colour tends to be lighter in dry seasons than wet ones, but in general is least affected by environmental conditions. At Lincoln it has been observed that differences of maturity within cultivars compared with ratings established for North America as well as seasonal effects, e.g. the current drought is maturing fruit considerably earlier than observed in the past four years. Flavour of fruit is said to improve the further north a cultivar is grown but in very cool climates berry acidity may become too acid for the average taste. This of course, refers to the Northern Hemisphere, therefore, for New Zealand the opposite would apply.

TABLE II

Ratings of Rabbiteye Blueberry's Characteristics (Darrow & Moore 1962)

Cultivar	Bush Size	Maturity	Berry Size	Berry Colour	Scar
Coastal	9	10	8	6	9
Garden Blue	10	10	6	8	9
Callaway	7	9	8	8	10
Tifblue	9	9	7	10	10
Homebell	10	8	9	7	9
Menditoo	9	7	9	6	10
Woodard	8	10	9	10	7

Note: Bush size 1 = small
10 = large

Maturity 1 = late
10 = early

Other characters 1 = poor
10 = best

Tests have shown that the rabbiteye cultivars are nearly self sterile. Therefore it is essential that two rows of one cultivar should alternate with two rows of another. All have a relatively long ripening season and some fruit can be picked for four to six weeks making the rabbiteye well suited to home gardens. Rabbiteye may have some value as a grafting stock for Highbush scion wood, to encourage earlier high fruit yields and wide soil adaptability.

6. Pollination

A properly pruned blueberry bush, that has received good cultural care is capable of setting almost 100 per cent of its blossoms. To yield a good commercial crop a set of about 80 per cent is required. In this respect blueberries are quite dissimilar to apples and peaches and other fruits that may produce large yields with only 20 per cent blossom set.

From observations made at D.S.I.R., Lincoln Research Centre by Dr. Rod Macfarlane, insects have been identified that are attracted to the fragrant blossom, the glands of which secrete nectar, sought after by bees and other insects. Because the pollen grains are rather heavy and tend to adhere in masses, they are not easily propelled by wind. Bees and other insects are guided to the flower by colour and odour. Merril (1936) found that nearly 80% of the pistils of highbush blueberry remained receptive to pollen for up to four days after the opening of blossoms.

Pollinators observed working flowers Lincoln 1980:

Long tongue bumble bee	Bombus terrestris
Short tongue bumble bee	Bombus hortorum
Honey bee	Apis mellifera
Native bee	Lasioglossum sordidum

SUMMARY

1. At least 10 years are required to accurately evaluate a new imported cultivar.

2. At least 15 years are required to breed and field test a new cultivar.

3. A rating system should be established for all cultivars from age 5 onwards for each district growing blueberries in New Zealand.

4. Of prime importance is the need to identify those cultivars with longest shelf life for export.

5. Cultivars best suited for processing need to be identified for machine harvesting.

6. Cultivars that produce the best flavoured pies need to be identified.

7. Cultivars that produce the best wines/liqueurs need to be identified.

8. Many more years of research, properly financed and adequately staffed is urgently required.

REFERENCES

ESK, P.; & CHILDERS, N.F. 1966. Blueberry Culture. Rutgers University Press, New Brunswick, New Jersey.

DRUPER, A.D. 1979. Highbush Blueberry Cultivars. Fruit Varieties Journal V33 N2. 48.

AUSTIN, M.E. 1979. Rabbiteye Blueberries. Fruit Varieties Journal V33 N2. 51.

DAVIES, D.J.G. 1979. Blueberries - A Crop of the Future. Alternative Land Use Seminar - Lincoln College Horticultural Department.

OBSERVATIONS ON THE PERFORMANCE OF DIFFERENT CULTIVARS IN U.S.A. EUROPE AND NEW ZEALAND

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"Which is the best variety of Blueberry to plant?" is a question posed by nearly every grower at some stage and therefore became one of my prime reasons for visiting the U.S.A. and Europe last year - to make observations on the performance of different Blueberry Ciltivars - *under commercial conditions.*

Firstly from three regions in U.S.A., different in topography, climate and distance from their markets, and each in turn having some features similar to New Zealand.

Do I hear an unspoken interjection, 'What does he mean "same as New Zealand". We have different climates from the South to the North Island, from one province to another.' Sure, and for this reason we must attempt to classify our conditions in relation to where Blueberries are a major farm crop - so back to U.S.A.

The nearest growing region for Blueberries to us here are the states of Oregon and Washington; their coastal plains remind me very much of parts of the South Island. They have a rainfall fairly evenly distributed throughout the year but their winters are longer and harder.

Blueberry farms I saw in this region ranged from 0.2 ha for a mixed gate sale operation, to 40 ha and upwards. JERSEY is the predominant variety yielding up to 25 tonnes per hectare, but it was also the latest and was often at risk from early frosts. They let it hang to mature the fruit but if the weather changes, the fruit can freeze on the bushes.

STANLEY and CONCORD also grow in this region, but are older plantings 20 to 25 years old and are no longer being planted. Why? The small size of the fruit in the case of STANLEY (though the bushes were very large carrying a heavy crop). CONCORD was disliked by the pickers. This is a very important consideration. They were on piecework at 30c per kg and couldn't make decent money. Also, the growers had lost interest in CONCORD as the fruit did not travel well as it was inclined to go soft.

The best early variety was BLUETTA, but due to its breeding, which appeared to indicate some lowbush ancestry, flower break was a problem in a mild autumn (lowbush blueberries are native to cooler and more northern regions), and they are accustomed to a longer period of dormancy. Canadian researchers have done work on fruit bud initiation and the influence of photoperiod on the commencement of dormancy. This is a tricky one. Get a good early variety which hopefully has been bred somewhere along the line from the Highbush - Lowbush cross; move it to a region in a different latitude when day length between the seasons is not as marked or where the winter is shorter or the autumn milder, and some of its productivity will be lost. Or, at worst, the plant will be thrown right out of gear and perform poorly. However, BLUETTA had rich blue round large berries - a peculiar flavour, but I liked it!

BLUECROP and BERKELEY are the heaviest early/mid season croppers, consistent in their bearing habit. BLUERAY is also planted, but BLUECROP preferred most of all.

From a region whose cash crops are hay and peas, where the superb local steak was partly fed on green grass, to one where the roadside stalls sold peaches and water melons and grapes, and fields bore crops of maize, soya beans and tobacco. A much lighter soil type covered North Carolina, mainly sandy and only after rain took on a darker look, the humus content being quite low at 2% to 4%. The soil is similar to that used in the same state for tobacco, except underlying pans which keep the water from draining away, cause a higher water table.

In this area the rabbiteye grows vigorously, but let me dispel a

misconception. Despite the heat, the droughts and less winter chilling, 95% of blueberries in commercial production in this state are of the highbush type, because the farmers produce what the market requires. The fruit of improved cultivars of the rabbiteye is very similar in flavour, very good in fact when picked at maturity and at consistent daily temperatures of 30°C plus, but there is a certain seed awareness which can be picked up straight away and can irritate those with dentures. Notwithstanding these observations, there are many big cities in the South of U.S.A. (the bulk of the crop of North Carolina goes North to the early markets in Washington, New York, Boston etc.) Atlanta, Birmingham, New Orleans or further west to Houston, Dallas and Denver where North Carolina would have an advantage regarding freight costs and where a market could be developed. But the fact remains that they still do NOT produce *Vaccinium ashei* on any scale commercially. Another widely circulated idea was that IVANHOE was a variety bred for and grown in North Carolina because of its low winter chilling requirement. Well, I didn't see any IVANHOE in North Carolina (I did see it growing in Oregon) and it doesn't even have one mention in the latest booklet put out by the N.C. Agricultural Extension Service. It is just another superseded variety. The ones in commercial production are WOLCOTT, MURPHY, CROATAN, BLUERAY, BERKELEY and JERSEY.

Specially bred highbush types with less chilling requirements and a resistance to stem canker which is a problem in this region, are not crosses with the rabbiteye but with a native of Florida *Vaccinium darrowii*. The latest releases bred from CROATAN and carrying departmental numbers at the moment show a lot of promise but will be under evaluation for another 5 years before commercial release.

But back to realities, not what we might have but what we do have to select from in New Zealand at present. BERKELEY is prone to some frost damage - if the temperature goes down as low as a severe North American winter, but it crops heavily in North Carolina. Likewise BLUERAY seems slightly more resistant to stem canker than BLUECROP, but JERSEY which was formerly widely planted is now being pulled out and replaced by locally bred cultivars.

NEW JERSEY

The biggest blueberry farms in the world are situated in this state, only a couple of hours by Highway to New York City. Huge areas,, up to 440 ha in one operation, are run by private ownership. The Galetta Bros for example, a family concern, has 2.25 ha paddocks of the same variety, not planted north to south, and a nursery with 1,000,000 plants, many for export to Europe including Poland.

When you are dealing with a long term crop then what was planted 20 to 30 years ago and still yielding is not easily torn out, but there was a replacement programme under way. Just about every variety was represented, but the main cultivar being planted now in this State is BLUECROP without a doubt.

JERSEY used to be the one - but I'll deal with the reason for its demise later; WEYMOUTH is still the number one for early fruit but has a poor flavour and some considerable effort is being made to find a replacement. COLVILLE is the latest berry.

Why should a variety which yields 25 tonnes per hectare in Oregon and Washington and once have been the biggest producer in New Jersey be down to 10% or less of the acreage with declining yields?

The bees are to blame, or rather man and his indiscriminate use of powerful insecticides. JERSEY is a variety preferred by wild bees. Without good pollination, the fruit is parthenocarpic i.e. self fertile and small, whilst honey bees go for BLUECROP - it's as simple as that. Why they do has research workers puzzled; it is apparently not the quantity of nectar. RUBEL for example, has far less nectar than JERSEY but receives more visits by honeybees. BERKELEY seems very dependent on wild bees (which can pollinate 4 flowers in the time a honey bee takes to vist one), as does STANLEY. EARLIBLUE has a variable or poor pollination record in the States, and for this reason does not figure widely in new plantings.

EUROPE

I hadn't been to Europe for 23 years and so my first impressions of blueberries and their environment, were that the summer was cooler than in America, and the light intensity even on a sunny day was noticeably lower than in New Zealand. There are European varieties bred from American material. HERMA I, HERMA II and others are vigorous growers, very winter hardy but lacking in size and flavour.

In Germany production was based on BLUERAY, BLUECROP, BERKELEY, IVANHOE and DARROW. All produced good looking berries, the best flavoured were DARROW, BLUERAY and IVANHOE, but all seemed to be lower in sugar content, to my taste at least, than here or in America. DARROW and IVANHOE were confined mainly to central or south Germany as they had difficulty in maturing in the north where the main growing region lies.

ENGLAND

England, despite being in the EEC, is still quite a different country and the blueberry either unknown or only within certain limited areas. The plantings are quite small, quite a big farm was 3.5 ha and BLUECROP, BERKELEY and BLUERAY were the main cultivars. HERBERT and IVANHOE, although good in flavour, were considered 'too soft'.

The English autumn near to the South Coast is milder than Europe which permits an extended growing season for later varieties, including COLVILLE. This advantage turns to disadvantage when the early cultivars EARLIBLUE and COLLINS are concerned. One year, flowers of these two appeared in January, their mid-winter!

SCOTLAND

Only the earliest varieties in the summer of '79 started to colour outdoors. EARLIBLUE for example, was taken inside a glasshouse to ripen by mid August. In a trial block BERKELEY, BLUERAY or BLUECROP were making better growth than other sorts, but all were considerably smaller in bush vigour than in the south of England or the Continent.

IRELAND

As bullet-proof vests add to luggage weight when flying, I was not prepared to visit the Emerald Isle, but a first hand report informed me that DIXI was performing well, so were BERKELEY and BLUECROP. JERSEY failed to produce in one area, yet was best in another.

At this point it would be worth looking at heat requirements. There has been a lot of talk about winter chilling but what about the number of hours of warmth necessary for each cultivar to attain maximum development in yield, size, quality and flavour. I can quote from no manual although I have corresponded and discussed this point with overseas authorities, and there appears to have been no specific work done to measure this. Therefore I make my own observations. The colour of the leaves on mature fruiting bushes in north Germany and Scotland in particular was the same as we see in spring-time in New Zealand. This copper red colour, I believe, is due to cooler temperatures. Take a plant in October or early November here and put it into a glass-house, and the colour is replaced by a healthy green and more vigorous growth within a week. Sweetness of fruit (i.e. sugar content), comes of course, from the activity within the leaves. If the growing season is too cool some highbush cultivars will not mature their fruit at all whilst others will colour but lack flavour.

Therefore I recommend at least 6 weeks of 20^{o}C plus as necessary prior to and during the ripening period. If you are in doubt, don't plant - they won't make export quality.

NOW TO NEW ZEALAND

In general terms the original releases of ATLANTIC, BURLINGTON, CONCORD, DIXI, STANLEY and JERSEY appear outwardly to be the same as their kin overseas. We may even claim to have better quality, perhaps due to our climate - at least speaking from experience in the North Island, but there are limitations, limitations within the breed. No farmer here would consider running a herd of Jerseys for beef or putting 200

Herefords through a herringbone twice a day - probably cut down on your milking time though!

BURLINGTON produces smaller berries. If you're planning to supply the processing market and machine pick, then fine, go ahead and plant Burlington. The flavour is good and they keep well, but if you intend to hand pick a dessert berry for overseas, then there are alternatives.

CONCORD I believe should not be planted at all (we have already pulled ours out and burnt them). In New Zealand as overseas, its tight clusters, delicate skin which often tears when being picked, and its reputation as a poor shipper rule it out other than for a home garden.

I don't believe ATLANTIC should be planted either. It has many good points and has been successfully exported from New Zealand, but it has a well earned reputation for dropping its fruit before you have time to pick it, or if you are picking on one side of the bush they drop off from the other!

DIXI is another cultivar I feel should not be planted and by adding this familiar name I know I am inviting controversy. Despite its record of consistent high yields,vigour and fruit flavour, it has two black marks which, from a *commercial* point of view, are high risk factors to be taken into consideration before any further plantings are undertaken.

* Scar (large MOIST scar) It is true that some of the new introductions have a large scar, BLUERAY for example, but DIXI also tends to be moist and this can lead to growth of mould during transit. Not, of course, if you soak them in a fungicide before shipping, but I wouldn't advise any grower to try that preventative measure with the regular sampling for residues now being practised in U.S.A. ports of entry.

* Splitting. Perhaps this is why the cultivar survives in Ireland with its continually moist climate. In New Zealand

however, we have experienced loss from splitting in our hot summer after rain and this is despite regular irrigation before the rains came. Splitting, or rather exploding, completely ruins the blue fruit, the purple fruit and even the red/purple stage. The mess spreads over immature green berries and 50% of the crop can be lost overnight.

STANLEY, though discontinued overseas because of size, is still my favourite for flavour amongst the early fruiting types. Care and patience is necessary at picking time or tearing will result.

JERSEY crops well here, but in many districts doesn't produce large fruit after the first picking. This is usually due to one of two reasons:

* insufficient irrigation

* too much fruit.

This cultivar must be regularly pruned to encourage younger wood because older wood, althoug it crops heavily, produces small fruit which is not suitable for export grade.

To date there are no 'Big 7' cropping under commercial conditions in New Zealand. There are plants which have fruited at Moanatuatua and Lake Cameron near Hamilton, but these have not been managed as a commercial block. Let me give an example. Due to lack of space, young two year plants have been interplanted in blocks with 10 year olds over 2 m high; there has been no regular irrigation and they have had to compete for water and nutrients with the mature root systems of the older plantation. Furthermore they have not been de-flowered or fruit removed to aid establishment. Where they are managed in rows it has been in the main for whip production and this of course gives no cropping data. Or, in another location, insufficient shelter has favoured plants with a stronger vegetative growth - in a survival sense - which does not necessarily mean they will prove to be the highest yielders of

export quality fruit. A few growers have fruited individual specimens on a nursery scale, we have seen and tasted BLUECROP, BLUERAY, BERKELEY, COLLINS, COLVILLE, DARROW, IVANHOE at Whakatane and made comparisons with older selections.

The charts below are a summary, based on observations in New Zealand. Where an "X" has been superimposed I consider the variety as unsuitable for intended export plantings and "?" to mean probably suitable, and "50/50" could be suitable if care is taken.

So, to sum up, in two Continents commercial growers favour BLUECROP, BERKELEY, and BLUERAY. These are the cultivars which appear as the backbone of *all new plantings*, plus BLUETTA, COLLINS or EARLIBLUE as early croppers and DARROW and COLVILLE as late types.

There are newer varieties released from university experimental stations which have only a localised appeal overseas so far. For this reason, plus the fact that most are not in New Zealand (and those that are, still remain in quarantine), they are still five years away from the commercial planting stage.

This applies also to locally selected cultivars through the Ministry of Agriculture and private growers who have testing programmes under way.

So finally, is there a logical reason why we should continue to base our growing industry on superseded strains when improved *commercially proven* cultivars with more appeal, ease of harvesting, better handling and shipping qualities are there, wanting to be planted?

PLUS POINTS	VARIETY	MINUS POINTS
size - medium/large, flavour - good, colour - good	~~Atlantic~~	growth habit, fruit drop when ripe
keeps well, good shipper, good for machine packing, yield high, flavour good	Burlington 50/50	tight fruit cluster for first berries, small fruit tedious to pick
colour - good, flavour - average to good	~~Concord~~	tight fruit clusters, tears easily, poor shipper
excellent cropper, good flavour, good size	~~Dixi~~	large moist scar, therefore uncertain shipper, strong tendency to burst after rain
very good flavour, does not burst, yield quite good if close planted and well pruned, colour and size of early fruit good	Stanley 50/50	medium to large scar, care needed when picking, colour of late fruit - dark, size of late fruit - poor
good cropper, good colour, firm berry, good shipper good keeper, late flowering, easy to pick	Jersey ✓	needs hard pruning or size too small, stems sometimes hang on berry, flavour just average. Bees? Consider pollination for large blocks
size, colour and flavour - all good, does not drop, later fruit continues to size	Collins ?	yield questionable

PLUS POINTS	VARIETY	MINUS POINTS
yield, flavour, size all good, does not drop	Blueray ✓	scar large, but not wet, shipping not as good as Bluecrop but still keeps well, tight cluster at first picking
light blue, hangs well, excellent shipper, drought resistant, hardy, fastest hand picking of all cultivars	Bluecrop ? Yield in N.Z. still unproven	flavour average, bends with weight of fruit, not best shape for machine harvesting, cropping season re overseas markets ??
light blue, heavy bearer, good size and shipper	Berkeley ✓	flavour only fair to average, pollination ?? (large acreage only) *Godronia cassandrae* cooler weather fungus disease overseas
hardy, flavour, size all good, hardy in regard to wind	~~Ivanhoe~~	not the best shipper, yield fair to average, grows a higher % of wood to fruit
exceptional flavour, large berry, good colour	Darrow ? shipping quality unknown	vegetative vigour suspect, tight fruit cluster for first berries, danger of compulsive eating !!
good cropper, colour, size and shipping, keeps sizing up to end of harvest, doesn't drop or burst	Colville ✓	risk (overseas) of *Anthracnose*, Bees ?? (large acreage only)
good cropper, excellent flavour and size, hangs well	Herbert 50/50	thinner skin, mid to dark blue, shipping quality yet to be determined under NZ conditions

BLUEBERRY MICROPROPAGATION - A RAPID METHOD TO INCREASE NEW CULTIVARS

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Horticulture in New Zealand is in a phase of rapid expansion creating a demand for large numbers of plants, often with little advance warning to the nurserymen who are expected to produce them. New varieties of plants are being imported and there is pressure for rapid multiplication after release of the plants from quarantine. Recent experience with blueberries provides a good demonstration of some of the problems involved.

In 1978, we commenced a project at Plant Physiology Division to develop a micropropagation (tissue culture) method suitable for blueberries. Initial method development took approximately eight months and we then requested the Blueberry Research Advisory Committee to nominate five cultivars in short supply. We offered to use our procedures to propagate 1,000 plants of each variety over the next year. The five cultivars suggested were Berkeley, Ivanhoe, Blueray, Bluecrop and Earliblue. Stock plants were supplied to us by Ruakura Agricultural Research Centre. The methods used have been outlined in papers presented to the annual meeting of the International Plant Propagators' Society in 1979 and 1980 and copies of these papers are available.

Our initial work was done with the cultivar Atlantic which has proven to be one of the easiest cultivars to handle at all stages. Stock plants were grown in a glasshouse and shoots collected at the end of a flush of growth. These shoots were surface sterilised using hypochlorite, cut into single node sections and placed on sterile media. Shoots developed from the axillary buds on about 50% of the sections and produced shoots 2-4 cm long with 6-10 leaves after about six weeks. These shoots were excised, cut into sections of 1-3 nodes and replanted on fresh medium in petri dishes. Most of the new cultures produced axillary shoots which were again cut into sections after 6-8 weeks. This procedure has been repeated, to date, up to nine times giving a proliferation rate of around 5-fold per subculture.

In vitro grown shoots were dipped in Seradix 2 rooting hormone powder, planted in a seedling flat containing fine pumice:peat (50:50) and kept under high humidity and two layers of 50% shade cloth. With the cultivar Atlantic 90-95%

of cuttings had rooted after two weeks and the cuttings could be hardened off by first transferring the flats to intermittent mist for one week and then to a glasshouse bench.

Once rooting had taken place, the plants were fertilised twice weekly with a complete nutrient solution. When the shoots were 7-10 cm long they were transferred to propagating tubes. Plants with 1-3 shoots over 30 cm long were produced within a further 2-3 months.

Other cultivars often behaved differently to the above description for Atlantic at some stage in the propagation sequence. The characteristics of the five varieties referred to above are noted:

BERKELEY:

Cultures established easily and proliferation was similar to Atlantic.
Rooting was excellent with root initials appearing in 10 days and about 95% of the cuttings were usually rooted within three weeks.
Subsequent growth has been very good.

BLUERAY:

Cultures established easily but proliferation rate during the first three subcultures was only 2-fold. At subsequent subcultures proliferation improved to approx. 4-fold.
Rooting of shoots was similar to Berkeley and Atlantic.
Subsequent growth has been vigorous. This is the most precocious variety and many of the shoots developed floral buds in the greenhouse during the winter.

IVANHOE:

Cultures established easily but proliferation rate was intermediate between Berkeley and Blueray.
Rooting was slower than for the above varieties. Only about 70% were rooted after three weeks.
Subsequent growth has been very good.

BLUECROP:

This has proven to be the most difficult variety to establish in culture. Bud break has been erratic and when shoots were cut up for the first and second subculture only a small proportion of nodes have produced shoots. At the third and subsequent subculture the

proliferation rate improved.

Rooting has been difficult with only 50-60% rooted after four weeks.

Subsequent growth has been very good.

EARLIBLUE:

Culture establishment has been good. Shoot growth has been very vigorous with good proliferation rates.

Rooting, however, has been poor. In one large trial only 51% of cuttings formed roots in four weeks.

Subsequent growth has been very good.

The plants we produced have been offered for sale to growers and nurserymen by New Zealand Berryfruit Propagators Limited. Plants of varieties Berkeley, Blueray and Ivanhoe have already been distributed. Plants of Bluecrop and Earliblue will be distributed in early December. Plants remaining after these sales are being sent to research stations for further trial work.

Fears have often been expressed about trueness-to-type of tissue culture grown material. There is no evidence to suggest that this will be a problem with blueberries. Unfortunately, many early attempts at micropropagation used systems involving callus culture followed by induction of adventitious buds. In these cases, variation was found. In addition, some ornamental plants are variegated and have a chimaeral structure, which is unstable in any propagation system. This instability is put under even greater pressure in a rapid propagation method.

The procedures recommended for blueberries are a most conservative approach to micropropagation. If hormone levels are increased, more rapid proliferation is possible but adventitious buds arise from basal callus and from leaves. Although we have no evidence for any variation in such buds, we nevertheless have not subcultured adventitious buds.

The plants produced in these procedures appear to be very vigorous and have a number of characters similar to seedlings. This 'rejuvenation' has been reported with a number of crops and is one of the advantages of micropropagation over conventional propagation methods.

What then is the role of these methods in blueberry propagation? Several commercial laboratories are currently propagating blueberries. As long as there is a high demand for plants, any added costs of micropropagation should be able to be recovered in the price charged. If demand falls, the

price tissue culture grown plants can fetch will depend on whether subsequent growth in the field proves to be as good, or better, than cutting-grown plants. The cost of the micropropagation procedure will vary depending on the overheads of the laboratory and the efficiency with which it is run.

References:

Cohen, D. and D. Elliott. (1979). Micropropagation methods for blueberries and tamarillos. Proc. Int. Plant Prop. Soc. Vol. 29.

Cohen, D. (1980). Application of micropropagation methods for blueberries and tamarillo. Proc. Int. Plant Prop. Soc. Vol. 30.

A BASIC APPROACH TO LAND PREPARATION

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How many times have you seen a wild bird with a blueberry in its mouth, or so full that the seeds are coming out at the other end? The seeds germinate on the surface and a plantation grows. Well, maybe under natural conditions millions of seeds are produced but only a small portion ever come to maturity. We want to try and understand a more dependable way of preparing land for blueberries.

Firstly let us look at conditions as they prevail in their country of origin, looking specifically at the highbush blueberry. It grows naturally when ground has been cleared from what we call second scrub country. Americans call it pine barrens, country with low-growing pine trees about as high as telephone poles, not like the towering timber in Radiata. The soil is usually sandy but has a mixture of decaying leaves, wood and bark. Undergrowth is not heavy, but there is a top soil of variable thickness sitting on top of the free draining sand. But, underneath is a pan which may vary in depth from 2 to 4 feet and it has the effect of retaining rainfall quite high in the soil.

So in effect it is only free-draining at the surface, and it supports the blueberry by giving a continuous supply of moisture within easy reach of the shallow root system. Furthermore, this moisture over the pan is on the move towards an outlet, like a large shallow underground reservoir.

How do these conditions compare with what we have here? Let's look at three types of land.

Scrub

Usually covered with Manuka in this area. If not too large you could rotary slash the whole area then disc into the surface and leave fallow for a while. This would be similar ground preparation for pine planting up to this stage. Follow this up with a further discing and pulling a ripper through to tear any roots and aerate the ground. Finally rotary hoe and level.

Reason Not to bury the valuable scrub or forest type top soil too deep as you would with ploughing - remember the surface rooting habit of blueberries.

Swamp

First consideration is to plan a drainage system that will enable you to firstly work up the ground, but secondly serve as a water control system after you have planted. In new swamp the whole operation may take two full seasons, the first to put through a main drain with feeder canals with some land clearing, and the second to plough in order to bury rushes, sedge, flax and so on, and prepare the ground for planting. If this work is hurried - on new ground at least - when it settles (and settle it will) an uneven surface will cause ponding and loss of the new planting, so although two years man seem to be working ahead too far this is what you will need.

Pasture

Most likely however you will be preparing ground out of pasture and the aim here is to get rid of perennial weeds.

Ploughing There are many types of ploughs and most modern 3-point linkage ones turn the furrow over and leave it standing on edge at an angle; fine if you are putting in a crop, but rushes, docks, paspalum and others soon find their way in between. We want to get rid of them so the type of plough with sufficient adjustment such as an old swamp or semi-swamp plough is the one to use.

At this point you may say to yourself "There's a contradiction. He says to leave the top soil, now to bury it". The answer is in the two types of soil; in scrub there is a forest type structure but in pasture bury the top soil and bring up materials with a lower pH. Earthworms which produce their casts at the surface raise pH by secretions from calciliferous glands! In pasture this can be up to 7.2 or 7.4 in the top few centimetres.

When to plough In early summer where there is moisture still in the ground to break down the turf, rotary hoe NOT TOO DEEP or you bring up too much of the top layer again.

Chemicals The use of dessicants before cultivation speeds up the process of breaking down the turf. "Grammoxone" and "Reglone" are frequently used, however if there is a predominantly paspalum sward you could consider "Round-up".

There will always be seedling regeneration. A final mechanical cultivation may be sufficient to kill these, but with some persistent perennial weeds a further spray immediately prior to planting could be necessary. For example, we have a problem with docks; they seem to appreciate mechanical cultivation as a way to divide and reproduce, and a generation even managed to turn around and poke up their heads to seed in between ploughing and rotary hoeing. The answer, now we believe is to spray in strips in the late Spring, before planting. Not only should the docks be caught once and for all, but also any surviving twitch and paspalum.

INFLUENCE OF CLIMATE, (particularly rainfall)

There is no hard and fast rule that blueberries should grow on ridges, or that drainage pipe is absolutely necessary. It will depend on your soil type. Water in the ground is vital; if it runs away too quickly on to lower ground you may be losing up to half of it (625 mm in my case) leaving too little for growth. If on the other hand your proposed block is on the flat where hills surround, your 'rainfall' may be over 100 inches or 2,500 mm, too much, a miniature catchment area.

Only last month on one of the farming programmes on television there was an excellent report from Nelson about establishing new orchard blocks. The fruit was the apple, but the experiment could well have been done with blueberries. Apple trees planted on ridges and irrigated, far outyielded those under other conditions. Blueberry rooting systems need also to be moist, without being waterlogged, they need aeration without drying out and this is why most commercial blocks in U.S.A. are on raised rows 250 to 500 mm higher than the interow alleyway. Naturally, if you were preparing light land, pumice or sand, on a slope there would be no need.

Swamp

Ridge individual rows, or two rows to facilitate tractor access.

Pastures

Either as with Scrub or Swamp, depending on the RATE OF WATER FLOW through the soil, i.e. check the drain level compared with that in the block, or one day after rain dig a spade hole.

Observe In pumice or river shingle the water level will almost be the same as in the drain, but if appreciably higher, e.g. in ground with slower water movement, then ridge and pipe.

Temperature is another climatic factor for consideration, as is the need for shelter. Your first crop is your shelter, not the blueberries. There are many areas in New Zealand where the wind could be the biggest single factor limiting the establishment of horticulture. To create a micro-climate suitable for blueberries, well established, double shelter at least, should exist on the sides affected by prevailing winds. The use of artificial shelter within the blocks is not just an option but a necessity.

FERTILISER

A soil test is absolutely necessary, but when should it be taken? As

the land is going to be cultivated and possibly moved from one place to another, it would be an advantage to take one when this first stage of the operation is over.

The form comes back with recommendations for so many kg of fertiliser per hectare; how and when do you apply?

For example. Sulphur is very expensive and you may be tempted to give each small plant, say a handful. Do you know how much is in a handful?

If there are about 200 g in a handful, and your plant density is one plant per square yard, an acre (4840 sq yds) will require

$$4840 \times 0.2 \text{ kg} = 968 \text{ kg}$$

and a hectare will require

$$968 \times 2.5 = 2420 \text{ kg of fertiliser.}$$

Now assuming that 1000 kg/ha will lower the pH by 1.0, 2420 kg/ha will lower the pH by 2.4 in one fell swoop. Furthermore, if the fertiliser is simply spread around the base of the plant rather than evenly over the square yard, the effective application rate around the plant will be double what is already an excessively heavy application.

Blueberries are no more able to withstand the resulting very acid soils than most other plants. The result? The leaves will turn yellow and red and the plant will die.

Thus, broadcast over a measured area the exact amount, same with super-phosphate. The exception is nitrogen which I would heave until the plants are in full leaf. Apply in LIGHT side dressing not too near the plant with young plants, but over the whole area on established plantations.

Another option is to apply only what is necessary to adjust the pH, plus

basic applications of phosphates and potash, at least 3 but preferably 6 months before planting. Then no fertiliser whatsoever in the first growing season.

This is partly to eliminate risks of root damage and even plant death from chemical residues but also to stimulate the roots into activity in association with the community of living organisms in the soil, including mycorrhiza.

By the way, many growers in U.S.A. and Europe applied no fertiliser in the first year - they did not know exactly why in most cases - but they believed the young plants established themselves better.

And remember too that there is a natural process of nitrification when plant residues from previous cover are being broken down. In most new blueberry ground either from swamp, scrub or pasture, this activity will be taking place.

Preparing land for blueberries also includes PEST CONTROL! Whether or not we have mesurol in future, there will always be a need for protection against pests, including deer, oppossums, rabbits and hares, all of which like to browse on blueberry shoots. The list does not stop with wild creatures - sheep were one year responsible for 'over-pruning' the Ministry of Agriculture's plantation near Hamilton! Cattle will eat what they do not trample, and I even know of a case where turkeys have chosen the clean ground alongside new plants to have a competition to see who can scratch the biggest hole. Last and not least, the insignificant snail is capable of eating off new shoots as fast as they appear in springtime; they hide and breed in long grass. So plan and be prepared for unwelcome invaders; galvanised netting, electric wires, sprays and reducing cover inside and outside the block will be good insurance. When you consider the crop you are putting in is for 20, 30 or even 50 years or more, ALL YOUR PREPARATION WILL BE WELL WORTH YOUR WHILE.

BLUEBERRIES - PLANTING, MANAGEMENT & HARVESTING

E.M. Gray,
Managing Director.
Kiwi Blue Co-operative Limited

INTRODUCTION

As a grower, my major concern with the cultural aspect of growing blueberries is not so much the technical or scientific approach but rather how this knowledge can be applied on a practical basis. We have obtained this information by ten years of making mistakes, correcting them and then making ten more. When I began growing blueberries ten years ago, there was very little information we could turn to. Some elementary research had been carried out by the Department but in many cases this was not suitable for wide spread application to commercial plantings. We have therefore had to carry out much trial work ourselves and there have been many occasions when I have been on the verge of putting the mower right through the lot; a feeling you all will no doubt appreciate in time to come. I have assumed in this paper that most of you here are in the early stages of growing and have therefore kept it relatively simple and in practical terms.

PLANTING

Assuming that your ground has been prepared and that you have plants available for field planting, we move to the first of your problems. And that is the spacing of your plants. Before planting of course you must decide on your spacings. There are several considerations to be made when planning your block. If, as seems likely at this time, we have to continue with a canopy for bird protection, then it is important to have as high a plant population as practical. Table 1 gives an indication of space between bushes and between rows to give the required number of plants.

Table 1

Plants/ha at various spacings

Between row	In row	Number of plants
2.4m (7.8ft)	0.9m (3.0ft)	4630
2.4m (7.8ft)	1.2m (4.0ft)	3472
2.7m (8.8ft)	0.9m (3.0ft)	4115
2.7m (8.8ft)	1.2m (4.0ft)	3086
3.0m (9.8ft)	0.9m (3.0ft)	3704
3.0m (9.8ft)	1.2m (4.0ft)	2778

Our spacings are 2.7m between rows and 0.9m between plants. This means in time you will be growing your plants as a solid hedge-row. Indeed after five years we can no longer get through the rows. The suggestion has been made that eventually every alternate plant can be removed thus setting up a second block. However our experience has been that when this stage is reached it is rather difficult to transplant trees of this size without considerable disturbance to the row and that extreme care has to be taken to ensure that the transferred plant survives. An alternative is to hard prune back to the crown every second to third bush to give the additional room required thus rejuvenating the bush at the same time. However it should be 10-12 years before you need to consider any action at all. I would therefore suggest as high a plant population as possible where the use of netting is going to be required.

The second problem you will be facing in this region is 'to mulch or not to mulch'. The use of polythene mulches on initial planting out is recommended in many areas. In the Waikato it is almost essential we do this to gain weed control. In Canterbury I believe there is another problem which may affect the use of polythene and that is the prevalence of certain insect grubs i.e. grass grub and porina. The essential thing when placing young plants in the ground is to give them complete protection from competing weeds. This competition will cause a severe set back to the young blueberry plant during its first year. This coupled with the necessity of supplying adequate moisture means that some sort of mulching is required. If polythene is considered unsuitable I would suggest at least 15cm of untreated sawdust could be used.

Plants should be placed in the ground slightly deeper than they have been grown in the nursery and if being grown on a heavy soil type, a layer of peat in the planting hole can be beneficial in the establishment of the new rooting system. It is not recommended that any fertiliser should be incorporated at this time except perhaps a small amount (10-15g) of a slow release nitrogen compound e.g. osmocote. Planting may commence any time after plants have entered their Autumn dormancy and can continue through until just before spring growth starts. Developing flowerbuds should be pinched out at the time of planting.

MANAGEMENT

Well, you now have a block of young blueberry plants and your problems are just starting! What do you do now?

Water Supply

Because blueberries are a shallow rooted plant with no tap root or root hairs they must be kept supplied with an adequate level of moisture particularly during establishment phase. Other important times are during fruit sizing (late November) and during whip growth extension in late summer (February/ early March). You should be prepared to irrigate if you anticipate soil moisture shortage at these times. This may be by -

1. Control of water table by damming ditches etc.
2. Trickle irrigation with microtube supply to each plant.
3. Overhead sprinklers - use more water and create greater evaporation losses.

With both trickle and overhead sprinklers the presence of iron in the water can be a major problem. Possible solutions are -

1. Use larger microtubing (trickle).
2. Fed direct from pump to avoid contact with air.
3. Use a sand filter to aerate before irrigating.

As a general guideline the moisture requirement for a blueberry plant is in the general vicinity of 3 gals per day supplied with trickle irrigation. However the actual amount of water supplied must vary with local conditions, soil types etc and so growers are advised in an approaching dry spell to be constantly monitoring their block for anticipated moisture shortage. By picking up a handful of soil, squeezing it together and then opening up your

hand you can tell if you are too late. If the soil sample falls apart then it is too dry. Mulching also helps to retain soil moisture and on mineral soils it is advisable to continue the sawdust mulch applied to young plants right through to the mature bush stage. We blow the grass clippings from the grass strips between the rows onto the rows which also acts as a mulch.

FERTILISER

The blueberry plant has a low exchange base for fertilisers. (I could go into cation and anion exchange rates but I won't.) Consequently many recommendations have been for little or no fertiliser. We have always used a base fertiliser amounts varying with the age of the plant.

TYPE

We use a complete fertiliser containing equal parts of N, P and K usually a 12.12.12 mix for economy. Nitrogen side dressings have been either Sulphate of Ammonia or Urea.

Time of Application

A split application 50% of base mix at bud break and the remaining 50% about six weeks later. Nitrogen is applied at four weekly intervals following base application.

Amount of fertiliser

No fertiliser applied on planting out. A light application of base mix was made in February to encourage autumn growth. Thereafter we have applied fertiliser at a rate of 1cwt/acre (130kg/ha) increasing at a rate of 1cwt/acre per year until year five. Nitrogen has been applied at a rate of 100lb/acre (120kg/ha) of Sulphate of Ammonia per application. When our pH dropped to 4.5 we switched from Sulphate of Ammonia to Urea at a rate of 50lb/acre.

Because our peat soil is usually deficient in Magnesium and there was initially some indication of leaf margin chlorosis typical of Magnesium deficiency we have been applying magnesium as an additive to our base mix as well as occasional dolomite applications. For trace elements we rely on the results of leaf tissue analysis for the correct balance of feeding (e.g. Copper, Boron etc.)

Also typical of our peat soils was the apparent locking up of the element phosphorus as indicated by the differing values of P in soil tests and leaf tests. To overcome this we apply 2 or 3 foliar feedings during early Autumn. The following table represents our feeding programme as applied to our five year old bushes.

Table 2

Fertiliser Applications to Five Year Old Bushes

Date	Fertiliser	Amount
Early October	12.12.12	250lb/acre (300kg/ha)
Mid November	12.12.12	250lb/acre (300kg/ha)
Late November	Sulphate of Ammonia or Urea	100lb/acre (120kg/ha) or 50lb/acre (60kg/ha)
Repeat Nitrogen Applications Mid December, March & April		
Early March	Wuxal	2/3 applications

Note: Fertiliser is applied as a band up the rows only. The effective root absorption area extends out to the width of the branches.
One word of caution Blueberry plants can be damaged by excess use of fertiliser especially nitrogen.

Young nursery plants in planter bags also need adequate feeding. As well as the normal use of fertiliser in the potting mix we normally apply a series of liquid feeding every ten days or so using one of the commercial brands available (Lush, Zest, Maxicrop etc.). We also rotate these in sequence applying a different chemical with every application.

WEED CONTROL

The importance of weed control in young blueberry plants has already been stressed. It is also necessary to control weeds in more mature plantings. We do this with a complete programme of pre-emergent herbicides. I would stress however that because we are on peat soil our chemical application rates are higher than necessary on a corresponding mineral soil. Some eight years ago we began trial work with these chemicals, as at that time there was little information available on what chemicals to use or what rates. We would apply

a chemical, wait twelve months to see if the weeds died, the bushes died, both or neither - a long slow process.

The following recommendations are based on our trial work and reading on the subject both in New Zealand and abroad. Some herbicides can be translocated into the plant systems and these may show up as residues in the fruit. As chemical residues are one of our biggest problems on overseas markets we endeavour to restrict chemicals used to either those with a proven nil residue level or those that have been clearedfor use in the U.S.A. They should apply to both peat and mineral soils but READ the label.

Casoron (Dichlobenil) is a granular herbicide that has been effective in the control of hard to kill perennial weeds, Canada thistle, dock, wild carrot, couch etc. It should be applied late in winter when the ground is cold and wet. It is highly volatile and when temperatures are over 15 degrees C. dissipates very quickly. This chemical does not leave residues to control summer grasses so one of the following chemicals need to be used.

Chemicals for Summer grass control include -

Karmex	(Diuron)
Princep	(Simazine)
Sinbar	(Terbacil)

Diuron and Simazine should be applied in spring at the rates recommended on the label, using the higher rate for peat soils. These materials may be alternated so that Karmex is applied one year and Princep the next, to obtain better weed control and less chance of injury to the blueberry plant. They should be applied before weeds emerge and best results are obtained when one-half to one inch of rainfall occurs within ten days of application. Sinbar (Terbacil) can be used on the more difficult to control weeds or when Karmex or Simazine become ineffective. Terbacil especially must not be used until plants have been established for at least one year in the field. It should be used as a band application to the ground beneath the bushes in the spring before weeds emerge or are in the early seedling stage.

Note: Do not use Sinbar on soils of less than 1% organic matter nor on gravelly soils or on eroded areas where the subsoil or roots are exposed.

GENERAL PRECAUTIONS to be observed when using these three chemicals. All should be applied at the base of the bush keeping as much as possible off the plant. Do not spray any herbicide around plants that are diseased or lacking in vigour as damage may occur; or on any exposed root or fruit as these

chemicals may be absorbed thus damaging the plant. READ THE LABEL CAREFULLY.

PARAQUAT is a liquid herbicide that kills any green tissue it makes contact with. It may be sprayed on emerged green weeds and kills the tops. Annual weeds will be completely killed but perrenials will recover. Paraquat must not be applied to new shoots of blueberry plants as they will be killed or injured. This is a dangerous chemical and should be used with caution.

ROUNDUP (Glyphosate) is currently being investigated for registration on blueberries in U.S.A. It has the same effect as Paraquat but in addition it is translocated into the root system of the plant killing the entire weed. Care should be taken to avoid contact with the foliage of the plant. There is a definite place for this chemical in blueberry weed control and it is hoped that full registration will be available shortly.

VELPAR (Hexazinone) This chemical has undergone trials recently on blueberries at Ruakura and shows great promise. However it appears to be suitable for use on soils with higher organic matter and more information is needed on varying soil types, residues etc. As with all chemicals use herbicides sparingly, carefully and READ THE LABEL.

PRUNING

It has been established that for high quality export fruit heavy pruning is necessary. Young plants should have any broken branches and light twiggy growth removed. Longer canes may also be tip pruned to establish a better framework for the growing plant.

As the blueberry produces fruit on wood from the previous season's growth it is necessary to encourage that maximum possible fruiting wood. This is carried out by cutting out old disused wood, dead or diseased wood, weak growth and low twiggy branches. The aim on a mature bush is to cut back 20% every year thus completely rejuvenating the bush every five years. It is best to use a large pair of lopers for the first cut to remove complete brances or older mature wood; to follow this with secateurs removing lighter more twiggy branch growth and completing the job by rubbing off excess small lateral growths or buds with a leather glove. After pruning the bush should look naked! Although heavy pruning will reduce total yield the size of the fruit and subsequent weight of the crop is increased.

PESTS & DISEASES

We were told in the early days of blueberry growing that there were no pests or diseases worth bothering about in New Zealand although there were many in overseas countries. On one of our early consignments to Los Angeles there was discovered one dead larva of a leaf roller on one berry. I still have the telex 'Permission to dump at sea'. $10,000 worth of blueberries! Spraying is vital not only to control leaf roller and other insects but also to prevent fungal spores especially Botrytis from affecting the fruit and reducing its shelf life. Spraying should commence as a winter clean-up spray and continue through until the end of fruiting. On export fruit it is very important to use only those chemicals recommended and at the rates recommended as excess chemical residues will see complete rejection by U.S. E.P.A.

Unfortunately one of the side effects of a complete spray programme is the removal of the desirable predator mites. We now see appearing in many blocks the common tydeiid mite which is immune to the chemicals being applied. Trials are nowbeing carried out to find chemicals suitable for controlling this insect. Solve one problem and you create ten others! The following table indicates our spray programme and is compiled in conjunction with M.A.F.

Table 3

Time of Applic.	Fungicide	Disease	Insecticide	Pest
Pre Bloom	Thiram	Botrytis	Gusathion	Leaf roller etc
Mid Bloom	Ferbam	Botrytis	nil	Leaf roller etc
Petal Fall	Captan	Botrytis	Dichlorvos	Leaf roller etc
1st Cover	Captan	Botrytis	Gusathion	Leaf roller etc
2nd Cover	Captan	Botrytis	Gusathion	Leaf roller etc
3rd Cover	Captan	Botrytis	Dichlorvos	Leaf roller etc
Repeat 3rd Cover Spray at 10 day intervals throughout the fruiting season				
Application Rates	Thiram 150 grammes per 100 litre Ferbam 120 grammes per 100 litre Gusathion 50 grammes per 100 litre Dichlorvos 60 grammes per 100 litre			
Waiting periods	Thiram Apply only during flowering Ferbam Apply only during flowering Captan 4 days Gusathion 21 days do NOT apply after November Dichlorvos 3 days			

HARVESTING

If you follow good cultural practice you may end up with a high quality berry hanging on your bushes. That is only half the exercise. You now have to pick, pack and transport that berry to the market place with minimum of damage. Quality fruit especially on the export market is vital if this industry is to succeed.

Picking: For this high quality export fruit hand picking is always going to be necessary. We have tried the small hand held vibrator but even this caused too much bruising of the fruit. To hand pick fruit, it is rolled between the thumb and the first finger in to the palm of the hand and then placed in the receptacle such as a 1 gallon bucket, Dixi Bag etc. We have found that to grade fruit to the necessary quality eliminates picking direct into the punnet. On the other hand, care must be taken to handle the fruit as little as possible as this destroys the waxy bloom on the fruit.

This bloom is seen as a quite opaque covering on the berry and serves as a protection layer. The fruit must be cool stored as soon as possible after picking to remove the field heat from the berries. It is also important to organise your pickers so that you can control the quality of the fruit being picked. (It will require up to 8 pickers per acre to handle the crop at its peak.) It is essential to instruct your pickers in exactly the way you require the fruit to be picked and ensure that these instructions are carried out.

Packing: After having field heat removed from the berries they can then be packed into their market containers. We have constructed a sorting and grading table. The fruit is tipped from the buckets onto a variable speed moving belt which feed them through a blowing mechanism designed to remove leaves, trash etc. From here they pass to the main sorting belt, also adjustable speed, where defective berries are removed by staff operating four sorting stations. Berries pass from here over a sizing device (to be incorporated in the machine this year) and thence to the punnet filling station. The filled punnets are then weighed, capped with cellophane and packed neatly in the cardboard master containers. The containers are strapped in bundles of three or five and are then ready for shipping. The completed master containers are held in cool store at 1-4^{o} C until the consignment is ready for export. During the packing operation we run random checks to ensure the fruit is up to the quality standard that we are endeavouring to attain. These standards have already been circulated to all our Company members and all will be expected to achieve this standard quality.

This then is the blueberry industry. There is much, much more for us all to learn about the growing and cultural practices in New Zealand. The collecting and correlation of the results of growing on the many and varied soil types and conditions in this country is going to take many years. However, I believe that if as growers, scientists and research workers we all work together and pool our results, we can obtain an industry that is going to grow in strength and stature from these small beginnings to become a force to be reckoned with in New Zealand horticulture.

PRUNING

A.L. Firmin,
Grower,
Whakatane.

Part of any pruning programme is to remove plants which are diseased, poor producers, lacking in flavour or character - remove them altogether. Identify these during the fruiting season with tags or similar markers and dig them out as soon as possible afterward. It will then be possible to spell the ground for up to six months before replanting and at the same time, if removal has been due to disease, may indicate the cause. For example, if water lies close to the surface over the winter where the plants used to be, then you will know what to do before replanting.

The first aim of pruning is to improve fruit quality. As blueberries are precocious bearers, high yield comes almost naturally to a healthy stand so this is not our primary aim. Size is important because firstly, it makes picking quicker and saves on labour costs, secondly and of equal importance, the export market for hand picked dessert grade prefers larger berries. Another aim in pruning is to maintain a healthy plantation by removal of old or diseased wood, and constantly rejuvenating the stand to keep a good balance of younger vigorous wood (see Table 1).

TABLE 1

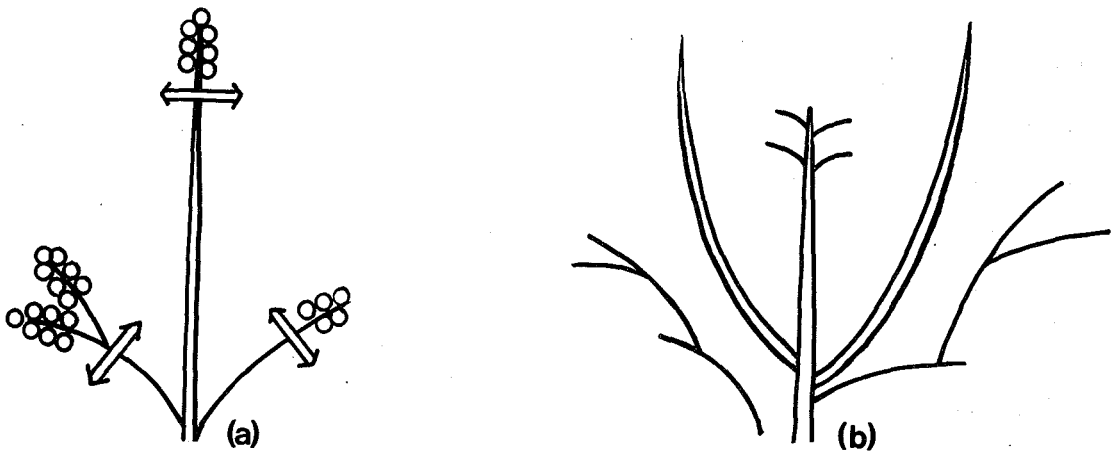
HARD PRUNING	LIGHT PRUNING
Vigorous growth	Weaker growth
Stronger wood	Thinner wood
Later flowering	Earlier flowering
Bigger berries	Smaller berries
Earlier berries	Later or more spread out ripening
Smaller harvest	Highest total yield

There are markets which prefer small to medium sized berries. In baking for example, the Americans even have regulations regarding the number of berries which must be present in a blueberry muffin, so some of their producers gear their production techniques for this type of market to obtain the maximum number of muffins to each kg of berries. Also, a large dessert berry collapses into too much juice when baked in one form or another. Since there are literally hundreds of recipes apart from blueberry pie, there is a distinct market for smaller fruit which some of us no doubt may chose to supply in the future.

PRUNING YOUNGER PLANTS

At the time of planting - for most it will be in the dormant stage. I prefer cutting back just below the fruiting wood (see Figure 1a). Some remove the flowers or fruit, but as the framework of your future plant grows from nearer the base of the bush (Figure 1b) there is not much advantage in leaving on thin twigs, which after removal of the buds could serve as entry points for diseases such as botrytis. The time to cut is just before sap flow, which will be August to September, depending on the district.

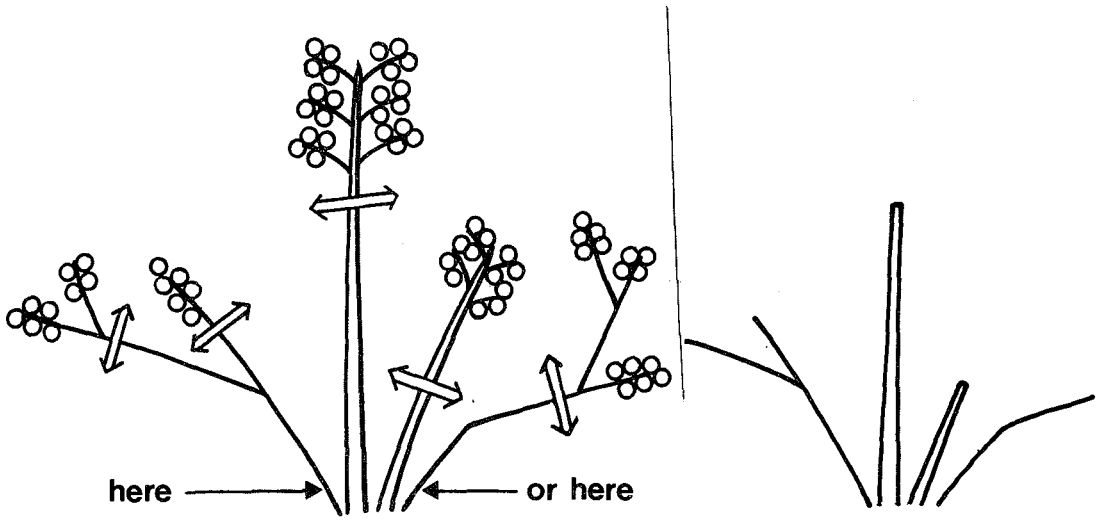
FIGURE 1



Provided there is enough moisture and shelter, there is no reason why you could not plant now, or any month, with container grown plants then only remove branches which lie tooclose to the ground where they are likely to get in the way of herbicide application. Staking with something like bamboo is worth while for late spring or summer planting, otherwise air movement could 'rock' the plants (nursery grown plants usually have large leaves) and break the fine roots as they move from their root ball into the surrounding soil.

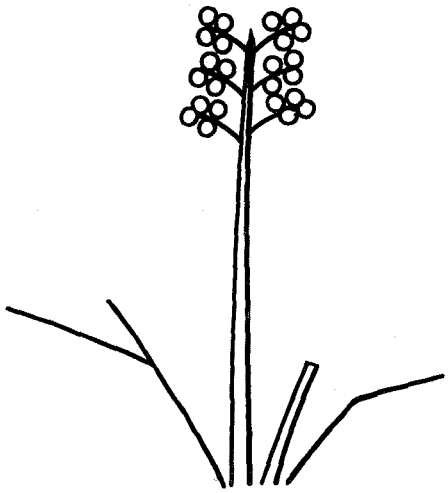
Pruning at the end of the first growing season in the field is along similar lines to new plantings, the aim being to build a framework for the future (see Figure 2).

FIGURE 2



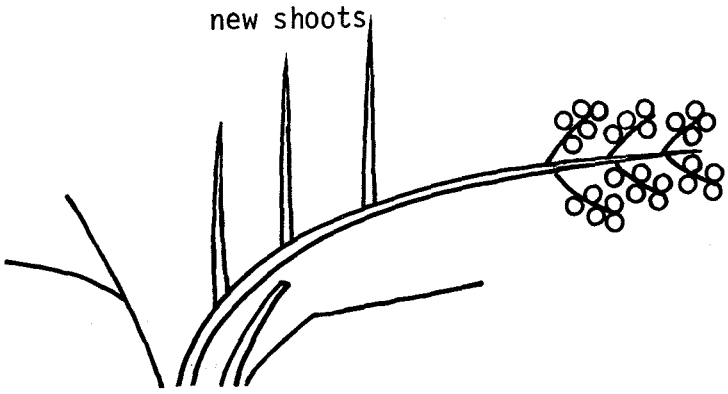
But if your growing conditions have been very good or you just can't wait any longer to try blueberry pancakes for breakfast made from fresh berries - what a way to start a day - then leave the bush as shown in Figure 3 and hope to pick 100 to 200 g from the one shoot.

FIGURE 3



New shoots will arise (see Figure 4), but usually not until the fruit has been removed. If, on the other hand, you had pruned all the fruiting buds off before the beginning of the growing season, then they would start early in the spring to produce wood for next season. Follow up with a fungicide such as Difolatan to prevent entry of fungus disease into cuts.

FIGURE 4



With established fruiting bushes, assuming you wish to have as large a berry as possible, a different approach is made according to variety.

As a general guideline, prune back the strong upward-growing types such as Jersey and Stanley, to about 15 cm (6 inches) from the ground to encourage shoots to arise from the base.

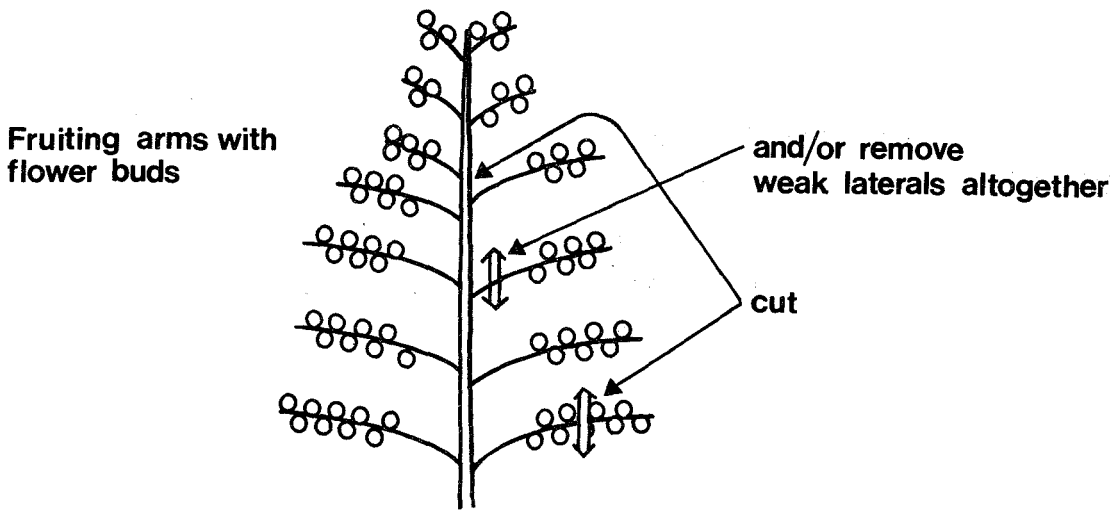
The bushy types such as Burlington and Berkeley need a lot of finer pruning in the middle as they make lots of twiggy growth, though they will also send up strong shoots from low down.

The growth of spreading varieties like Dixi and Atlantic need constant vigilance or they will soon force you into early purchase of a mini tractor. They grow mainly sidewards and those shoots which manage to go up straight for a while, seem to fall outwards after one year. Prune hard, especially the lower branches to upward growing buds.

Finally, the slender upward-growing ("weeping willow") varieties like Bluecrop need more pruning to reduce the fruiting area until the lower frame of the bush is strong enough to support its heavy cropping habit - or it too will spill over into the outer row alley ways.

One way to achieve this is by shortening lateral fruiting arms or, depending on how many fruit buds are at the leading tip, the leader itself (see Figure 5).

FIGURE 5



This is also a method of improving fruit size in all cultivars.

PRUNING OLDER PLANTS

Mechanical Pruning

There have been trials using a raised cutting boom in an attempt to save on labour costs. Yield and fruit quality suffers however, because the machine cannot selectively remove old or unwanted wood.

Zero Pruning

Cutting the whole bush back to near ground level may be carried out to renew an old plantation, but of course one complete year's production is lost altogether with only a light crop the following year. However, it is a good way to re-introduce vigour and quality if other pruning methods have failed.

Summer Pruning

Has several practical applications under New Zealand conditions (particularly favourable climatic influence) which permits regrowth of new fruiting wood during the same growing season. It is essential though, that timing is spot on, and that the plants are under no stress at the time.

When to prune? The ideal time is before your last pick of fruit. I know it is very hard to cut off fruit but the last berries (unless you are doing a yield trial) have little commercial value as it is uneconomic to pick them, and the plant is still in active growth. There is no advantage in pruning in February for example, because the wood has hardened and the plant has started to prepare itself for dormancy. In fact, it could be harmful at this time because by reducing the leaf area, the ability to manufacture and store food in the tissues,including roots, has been interfered with. This reduces the plants vigour at the start of its next season.

So if you decide to prune in summer, once again whilst the bush is in active growth, give a side dressing of suitable fertilizer such as 12.10.10. at the first rain following pruning or through the irrigation system, to help it along.

Tipping

May be practised if strong rods grow too tall, by pinching out the terminal growing shoot. Laterals usually develop in the same season and/or more fruit buds are formed within easy picking reach. Also the rod is less likely to fall out into the outer row space as the fruit develops.

Light pruning just around the base may be useful in summer prior to the application of herbicides if you have an infestation of summer grass for instance, and would like to use "Roundup". I must admit this is also from practical experience!

'Market Pruning'

Peak prices are obtained on overseas markets at certain times and to a lesser extent on the local scene. The timing of pruning with this factor in mind is another consideration to be added to the list in deciding when and how much to prune.

Examples: Summer pruning, *at the right time*, will extend growing vigour further into the autumn. The wood will therefore form fruit buds later and the cropping season will also be later than with those which have been pruned in winter.

Heavy winter pruning will bring the crop forward.

In both cases the movement away from normal time of ripening will be 7 to 14 days forward or backwards, and yield also will be affected.

If you wish to anticipate the use of "market pruning" in the future, it may pay to consider closer planting systems NOW. More plants

per hectare give you this management tool without sacrificing yield.

Qualifying terms: I consider "normal" pruning, that done on an annual basis, to be about 25% to 30% of the total vegetative matter, whether it be main branches or fine pruning. "Hard" pruning is in the order of 50% and "light" pruning about 15%.

Lastly, fruit should be trained in such a way as to make picking easy, without pickers having to crawl on their knees (low fruit is usually soiled or damaged by slugs anyway), use ladders, or contend with very dense bushes.

IRRIGATION OF BLUEBERRIES

L.H. Weston,
Farm Advisory Officer (Eng.),
M.A.F., Dunedin.

WATER REQUIREMENT

Up to 25 mm per week depending upon climatic conditions and crop stage.

For planning irrigation the theoretical volume of water per hectare is $250m^3$.

IRRIGATION SYSTEM POSSIBILITIES

Surface
Flooding a basin or flat with a large flow of water for a short time.

Block flooding several rows at a time. Level ground with a gentle slope of about 1:200 is required.

Furrow irrigating on sloping ground.

The quantity of water required can be up to eight times the theoretical amount due to wastage and uneven watering.

Trickle Irrigation
Watering ideal at twice weekly applications.

Water is placed in the root zone.

Efficient water use - small losses from evaporation
- bare ground not watered.

Small flow of water suitable but ..... water must be pure and FILTERED.

Trickle systems available:

A. Whisker microtube - low cost
Water pressure 3 to 12 metres head
Whisker length adjusted for height and pressure
Flow rates:
.5 to 3 litres/hour - .54 mm whisker
2 to 8 litres/hour - .89 mm whisker
6 to 30 litres/hour - 1.4 mm whisker
(see Aglink HPP 160; and NZAEI manuals 7 and 8).

B. "Bi wall"
Pre-punched plastic tube with holes .3 m, .45 m and .6 m apart.
Pressure 69KPa (52 to 86 range).
Height compensation 5 metres difference.
Best buried 50 to 150 mm.
Requires - Pure filtered water
- Pressure control
- Chlorination
- Air bleed valve.

C. Emitters
i. Plain, insert into laterals down rows
ii. Pressure compensated and self-cleaning
e.g. "Netafim" (40 cents). Supply 4 litres per hour at 5 metres head
iii. Automatic self-closing
e.g. Autawata (90 cents). Flow freely until they close off.

Sprinklers

A. Micro-sprinklers - placed at ground level
e.g. "Mamtiron". Self pressure - regulating, in the range 10 metres to 80 m head. (10 m = 14.3 p.s.i.).

Flow Rates			Diameter
40 litres / hour	8.8 g/m -	green	3.5 m
70 " "	15.4 "	orange	5 m
90 " "	19.8 "	yellow	5.5 m
120 " "	26 "	blue	7 m
160 " "	35 "	(coming soon)	-

B. Overhead Sprinklers

On upstands from permanent underground pipes.
Also used for frost fighting (see Aglink).
Best suited to large regular areas.
Ample water supply necessary.
Likely cost $4,000 per hectare.
Typical spacing with 5 mm nozzles - 16 x 20 m and 22 m x 22 m.
Pressures 2 atmospheres (30 psi) for irrigation
to 5 " (73 psi) for frost.
At the Nozzles of the sprinklers.

C. Travelling Gun Irrigator

Costs $5,000 to $20,000
Suitable for regular shaped areas
Example 12 ha. machine - 200 m run width 55 metres
Pressures up to 50 m head required.

D. Travelling Boom Irrigator

Low pressure so less lower usage only 7 m head 10 p.s.i. at nozzles
Efficient run length 400 metres width 70 metres
2.8 ha gets 50 mm (rainfall) in 12 hours
Large area or other uses needed to justify it
Costs some $20,000 plus pump etc.

CLIMATIC AND SOIL FACTORS IN BLUEBERRY PRODUCTION

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There is a rising interest in blueberry production in New Zealand and I have become involved in recommending soils for research and commercial production in the Canterbury-Westland area. From reading the book "Blueberry Culture", and from very limited experience I have formed an initial impression of climate and soil suitability and have devised climate and soil classifications which may be used as working classifications to be modified with further work. The aim of both tables is to rank soils in order of their limitations to economic production of blueberries.

TABLE I

Climatic factors in blueberry production

Limitations	Frost free period	Cold requirement at $< 7^{\circ}C$	Maximum period with $<$ 25mm rainfall
Negligible	$>$ 5 months	$>$ 850 hours	$<$ 5 days
Moderate	4-5 months	650-850 hours	5-10 days
Severe	$<$ 4 months	$<$ 650 hours	$>$ 10 days

This table is devised mainly for highbush blueberries. Rabbiteye, for example, has a much shorter cold period requirement and some recently developed highbush varieties only require 200 hours.

Areas with moderate limitations are expected to be able to grow blueberries but will have lower yields on average (o.t.b.e.) than areas with negligible limitations. Areas with severe limitations (except for the rainfall requirement) are rather doubful economically unless special varieties can be found suitable to these conditions. In the zone of moderate rainfall limitation irrigation should improve average yields. In the area of severe rainfall limitations, irrigation is essential for good production.

1. Frost free period

In their dormant period (i.e. over winter) blueberries can withstand -30°C therefore there should be little problem with winter frost in New Zealand.

Blueberry flowers are very sensitive to frost and cannot tolerate temperatures below -2-3°C and even light damage can occur at 0°C. Flowerbuds not fully developed may tolerate 3-4°C but even tightly closed buds may be damaged by 4-5°C or less. Young developing fruit may also be damaged by frost $<$ 3°C. Frosts in the early growing season are therefore damaging but may not necessarily prevent blueberry culture. Dr Paul Eck has commented that in blueberry growing areas in U.S.A. "frosts are frequent and spotty and can be expected to cause economic loss on a local basis almost every year".

2. Cold requirement

Blueberries require a certain minimum chilling period during dormancy. If the chilling period is not fulfilled poor and delayed opening of buds results, with a consequent poor crop of fruit.

The cold requirement of the highbush blueberry is similar to that of the peach. An accumulated minimum of 650-850 hours below 7°C. Rabbiteye varieties require 300-400 hours. New varieties of highbush developed in Florida require only 200 hours.

Most of the South Island will meet the 850 hours chilling requirement and may provide some advantage in comparison to the equitable parts of the North Island.

3. Rainfall (soil moisture)

A uniform and adequate supply of soil moisture is of the utmost importance in successful blueberry production. As a general guide 25mm of rainfall plus irrigation is required during the growing season. The period of fruit development is particularly sensitive of moisture stress. Since the fruit matures over an extended period of time, the need for maintaining optimum soil moisture from the expanding of the first berries until the last harvest may extend as long as six weeks.

TABLE II

Soil factors in blueberry production

Limitations	Limiting factor in upper 30cm of profile			
	Acidity pH	Organic Matter %	Consistence/and Structure	Drainage/and Infiltration
Nil	4.3-5.0	>12	V.friable/fine structure	Free drainage
Slight	3.5-4.3	3-12	Friable/fine to medium structure	Imperfect drainage
Moderate	<3.5 >6.5	<3	Friable/medium block structure	Poor drainage/ good infil-tration
Severe			Firm/block	Poor drainage/ slow infil-tration

1. Acidity

It is generally held that blueberries require acid soil for optimum growth. Some recommend pH of 4.3-4.6 others recommend a pH of 4.5-5.5. Some attribute the need for low pH to be associated with the requirement for low calcium levels while others suggest that high pH upsets the nutrient balance. I am not personally convinced of the need for low pH in New Zealand soils. A pot experiment on Templeton soils with a pH of 6.5 had pots amended with ground sulphur to achieve a range of pH values down to 3.8. There were no differences evident in growth after sixth growth under glasshouse conditions. Also at the Neal's property in Christchurch, blueberries are thriving on a poorly drained soil with a topsoil pH of 6.5. At C.R.D. we have begun a field trial to further test the effect of pH on growth and productivity. Until further research results are known it is probably wise to accept overseas results and drop the pH wherever pH is much greater than 5.5. However I consider that the use of an acid mulch plus ammonium sulphate fertiliser ought to satisfy the pH requirement without amending the mineral soil.

2. Organic Matter

It is unclear why organic matter content is so important for blueberries other than its ability to hold water and nutrients and to form friable soil structure.

It may therefore be found that a well watered and well fed plant on sand with low organic matter content would produce just as well as a plant on soils with high organic matter.

Limitations of low organic matter are overcome by using a surface organic mulch or by planting into holes filled with peat or organic material.

3. Soil Structure

The blueberry is a shallow-rooted plant with a root system characterised by a lack of root hairs. The fine fibrous roots of the blueberry require an open, porous soil for ease of growth. The vast majority of roots are concentrated near the soil surface where growth conditions are most favourable. Where peat and mineral soil are mixed almost all roots will be found concentrated in the peaty patches. A number of studies have indicated that the growth and yield of blueberries is proportional to the amount of organic matter in the soil and this is probably due more to the favourable physical conditions than to the chemical and biological. Peat soil therefore provides an optimum physical environment for blueberry roots. Mineral soils need to have friable, fine structured topsoils and for good growth I suggest they need a surface organic mulch. The mulch should have the added benefit of reducing weed growth and reducing loss of soil moisture.

4. Drainage

Soils that waterlog for more than a few days within 30cm of the surface during the growing season will almost certainly cause economic loss of production. In sections of paddocks covered by water for several days after storms plants are consistently smaller and less productive than plants in well drained sites of the same paddock.

In poorly drained areas, including drained peaty areas, mounds or ridges may be built up to provide better drainage around the plant.

MYCORRHIZAL INOCULATION FOR BLUEBERRIES

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Mycorrhiza literally means fungus plus root and describes the beneficial association of some soil fungi with plant roots. There are two types of mycorrhiza of interest to us in agriculture in New Zealand: vesicular arbuscular (VA) and ericoid mycorrhiza. The VA type are simple phycomycete fungi which infect pasture species (clover, ryegrass etc) crops (soybeans, maize, wheat, barley) and vegetables (potatoes, beans, tomatoes, onions etc). VA fungi increase P uptake and shoot growth in any or all of these host plants and are very non-specific.

This paper however is about ericoid mycorrhizal fungi, which only infect the roots of heath (ericoid) plants including blueberry, *Vaccinium corymbosum*.

Ericoid mycorrhizal fungi are already present in N.Z. soils but only where ericoid hosts have been growing for many years such as in some native grasslands and peat bogs. Most pasture soils and some peat soils are however, completely devoid of ericoid mycorrhizal fungi or have very low fungal populations.

So, what use are mycorrhizal fungi to blueberries? Original research by Dr D.J. Read at University of Sheffield, U.K., showed conclusively that ericoid mycorrhizas greatly stimulate N and P uptake from soil and enhance the growth of cranberry *(Vaccinium macrocarpon)*. More recently he has shown that mycorrhizal fungi can breakdown organic N in soil which is completely unavailable to non-mycorrhizal plants. In several experiments (mainly on peat soils) he found growth responses up to 100% to mycorrhizal inoculation. We thought that mycorrhizal fungi may also be important in the nutrition, growth and fruit yield of blueberries in New Zealand. From an initial survey of blueberry plants in nurseries and growers plantations we found that 1 year old nursery plants were never mycorrhizal and that only 44% of 2 year old stock, ready for outplanting, were infected with ericoid mycorrhiza. And

in most of these mycorrhizal plants very few roots were actually infected. (Mycorrhizal infection probably came from the peat used in the potting mix, especially if native ericoid shrubs such as *Epacris* had been growing on the peat in the field.) This means therefore that 56% of 2 year old plants were non-mycorrhizal when planted out. This would not matter if the soils which growers are planting blueberries in contain suitable fungi for blueberries, but many growers are planting in mineral or peat soils deficient in ericoid fungi (most of these soils will have plenty of VA fungi but these cannot infect blueberries). 30-40 percent of 3 and 5 year old plants in the field were non-mycorrhizal and in 70% of properties on which field plants were sampled, large healthy bushes were mycorrhizal while small bushes were non or poorly mycorrhizal. This suggested that blueberries need to be mycorrhizal to grow and fruit well.

Therefore, in August 1977 we set up a field trial on humified peat at Lake Cameron (near Hamilton) in which 6 blueberry cultivars were planted out as two year old plants with or without a 250ml layer of mycorrhiza-infested peat under the roots. The inoculum peat came from underneath a 15 year old stand of blueberries growing on a peat bog which had become highly infected with the native ericoid mycorrhizal fungus in the peat soil. At the first fruit yield in the 1979-80 summer, we found large responses to mycorrhizal inoculation, with increases in fruit yield of 92% and 69% in Stanley and Blueray, 18% and 51% in Ivanhoe and Herbert and 39% and 11% in Jersey and Dixi. We will begin picking the second season's crop in a few weeks and expect an equally large response this season. Financially it is obviously worthwhile to inoculate. With the cultivar Jersey, for example, inoculation gave 238g per plant extra fruit, equivalent to 600kg per hectare. At $5/kilogramme this is worth an additional $3,000/ha, especially important in the early years of blueberry establishment.

These results were all achieved by using large quantities of infected peat soil from old mycorrhizal bushes. It is not feasible or sensible to inoculate the millions of cuttings and bushes in nursery beds and field blocks in New Zealand in this way, and we have now secured a pure culture of a fungus *Pezizella ericae* isolated by Dr Read from cranberry and other ericoid hosts in England (we are also pure culturing the native ericoid mycorrhizal fungi from New Zealand soils). The advantages of the fungi *P. ericae* as an inoculum are that it can be cultured and maintained free of pathogenic fungi (such as *Phytophthora* under the laboratory conditions) and that it is a very concentrated inoculum source. As an example of

this, we inoculated young recently-germinated 'Herbert' seedlings with 5 mg fresh weight of fungal mycelium at two rates of fertiliser in the potting mix. In unfertilised peat-pumice mix, 43% of the blueberry root system had mycorrhizal infection while at the normal rate of fertiliser application, infection levels were down to 21%. But this does show that the fungal isolate from cranberry is infective to blueberries even at a low inoculum level. In addition, *P. ericae* had an immediate effect on plant growth especially in the fertilised potting mix. We are repeating this experiment in peat-pumice mix and in a range of the soils under glasshouse conditions to predict the effect of *P. ericae* on blueberry grown under a variety of fertiliser conditions.

I will now talk about our current experiments in the laboratory glasshouse and the field. In the laboratory we are selecting the best media and conditions for the rapid production and growth of *P. ericae* and have interested two firms in preparing inoculum for growers on a commercial scale. *Pezizella ericae* grows well on simple laboratory media (e.g. malt agar) and in liquid culture with glucose or cellulose as an energy source and reaches maximum growth in 10-20 days. One firm has already made good progress and is capable of producing fungal inoculum in 100 litre fermenters. In addition we are looking at the effects in pure culture on some routinely used plant protection chemicals such as terrazole (fungicide used against Phytophthora) and velpar (general herbicide) on *P. ericae*. Early results suggest that *P. ericae* is tolerant to normal rates of these chemicals but is inhibited or killed by excessive rates.

In our glasshouse trials we are working out recommendations for the timing and application rates of *P. ericae* on cuttings. At the moment we think it will be best to inoculate when the cuttings are bedded as N and P fertilisers applied after rooting seem to delay the onset of mycorrhizal infection. I expect that 1.0g (fresh weight) of mycorrhizal fungus will be enough to inoculate 20-50 cuttings but this can only be confirmed in our present trial. Application is simple; the macerated fungus is mixed with water and poured over the cutting bed.

Our field trials are the final test of mycorrhizal inoculation. After the large mycorrhizal response at Lake Cameron, we set up co-operative field trials on 6 properties in Waikato and Bay of Plenty in which we treated newly-planted blueberry plants with or without mycorrhiza. In a large 700 plant trial on mineral soil near Hamilton, we are testing the effect of mycorrhizal

inoculation on fruit production at 4 rates of N fertiliser. These trials should show us whether or not mycorrhizal responses in blueberry can be expected on mineral as well as organic soil types. There are no results yet from these recent trials, but it should be possible for growers with well established but non-mycorrhizal bushes to inoculate these by using higher rates of inoculum poured over the plants' roots.

We have sent culture of *R. ericae* to the 2 commercial firms for inoculum production and will be releasing inoculum and recommending its use to growers as soon as application methods and rates have been fully worked out. This is the immediate aim of our present work. I hope this paper has highlighted the potential for mycorrhizal inoculation on blueberries, brought you up to date with our present experiments and shown your our future research ideas.

BLUEBERRY DISEASES

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During the last two years we have carried out a survey of diseases of blueberries. The survey was concentrated in the Waikato and Bay of Plenty, since most of the established plantings are in these districts.

The most significant finding was that all of the disease-causing organisms recorded were previously known in New Zealand on other plants. None of the diseases reported overseas, which are specific to blueberry or other *Vaccinium* species were found.

DISEASES PRESENT IN NEW ZEALAND

Phytophthora cinnamomi root rot

This is the most important and widespread blueberry disease in New Zealand. It is commonly found on other hosts e.g. conifers, *Rhododendron* species, *Erica* species, avocados. Overseas it has been found that isolates of this fungus from other hosts will infect blueberry plants.

Symptoms
- stunting and cessation of growth
- defoliation
- small yellow or red leaves
- roots are brown and often restricted to original ball of potting mix.

Source of infection Most blueberry plants are on land which was previously under pasture, and as such, there should be little if any *Phytophthora cinnamomi* present in the soil. It is probable that diseased, container-grown plants from the nursery, provide the main

source of infection.

Control - in the nursery Hygiene - sterilise potting media
- do not place containers where they are subject to run-off water or rain splash
- filter bore water (10 m).

Control - in the field *P. cinnamomi* is favoured by water-logged conditions. Thus:
- establish blueberries on well drained site
- level field, hollows provide areas of poor drainage
- field tile drains
- mound plants.

Notes All popular highbush varieties are susceptible to *P. cinnamomi* when grown in water-logged conditions. Some rabbiteye varieties (e.g. Garden blue, Tifblue) show some tolerance.

Botrytis cinerea

Common on a wide range of crops in New Zealand.

Symptoms
- stem lesions. Red, target spot centred on leaf scars.
- stem dieback, young, soft, rapidly growing shoots and leaves are susceptible to attack. Mature shoots and leaves are usually resistant unless they suffer mechanical damage (e.g. hail).
- flower blight, fungus establishes on senescing and dying flower parts. May invade and kill flower before fruit is set.
- fruit rot. Young green fruit not usually visibly affected, although fungus may penetrate at flowering and remain quiescent until fruit ripens. Fruit may shrivel and die as part of general stem dieback.

- post harvest fruit rot. Ripening fruit may be attacked, especially when weather warm and wet. Fruit damaged at harvesting may become infected.

Control
- crop hygiene, prune out and destroy diseased stems
- avoid damage to plants and fruit
- spray.

Notes If plant growth is forced by fertilisers late in growing season, the resulting new branches may not have time to harden before dormancy, and are very susceptible to *Botrytis* dieback during the winter. Plants infected with *Phytophthora* may be very susceptible.

The following diseases appear to be of little importance in New Zealand at the present time.

Botryosphaeria dothidea stem blight

The fungus is widespread throughout New Zealand as a weak pathogen on various plants e.g. apples, roses, *Citrus*.

Causes branch dieback. Enters through wounds. The odd branch in an otherwise healthy bush may die. Death often extends down current years growth, but probably does not enter the older wood. Often occurs on weakened bushes e.g. those with root rot, or later fertiliser application leading to soft growth. Dead branches should be pruned and burnt.

Phomopsis

Two species of this fungus have been isolated from dead twigs and leaf spots. One species is similar to an unnamed species commonly found in New Zealand on woody plants (e.g. apple, kiwifruit). It is mildly pathogenic to other plants, but had no effect when inoculated onto blueberry. The second species caused branch dieback when inoculated onto blueberry.

Neither species matches *Phomopsis vaccinii* from North America.

Sclerotinia scherotiorum

This fungus was occasionally isolated from blighted twigs and leaves. Common on vegetable crops, kiwifruit, *Citrus* etc.

Alternaria tenuissima leaf spot

Irregular brown leaf spots with a red margin. Also causes a post harvest storage rot in America.

Cylindrocladium floridanum root and crown rot

Wide host range, including apple, conifers, redcurrant. Has been found once in a nursery near Tauranga.

Colletotrichum

Two species, *Colletotrichum acutatum* and *C. gloeosporioides* - blighted twigs, leaf spots, post harvest fruit rot. *C. acutatum* can cause spots on green fruit. *C. gloeosporioides* can attack green fruit, remaining dormant until fruit matures. Both species are common on many crops in New Zealand.

Crown gall

This disease caused by a bacterium *Agrobacterium tumefaciens*, has not been confirmed on blueberries in New Zealand, although it does attack fruit trees (peaches, apples, plums), tomatoes, raspberries. Different strains are probably host specific. In America, crown gall is a nursery problem controlled by hygiene - destroy plants, sterilise pruning equipment. Numerous galls have been seen on nursery plants and on field plants in New Zealand but the cause is unknown.

POST HARVEST FRUIT ROTS

In North America storage rots have been increasing in importance due to changes in methods of handling fruit (particularly mechanical harvesting). Careless picking causing damage at the base (site of 90% of all decays), picking over-ripe fruit (more susceptible to fungal invasion) will also increase incidence of disease. Hydro separation techniques for sorting picked fruit allows widespread dispersal of inoculum from a relatively few diseased fruit. Lack of adequate cool storage space.

The three most important fruit-rotting organisms in America - *Colletotrichum*, *Botrytis* and *Alternaria* occur on blueberries in New Zealand. As production of fruit in New Zealand increases, the potential for post harvest decay will also increase, especially if handling methods are altered with the introduction of mechanisation.

DISEASES NOT OCCURRING IN NEW ZEALAND

Mummy berry

Caused by the fungus, *Monilinia vaccinii-corymbosi*. Leaf and flower blight. Most serious phase occurs when berries are infected. Near maturation, infected berries turn tan to salmon in colour rather than normal blue, shrivel and become hard, and drop to ground.

Fusicoccum canker

Caused by *Fusicoccum putrefaciens*. Fungus enters stem at bud site or injury. Initial lesion appears as small reddish coloration. Centre of lesion turns grey or brown, margin remains red. 'Bull's eye' pattern may form. Small black dots (pycnidia) may appear in centre of lesion. Stem may finally wilt and die.

Botryosphaeria stem canker

Caused by *Botryosphaeria corticis*. Fungus enters stem through lenticels

on current growth. Stem becomes fissured and blister like. Blisters initially red but becoming grey with age. Small black pycnidia may be visible. May girdle and kill branch.

Leaf rust

Caused by *Pucciniastrum vaccinii*. Infected leaves have light green to reddish areas on the upper surface, and on the lower surface opposite those spots the spores are formed in rust-coloured pustules.

Powdery mildew

Caused by *Microsphaeria alni*. Fungus usually attacks under-side of leaves, producing a white growth on under-side, with chlorotic or red blotches on the upper-side.

Stunt

This is caused by a virus. Plants are dwarfed, branch excessively, have small leaves and berries, leaves may be cupped, turning red in late summer and remain this colour until normal leaf fall.

Red ringspot

Caused by a virus. Red spots, rings or blotches on upper leaf surface. Sometimes also on stems and berries.

PESTS OF BLUEBERRIES IN NEW ZEALAND, ESPECIALLY CANTERBURY

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INTRODUCTION

Many of the serious insect pests of blueberries which occur overseas, such as the blossom weevil, blueberry maggot, plum curculio, cranberry fruitworm, cherry fruitworm and the sharp nose leafhopper (a vector of the virus stunt disease) do not occur in New Zealand. Strict quarantine regulations and procedures in force here ensure that these pests are prevented from gaining easy access to this country.

In Canterbury vertebrate and invertebrate pests cause damage to blueberry plants. The foliage, fruits, stems, buds and roots may be attacked.

VERTEBRATE PESTS

These include especially domestic animals, hares, rabbits, possums and birds. Except for birds, damage from those animals listed occurs during general browsing on foliage, shoots and bark. In Canterbury, rabbits may also dislodge plants and damage the shallow rooting system through burrowing activities.

Birds damage the ripening fruits of blueberries which appear to be highly preferred to other food sources when plants are not caged. Holland *et al.* (1980) reported that the bird repellant chemical, methiocarb, applied during the fruit ripening period greatly reduced bird damage to fruits.

Damage to plants and fruits by vertebrate pests is largely prevented

if plantings (or plants) are grown under suitably netted systems.

INVERTEBRATE PESTS

The fauna of blueberries is being monitored by Entomology Division staff at the Lincoln Research Centre and by D.S.I.R. and Ministry of Agriculture and Fisheries personnel at other centres. The pest complex comprises various insect and mite species.

Leafroller caterpillars

This term refers mainly to three species, the light brown apple month, *(Epiphyas postvittana)* the brown-headed leafroller *(Ctenopseustis obliquana)* and the green-headed leafroller *(Planotortrix excessana)*. This complex is of major economic significance to horticulture in New Zealand. They each complete several generations annually. The relative importance of a species may vary according to locality or the time of year. However, in Canterbury *E. postvittana* appears to be the most important species on blueberry plants and *P. excessana* second in importance. *C. obliquana* is common during the early season in the Waikato and *E. postvittana* during late summer.

After mating, female moths deposit eggs in batches on the surfaces of leaves. The larvae which hatch from these eggs spin protective niches under leaves, between leaves, in buds, or within fruit clusters. During summer they feed for about six weeks before reaching maturity and pupating. Moths emerge and the cycle is repeated. There is no true resting or diapause stage during winter, but the caterpillars survive in buds and terminal shoots feeding on the available plant tissues. Serious fruit damage can accrue from the larvae feeding within fruit clusters.

Noctuid moths

In Canterbury a large cutworm caterpillar which is probably *Graphania* sp. belonging to the family Noctuidae, is responsible for fruit and shoot damage prior to and during the harvest period in the summer.

Although the eggs are often laid on the leaves the caterpillars normally feed for a period within the groundcover. Late stage larvae may reinvade and feed on the foliage of blueberry plants especially during the hours of darkness. Shoot tips and fruit bunches are often severed.

Silver Y month (Chrysodeixis eriosoma)

This pest is of minor importance in Canterbury but has been reported from blueberries in both islands. The larvae which are green and move with a looping motion will feed continuously on the foliage of blueberries. At least two generations per annum are completed in Canterbury but because the species appears to prefer other hosts, the incidence of damage caused by this pest has been low.

Bag moth

The bag moth *(Liothula omnivorus)* has been observed feeding on plants in both islands. This species is normally a foliar feeder during the encased larval stage but also damages fruit at various stages of development. In Canterbury this insect is of minor importance on blueberries at present. It passes through one generation annually.

Grass grub

Adults of the common grass grub *(Costelytra zealandica)* have been observed feeding on the young terminal growth of blueberries growing in Canterbury. Severe defoliation has occurred in isolated localities. The larval or "grub" stage has also been found associated with the roots of plants where root feeding almost certainly occurs.

In lowland regions this pasture pest passes through one generation annually, but at higher altitudes and exposed to cooler climates a generation takes two years for completion.

Adults of a related sepcies *(Pyronota festiva)* have recently been reported to have caused serious defoliation of blueberry plants in

parts of the North Island where manuka has been growing in close proximity to plantings. The life cycle of this species is similar to that of grass grub.

Passion vine hopper

This plant hopper *(Scolypopa australis)* is known to occur in blueberry plants in the North Island and the north of the South Island. There has been no record of its occurrence on blueberries in Canterbury or further south. Females of this insect insert 'rafts' of eggs under the bark of twigs of a suitable size. The nymphs and winged adults suck sap from the young stems. Large numbers of these insects will hinder growth and reduce vigour by depleting the plant nutrients. One generation is completed annually.

Scale insects

Greedy scale *(Hemiberlesia rapax)* and cottony cushion scale *(Icerya purchasi)* have been observed on plants growing in Canterbury which had received a minimal spray programme. The former has also been recorded from blueberries in the North Island. They suck the sap thereby causing a slow decline in plant vigour.

Mealy bugs

The long-tailed mealy bug, *(Pseudococcus longispinus)* has been found on unsprayed plants in both the North and South Islands. It also feeds on the sap. Mealy bugs secrete honeydew, which results in the growth of sooty moulds in tissues contaminated by the secretion. Several generations are completed annually.

Lemon tree borer

During 1979/80 the larvae of the lemon tree borer *(Oemona hirta)* were found tunnelling in the older stems of blueberry on one property in Canterbury. Infested plants were unthrifty and dieback of shoots was evident. The attack by this pest appears to have been isolated, as

there have been no additional reports. This species passes through one generation annually.

Katydid

The large green katydid *(Caedicia simplex)* is known to occur on plants growing in the North Island but has not been reported from Canterbury. This insect is a foliar feeder.

Spittle bug

This insect *(Philaenus spumaris)* was observed on plants growing in Canterbury during late spring/early summer of 1979 and 1980. It passes through one generation annually. The nymphs which hatch from egg batches laid at the base of plants, suck the sap from the young stems. They are usually found in leaf axils. As a nymph develops it produces a bubbly protective secretion - the spittle - which envelops them completely. Adults are winged and are free of the secretion.

Aphids

An as yet unidentified species of aphid was common on the young shoots of plants in Canterbury during the spring and early summer of 1980/81. Winged adults left the plants in the late spring and reinvaded during the summer. This species could be an important pest in the future.

Mites

The two-spotted mite *(Tetranychus urticae)* has become a significant pest of blueberry plants that have received an intensive spray schedule aimed at controlling other pests and diseases. This species passes through five or six generations during the summer. In the autumn the females that will overwinter undergo a distinctive colour change. Their normal two-spotted appearance is lost and they take on a bright orange hue. They aggregate around bud scales and at the base of plants in old leaves, where they rest through the winter period. In the spring they reinvade the new foliage, feed and lay eggs, thus

continuing the cycle.

Incidental and beneficial mites

Harmless and tydeiid mites and beneficial predatory species are known from blueberry plants in addition to the harmful two spotted mite.

GENERAL

The leafrollers are considered the most important members of this list. Accounts of their life-cycles are given in the D.S.I.R. Information Series (Green, 1979; Thomas, 1974 and 1979). Their importance in horticulture is recognized by potential importers, who will reject fruit that is infested, or that has been damaged by these species.

The Ministry of Agriculture and Fisheries have formulated spray programmes for the control of these pests and the diseases of blueberries. The schedule should be consulted by growers especially in relation to fruit which is destined for export.

As the blueberry industry expands and increases in the area of plantings takes place, it is likely that the status of insect and mite pests will change. It is imperative that both major and minor pests of blueberries, which occur in overseas countries are not allowed into New Zealand by illicit importations of plant material and lax quarantine procedures. Even a minor pest overseas could have serious consequences for the industry here if accidentally introduced into this country.

ACKNOWLEDGEMENT

The author wishes to thank Dr. C.H. Wearing, Entomology Division, Auckland for the information contained in Appendix 1, and the reported abundance of *C. obliquana* in the Waikato. Also to M.A.F. Ruakura for collaboration in the Waikato survey.

REFERENCES

Green, C.J. 1979. Brownheaded leafroller, *Ctenopseustis obliquana* (Walker), life-cycle. D.S.I.R. Information Series No. 105/27.

Holland, P.T., McFarlane, D.W. and Bates, P.M. 1980. Methiocarb as a bird repellant in blueberries. Proc. 33rd N.Z. Weed and Pest Control Conf.: 125-128.

Thomas, W.P. 1974. Light brown apple moth, *Epiphyas postvittana* (Walker), life-cycle. D.S.I.R. Information Series No. 105/3.

Thomas, W.P. 1979. Greenheaded leafroller, *Planotortrix excessana* (Walker), life-cycle. D.S.I.R. Information Series No. 105/26.

APPENDIX I

Since preparing this paper, results of a spring, 1980 survey by Entomology Division of insects on blueberries growing in the Waikato region has been supplied through courtesy of Dr. C.H. Wearing. The following insects were recorded in addition to those given in the main text.

1. Chinese (Hard) wax scale *(Ceroplastes sinensis)*.
2. Aphids* *(Myzus ornatus)*
   (Aulacorthum solani)
   (Aphis gossypii)
   (Aulacorthum circumflexum)
3. Mites. Two spotted mite was not reported as a problem pest. However, tydeiid mites were present in sufficient numbers to create a quarantine problem for export growers. It was necessary to remove them from fruit destined for overseas markets.
   Two beneficial predatory mites *Anystis baccarum* and *Amblyseius cucumeris* occurred on plants. A *Tarsonemus* species and a member of the family Cunaxidae were also present.
4. Thrips. *Thrips obscuratus* occurred on flowers, but there is no known damage from this insect.
5. Spiders. These included an *Araneus* sp., *Araneus pustulosus*, *Intruda signatua*, *Ixeuticus martius*, *Dolomedes minor* and an *Achaearanea* sp.

* Identification of aphid species was provided by Mr Rudi Sunde, Ministry of Agriculture and Fisheries, Auckland.

SUGGESTED SPRAY PROGRAMME : BLUEBERRIES

Advisory Services Division,
M.A.F., Hamilton.

New Zealand experience in pest and disease control in blueberries is extremely limited. However the following control measures are suggested by the Ministry for pests and diseases which are or could be a problem in this crop.

Note

The Ministry of Agriculture and Fisheries is suggesting the use of the following chemicals after full consideration of the information available to it on pest and disease control and pesticide residues. However, the Ministry can give no assurance that produce treated with sprays as suggested, will be acceptable to all countries to which it may be exported.

Leaf Roller Caterpillar

Azinphos methyl 38-50 g.a.i. */100 litres pre-bloom and/or up to 21 days before harvest PROVIDED blossoms are not present. Where control measures are required when blossom present, apply dichlorvos 62 g.a.i./ 100 litres. Spray intervals may need to be as close as 10-14 days. Do not apply closer than 2 days before harvest. It can be applied between picks provided this waiting period of 2 days is observed.

Caution: When blossoms are present spraying with DICHLORVOS must be confined to late evening. In addition bee hives must be removed before spraying and kept out of the area for AT LEAST ONE FULL DAY following spraying.

Carbaryl 150 g.a.i./100 litres may be applied up to 4 days before harvest

if no blossoms are present. It can similarly be applied between picks if the 4 day waiting period is observed.

Botrytis Ferbam 150 g.a.i./100 litres may be used in the immediate pre-bloom and early bloom stages only. Thereafter captan 120 g.a.i./100 litres at intervals as close as 10 days, to 4 days pre-harvest if the disease level and climatic conditions warrant. Sprays may be applied between picks if the 4 day waiting period is observed.

Thrips

These should be controlled by the spray chemicals suggested for leaf-roller caterpillar control.

Note: Noticeably visible spray residues must be avoided.

Changes from 1978 Suggested Programme

* Addition to note of caution on spraying with dichlorvos when blossoms present.

* Ferbam replaces thiram for botrytis control in the early part of the growing season. This is because there is a tolerance for ferbam in U.S.A. but not for thiram.

*g.a.i. = grams active ingredients.

THE COOPERATIVE CONCEPT OF BLUEBERRY GROWING

E.M. Gray,
Managing Director,
Kiwi Blue Co-operative Ltd.

I would like to begin by giving you a generalised view of the Cooperative Concept as I see it, and follow this with a more detailed view of our KIWI BLUE COOPERATIVE later.

The word cooperative can be divided into two parts, 'co' meaning together and 'operative' meaning to work thus the meaning of 'cooperative' in very simplistic terms is 'working together'.

The prime difference between a cooperative company and a corporation is that in a corporation the shareholding depends on the amount of money the individual has to invest, the more money the greater the shareholding, which means the greater the power. If a shareholder in a corporation has enough money, and consequently, enough power he can through the acquisition of sufficient shares gain effective control of the company regardless of his ability as an organiser or administrator.

On the other hand a cooperative has shareholding based on the individual members throughput or as in the case of our company, shareholding on an equal basis. This means the only way an individual can gain an operational part of the company is by either his ability or his performance. If he is a strong cooperative man, takes an interest in his company and takes an active part in its organisation he will be rewarded by being elected on to the Board of Directors by the members. This may lead eventually to being elected to Chairman of the Board. Thus an efficient member will gain power which will be turned to the benefit of the cooperative company. With both the corporation and the cooperative company profitability depends on performance. If the management of a corporation is not efficient the shareholding will decline and the company may eventually go bankrupt. Similarly, with a cooperative company, if the management does not perform then it will lose its attractiveness to members who will drift away with the consequence of the cooperative itself failing. In both cases performance is the key to success.

One of the essential requirements of a cooperative company is that of strong leadership. The management of the company must be free to act

according to predetermined policies. One of the biggest dangers of the co-operative movement is the interference in the day to day running of the company by individual members. Because members all own equal parts of the company there is a tendency of the individual to consider his rights above that of the others. Members must take an active part in formulating the overall policies of the company and its long term planning strategy but once these decisions have been made the day to day running of the company as decided by the Board of Directors must be put into practice by the General Manager without any interference in the planned operations.

What are the advantages of a cooperative company? I see these as being three fold:

1. CULTURAL

   The supply and dissemination of cultural and technical information. Although this type of information is available from horticultural advisors of the Ministry of Agriculture and Fisheries it is sometimes difficult to obtain their services exactly when you require them. The management of a cooperative should have appointed a technical advisor who can supply this advice as and when required by members. The supply of information to members can be made available via newsletters, by general meetings or by local meetings. Already I am receiving almost daily requests from members for help with some cultural problem. Another very important aspect of the supply of needed cultural information is the ability of a cooperative such as ours with a membership spread over a wide area, a wide range of soil types and a wide range of climatic conditions, to correlate information supplied by members on the performance of different cultivars in different regions. This 'trial' work will be evaluated over a number of years and will ultimately be available to members on request. Through our central organisation we have access to research station findings, M.A.F. advisory services and various papers written on blueberries. We also have access to overseas information and indeed our organisation is becoming an associate member of several American Cooperatives thus enabling us to be updated on latest overseas developments.

2. MARKETING

   The second important aspect of the cooperative is that of marketing. By the members coming together as a group and selling under a joint

marketing policy,we have the advantage of being able to guarantee a continuous supply of our product. The marketing policy of the company is decided by the Board of Directors. It may be on our own account, through an agent or an export house and it is the duty of the Board to decide which system of selling is going to be of best long term benefit to its members. Whatever system of marketing is elected,it is essential that it be planned on a rational and orderly manner. One of the advantages of marketing through a cooperative is that we have access to our members projected plantings in the future. This means we can anticipate crop yields well in advance and prepare our markets accordingly. The orderly marketing of our crop is going to be the prime factor of future production. As production levels increase processing is going to become of increasing importance. As most processors deal only in bulk supplies the advantages of bulking together member's crops will rapidly become apparent. With bulk we can negotiate the best possible price, we can avoid the situation of buyers playing grower against grower as has happened in the past with other commodities.

Another feature of the marketing ability of a cooperative is in the pooling of all funds so that all members share equally in the profitability of near markets and the less profitable far away markets. All members share in developing new markets even if their fruit is not being sold on that market. It is also very important that a promotional programme for blueberries be started in the near future. My company has already commenced levying members for a special promotional fund. Thus all members will share equally in the cost of establishing an orderly and rational market and the promotion thereof.

3. POLITICAL

The third aspect of the cooperative concept is what I would call political. How many growers here today are aware that the H.E.D.C. is a part of the Ex/Im Corporation and is making decisions on your behalf? How many growers are aware that the third Horticultural Symposium recommended that a Trade Advisory Post be set up in Europe and that this will eventually be funded by you as growers? I believe you should have some direct say in these events. As

new growers your first consideration should be the establishment of your garden on an economically viable basis. To become familiar with and take an active part in this type of involvement is beyond most of you at this time. This is where I see the cooperative concept come into its own. The management should be aware of all developments in horticulture; they should be constantly aware of how suggested programmes may affect you as company members; they should be familiar with proposed changes and through the company organisation inform members of impending events. So often we see events take place as a 'fait accompli' and eventually have disastrous results for grass root growers. Whilst it is true that your immediate interests as growers are the responsibility of the N.Z. Berryfruit Growers Federation it is felt that at times movement through the Federation can at times be slow and ponderous. There are times when action must be immediate to avert a situation. If you have knowledge then action can be taken.

These then are the basic concepts that I see in the operation of a cooperative. I would now like to briefly give you an outline of the organisation that we have set up for New Zealand blueberry growers.

KIWI BLUE COOPERATIVE

This is an organisation known as the KIWI BLUE COOPERATIVE LTD. It has at present a membership of 25 reaching from north of Auckland to South Canterbury. Its major objective is the development and marketing of its members' products to give maximum long term returns to all its members. This organisation was conceived several years ago. It began when Harry van der Hulst and myself first came into production. We were offered a price by an export house that appeared to us to be below what could be a maximum return. We opted to take the export risk ourselves and commenced to export on our own account. Shortly after this a group of local business men attempted to set up an organisation which would have effectively controlled the developing blueberry industry. These men, albeit well meaning, were all non-growers. It was felt that the industry should be able to control its own destiny. Shortly after this we saw the nurserymen appearing on the scene claiming it was their right to produce plants for sale and that growers should have nothing to do with this part of the industry. We saw the export houses claiming it was their right to export blueberries and that we as growers had insufficient expertise or

business acumen to become involved in this highly specialised field. So it appeared we had every one against us. To counteract these forces we decided to form this company - a cooperative organisation of growers, controlled by growers, for growers. It was set up primarily as a marketing organisation based largely on the Michigan Blueberry Growers Association which has 500 members, 10,000 acres in production, an annual turnover of $14,000,000 and a permanent staff of three. At this stage we do not anticipate a large scale pack house type of operation for fresh fruit export of blueberries. Rather we envisage forming smaller groups in their own locality combining in localised packing operations. We have designated quality control standards which will be enforced on all members. Fruit will be inspected prior to export and any fruit not meeting the Company's standards will be immediately down graded to local market or process.

We are already, in the form of newsletters, distributing cultural and technical information to all members. The Board of Directors meets regularly to formulate policy and prepare marketing policies for the future. At this point in time we are marketing 50% of the crop on our own account, the remainder being marketed for us by an export house. We do, however retain control of the crop right through the whole of the production and marketing chain. Thus we are capitalising on our own ability to control and market our crop as well as utilising the expertise of an export house. We are thus working with an export house for the mutual benefit of both. Whether or not this policy will continue depends on future developments. Marketing must be flexible and this is a part of our basic cooperative policy. The whole of the Constitution of the company has been made very flexible so that we can adjust to different circumstances as they occur from time to time. Directorship will be based on number of members. As membership increases so will the number of directors and it is envisaged that eventually directors will be elected on a regional basis. We operate a pooling system of all income with progress payments made during the season and a final payment when all costs and levies have been met. I would emphasis that as a cooperative company we can only pay market realisation less administration and promotional levies. There is no way we can subsidise export crops. However, because we are selling on behalf of our members any export incentive can be passed directly back to the grower.

Information on the three aspects of the cooperative concept mentioned earlier, culture, marketing and political, are continually fed back to members by regular newsletters. Members are also kept informed on possible future developments so that they can adjust their own management programmes accordingly.

This, then, is KIWI BLUE COOPERATIVE. I believe it is the only way we can organise our industry on a rational and orderly basis. It gives everbody the opportunity to take part in the developing industry; it allows everybody to play an active part in the developing industry, but most important of all it brings growers together, brings problems together and brings solutions of those problems far more quickly than can happen if the individual is on his own. We have an organisation controlled by growers, working for growers, right from the time of initial production through the whole of the production and marketing chains. I believe this is the most effective way the industry can be developed.

A SUMMARY OF BLUEBERRY CULTURE

This paper was prepared as an assignment in Horticultural Management by:

Miss J. Try,
Lincoln College, 1980.

DESCRIPTION

The highbush blueberry *(Vaccinium corymbosum)* is a deciduous, woody perennial, normally 1-4 m in height and 2 m wide. The fruits are many seeded berries and the growth habit or bush size is similar to blackcurrants. Fruit is produced on the previous season's growth. Flower initiation takes place during the summer preceding the fruiting season. Flowering takes place from the end of August to early October. The flowers are self-fertile, although cross-pollination will improve fruit set and size, and thus, it is normal practice to have two rows of one variety followed by two rows of another. The introduction of beehives (one per hectare) before one-quarter full bloom has beneficial effects on pollination. It increases seed number with a consequent increase in fruit size. The largest berries are formed on the most vigorous wood. During maturity the colour changes from green to red to blue. Full maturity does not occur until several days past the full blue stage. The berries ripen 60-90 days after full bloom; mature berries can remain on the plant up to ten days. Fruits form in clusters of five to ten berries which ripen often in no particular order, over a period of several weeks. The growth curve is a double sigmoid for the fruit in three stages.

* rapid growth following fertilization,
* a plateau, no apparent growth,
* rapid growth. A berry may increase twentyfive percent in volume after turning blue.

The plants are shallow rooted and will not tolerate either extreme dryness or wetness for prolonged periods.

VARIETIES

Varieties available in New Zealand include Atlantic, Burlington, Dixi, Jersey, Stanley, Berkeley, Blueray and Darrow. There are numerous additional varieties in the U.S.A., and some have already been imported into New Zealand.

Description of three varieties (see appendix for additional information)

Berkeley bush medium upright, medium hardy. Fruit very large, lightest blue, firm, medium quality, resistant to cracking. Matures in mid-season.

Jersey bush spreading, vigorous. Fruit large. Cluster long and loose. Matures in late season.

Blueray upright spreading, medium-hardy. Fruit very large, firm sweet. Matures in mid-season.

PROPAGATION

Blueberries are usually propagated from hardwood cuttings, although softwood cuttings give quicker results. Both methods are described below:

Hardwood cuttings

Take 6-12 cm long cuttings from well hardened, disease free, pencil sized, dormant shoots of the previous season's growth. Wood for cuttings may be taken after the leaves have dropped (late autumn or early winter) before heavy frosts occur, or late winter before growth starts. Avoid selecting shoots with flower buds, as they are a deterrent to rooting. Cuttings from near the ground will do best.

Fill the bottom of an outdoor propagation frame with a 10 cm layer of sawdust (rotted if possible). Place 15 cm of a 1:1 peat/sand or peat/pumice mixture. The cuttings are inserted 2/3 length into the medium at a 5 cm x 5 cm spacing. Firm the medium around the cuttings and water in to eliminate air pockets. Rooting hormone No. 1 or No. 2 in conjunction with a fungicide may be beneficial. Do not allow the temperature to rise above 7^{o}C to maintain high humidity, therefore heavy shading and good ventilation are important.

The first top growth occurs while the cuttings are callusing. When the roots start developing, top growth stops temporarily. As top growth begins again, the roots should be well established. At this stage, increase the light and reduce the humidity level. When the second flush of new growth appears and the plants are well rooted, apply liquid nitrogen as ammonium sulphate fortnightly. Percentage strike depends on the variety; 85-95 percent is typical.

Established rooted cuttings are transferred to a nursery and spaced at 30 cm x 60 cm, where they remain for one year. An alternative is to grow on in polythene bags, using a potting mix of 2:1 peat/coarse pumice or peat/sand with suitable fertilizer additives. A third alternative is to place the rooted cuttings directly into the field. Remove all flower buds as they inhibit vegetative growth. At the end of one year the plants are called two-year old plants and are ready for field planting. At this time they are normally 30-45 cm high.

Softwood cuttings

Cuttings are taken as laterals once the terminal bud has set (late November-January), about 7 cm in length, with the lower leaves removed. Dip in rooting hormone No. 1 or No. 2, depending on firmness. Older or softwood cuttings can be wounded, dipped in fungicides and placed firmly in 12 cm of peat/pumice or peat/sand. When summer temperatures are high, the cuttings can be placed in a shade house, with eighty percent light exclusion. Cover the beds with white polythene film on wire supports and use black polythene under beds, perforated for

draining. Remove the covers for watering and ventilation periodically. A greenhouse with a mist bed and bottom heat could also be used. The cuttings should be rooted and ready to place in a growing-on bed in ten weeks. Remove gently and place in black polythene bags with a 2:1 peat/sand or peat/pumice medium and apply liquid fertilizer. Place in a shade house and allow the cuttings to harden off before transplanting to a nursery bed in early spring. If necessary, retain plants in containers and grow on under shade before pruning back, preparatory to field planting.

ESTABLISHING A COMMERCIAL AREA

In the autumn, before planting, spray the field with herbicides such as Round-up to eliminate all perennial weeds. Eliminating weeds is very important before planting out as the roots of blueberries are very sensitive to herbicides and young blueberries will not tolerate competition.

Plants are usually set at 1.2 x 2.5 - 3.0 m apart. Planting is done in early spring (August) after the soil has been well prepared. Plant about 5 cm deeper than in the nursery, and trim back the top growth.

WEED CONTROL

Weed control in blueberries is difficult. The roots form a dense mat directly under the surface. This allows only shallow cultivation for weed control, which is not effective against deep rooted or rhizomatous weeds. Other methods of weed control are mowing, hand weeding, mulching, and combinations of these methods.

In the U.S.A., clean cultivation is a common practice. Cultivate with a rotary hoe to a depth of 5 - 7.5 cm, and only often enough to check weeds. Grass swards are also common and are especially valuable when heavy equipment is used. Grassing down is usually delayed until the bushes are well established to eliminate competition in the early critical stage. Herbicides such as diuron, or simazine (2.3 - 4.5

kg/ha) before the buds open usually provides season-long weed control for less troublesome weeds. Paraquat + Diuron and Terbacil will give slightly increased production compared with no weed control. A herbicide could be used in the planting row with a grass sward between the rows, and mown.

Mulching has several advantages: suppresses weeds, maintains cooler soil temperature in summer, retains soil moisture near the surface, improves soil structure, avoids erosion, prevents root injury from cultivation, and it can be used to reduce pH. Straw, sawdust, peat, or block polythene can be used. Sawdust is often favoured because it reduces pH; it should be remembered that the sawdust will tie up nitrogen in the soil, so additional nitrogen fertilizer will be necessary. With the black polythene, one metre strips are laid in the planting row, and after the plants are set out, sawdust is placed over the hole, and grass sward sown between the rows. This seems an ideal system, if enough money is available to set it up. If a mulch is desired, and there is not much money, mulching in the row with sawdust to a depth of 10 cm is effective, with a grass sward between the rows.

FERTILIZERS

The blueberry grows and fruits at a lower fertility level than most other fruits.

In general, 0.75 - 1.0 tonnes/ha of a 10-5-8 NPK mixture is recommended, one half in spring prior to bud break, and the remainder midway through the season. However, periodic soil tests should be done to determine the correct amount of fertilizer to apply.

IRRIGATION AND FROST CONTROL

It has been suggested that 2.5 cm/week rainfall or irrigation is required during the growing season. Adequate moisture must be maintained, but excessive irrigation may leach nutrients.

Blueberries are quite frost tolerant. In fact, they can survive $-5^{o}C$ when in full bloom, but yield is reduced. However, if it is desired, overhead sprinkler irrigation can be used for frost protection. By applying 2.5 - 4.6 mm/hr when the temperature drops around the plant to 0.5 - $1.1^{o}C$. Continue to sprinkle for the duration of the low temperatures or until all ice melts off the plant. This may save the blossoms or young fruit if the temperature outside the protected area drops to $-3.9^{o}C$. Ripe fruit may split under a steady wetting by an overhead system. Sprinkler applications may be made prior to ripening or directly after a picking in the early morning so the plants will dry rapidly.

Many growers prefer trickle to overhead irrigation to avoid damage to the fruit during ripening.

PESTS AND DISEASES

The primary insect pest of blueberries is leaf roller. Mites, scales, black vine weevil can also be problems. Other pests may become more important as blueberry plantings increase. Chemical control of leaf roller may include Gusathion before flowering in August, Lannate during fruit development, and Gusathion post harvest. Winter oils before dormancy breaks at 4 ℓ/100 ℓ will help control mite and scale.

Diseases include *botrytis*, *sclerotinia* rot, *phytophthora* root rot, *colletotrichum* leafspot, *cylindrocladium* rot, and stem blight. Botrytis attacks and kills the tips of branches. During the blossom period it attacks and rots flowers and later, rots the fruit.

Stem Blight *(Botryosphaeria dothidea)* causes the death of branches. It attacks damaged or poor vigour plants. Affected plants show blanching, with reddened veins.

Sclerotinia rot causes twig and flower blight. The fungus produces a white, cottony growth in which hard, black sclerotes are formed.

Phytophthora root rot is only a problem on poorly drained soils.

Rotting of the fibrous roots causes dwarfing and a yellowing-reddening of foliage or death.

Colletotrichum leafspot was found near Hamilton in 1978. So far, the small red leafspots appear to be of little importance.

Cylindrocladium rot is a serious root and crown rot, with above ground symptoms of yellow and red leaves, followed by death. It was found in Tauranga in 1979 and is a soil-borne pathogen; control should consist of reducing the humidity, practising hygiene and the use of fungicides.

Fortunately, many of the diseases present overseas are not in New Zealand, especially the several viruses. Others include Powdery Mildew, Mummy berry and several stem cankers.

Because a large portion of the crop will probably be exported, an overall spray programme must consider allowable chemical residues. A spray programme similar to that for black currants, with adjustments to the blueberry blossom and harvest periods, could be suitable.

PRUNING

Pruning helps regulate both the current year's crop and the fruiting potential the following year.

Young Plants

Either before or soon after planting, rub off by hand some or all of the large compound fruit buds. Cut back about one-fourth of the top soon after planting. Remove small, bushy growth near the base of the plant to obtain a more upright bush and to keep fruit off the ground. Little further pruning will be needed until the third year after planting.

Older Plants

By the fourth year the plants are reaching maturity and should be

conditioned for full production. Practices are aimed at size and quality of the crop. Open up dense centres by cutting out thin wood, removing low spreading branches and reducing the number of fruiting areas to promote good berries. Usually, pruning is done in the dormant season. It should be completed before the plants start to grow in the spring. Annual pruning helps to initiate new, vigorous growth on which the crop is borne.

Regulate the amount of pruning according to the comparative value of total yield, berry size, and season of maturity. Heavy pruning may reduce the crop, increase berry size and shift the ripening period forward.

General

Prune enough, along with a good fertilizer programme, to strengthen the plant and so that enough new growth is produced for a subsequent crop. Often, weak bushes require more severe pruning than vigorous ones. Heavy pruning causes thicker and more leafy shoots than light pruning. Thick and later-developing shoots tend to set fewer buds than early and weak shoots.

Systematically, thin out shorter, weaker shoots, leaving enough of the thick shoots to bear the crop and provide new growth on the selected canes. Tip back long fruiting shoots to leave four to six buds for adequate fruit size. Large berries are necessary for export quality.

There should be enough leaves around fruiting clusters to provide adequate food materials (mostly sugars) for the developing fruit, but not enough to over-shadow the fruit or to reduce spray coverage.

PRUNING FACTS

* Blueberries produce fruit on the previous season's growth.
* Fruit buds are formed during summer.
* Vigorous growth produces high-quality fruit.
* Most cultivars tend to overbear, thus causing small fruit.

* Erect cultivars need centre thinning.
* Spreading cultivars require little centre thinning, but require low branch removal.
* Heavy pruning increases fruit size, hastens ripening, and reduces yield very little.
* No pruning results in thin, weak growth, and small, late ripening fruit. Yield may be higher than from pruned plants, but the size and quality of the fruit will be poor and over-bearing may result.

HARVESTING AND STORAGE

Maturing berries change from green to red to blue. Once the epidermis of the berry has become completely blue, it is hard to tell the maturity level of the fruit. Usually full flavour is developed two to three days past full blue. Berry size increases until full ripeness, so yield is increased by making five or six pickings.

Blueberries for fresh market should be plump, firm, uniformly blue; free from moisture, trash, and decay. The best harvest maturity is pH 3.43 - 3.73 and soluble solids of 10 - 15 percent. Freshly harvested berries can be held two weeks under optimum storage of 31 - 32^{o}F - (0.5 - 1^{o}C) and ninety percent relative humidity. It is important to use shipping containers with openings to permit air movement. The trays used for strawberries would probably be quite good. In the North Island, Blueberries are auctioned in 250 g punnets.

The berries become mature 60 - 80 days after full bloom depending on cultivar and temperatures. Harvest takes place from mid-December until February. Bushes should be picked once every six days to obtain maximum yield. One good picker should harvest six kg/hour.

As blueberries ripen, total sugars and soluble solids content of the fruit increases, and citric acid decreases. Low total sugars or soluble solids ratios are associated with good keeping quality and high ratios with poor keeping quality.

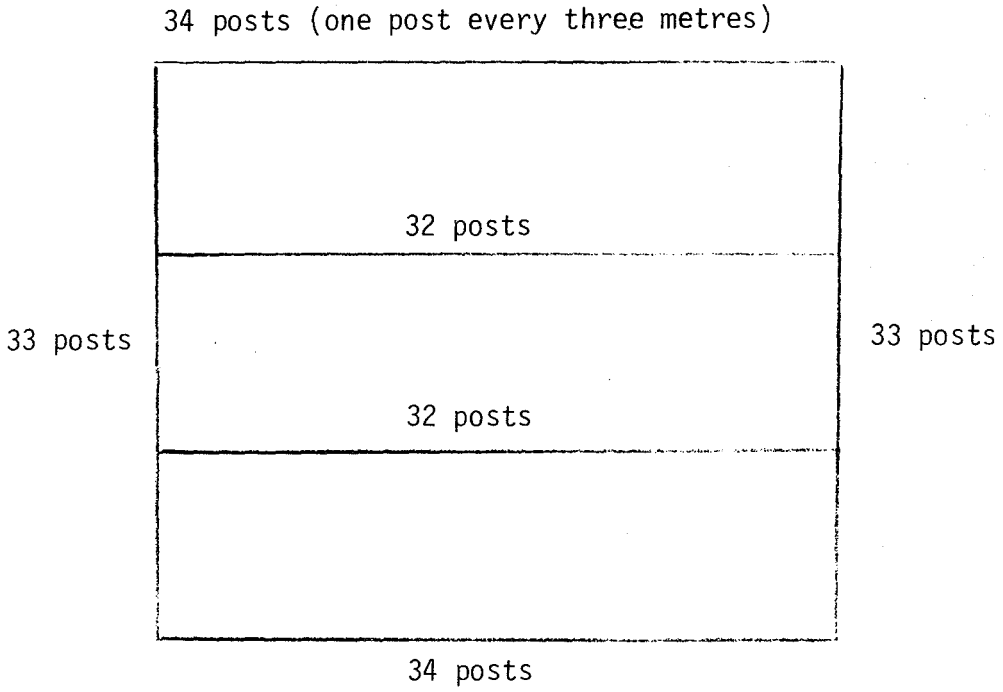
COSTS

Capital Costs per Hectare - Materials Only

		Least	Most
Canopy			
Framework and Netting		10,600	10,600
Irrigation (no bore)			
(a) Trickle	4,200		
OR			
(b) Overhead	5,000	4,200	5,000
Plants (3 m x 1.2 m spacing)			
(a) 2778 x $3/plant	8,340		
OR			
(b) purchase 500 plants and propagate	2,000	2,000	8,340
Planting			
Cultivation	30		
Roundup	150		
Sawdust mulch	450		
		630	630
		17,430	24,570

The future use of Mesurol for bird protection is still in doubt but it appears Mesurol-treated berries will continue to be unacceptable on overseas markets.

Canopy Details (for 1 ha)



Posts		
134 at $20 each (includes installation and straining)	2,680	
64 at $15 each (includes installation)	960	
		3,640
Wire		
28 coils of 4 mm wire at $22.50/coil (main support)	630	
8 coils of 2.5 mm wire at $23.50/coil (sew netting together)	188	
		818
Netting		
94 rolls of ½" spacing, 50 x 1 m wire x $64.50/roll		6,063
		10,521

Annual Costs per Hectare

Irrigation and frost protection	300
Mowing (including labour)	300
Fertilizer	175
Sprays	300
Pruning	500
Running repairs and maintenance and share of overheads	500
	2,075

Harvesting Costs

a. plants purchased				b. own propagation		
Year	Packages	Picking	Total	Packages	Picking	Total
3	696	1920	2616	207	420	627
4	1178	3120	4298	221	648	869
5	2035	5160	7195	938	2400	3338
6	2892	7320	10212	1487	3840	5327
7	3749	9480	13229	2344	6000	8344
8	3749	9480	13229	3046	7680	10726
9	3749	9480	13229	3749	9480	13229

Picking assumptions - $3/hour and eight hour days.

Estimated Gross Income per Hectare

a. plants purchased				b. own propagation		
Year	Local	Export	Total	Local	Export	Total
3	2710	5421	8131	487	975	1462
4	4587	9174	13761	825	1650	2475
5	7923	15768	23691	3648	7296	10944
6	11259	22518	33777	5787	11574	17361
7	14595	29190	43785	9123	18246	27369
8	14595	29190	43785	11869	23718	35587
9	14595	29190	43785	14595	29190	43785

Assumptions

Yields - year 3 1.3 kg/plant
4 2.2 "
5 3.8 "
6 5.4 "
7 7.0 "

Years = number of years after planting.

Half the crop of export quality ($3/kg), half the crop local market ($1.50/kg).

The profitability calculations depend predominantly on returns. Compared with present export prices the figure of $3/kg at the gate for export fruit is low. Nevertheless, it is necessary to be realistic both from the point of view of a large-scale increase in dessert crop to be marketed, and also to allow for a percentage of process quality fruit.

Cash Flows per Hectare ($)

These only include annual costs; no capital costs are included.

a. plants purchased

Year	3	4	5	6	7	8	9
Income	8131	13761	23691	33777	43785	43785	43785
Costs	4691	6373	9270	12287	15304	15304	15304
Margin	3440	7388	14421	21390	28481	28481	28481
Accumulated Cash Flow	3440	10828	25249	46739	75220	103701	132182

b. own propagation

Year	3	4	5	6	7	8	9
Income	1462	2475	10944	17361	27369	35587	43785
Costs	1042	1284	5413	7402	10419	12801	15304
Margin	420	1191	5531	9959	16950	22786	28481
Accumulated Cash Flow	420	1611	7142	17101	34051	56837	85318

NOTE: These figures may be deceptive. In the top table, the crop has reached its full production in year 7, with an accumulated income of $75,220. In the bottom table it is year 9 before full production is reached with an accumulation of $85,318. The difference between these figures is two years and $10,098; while the difference in establishing the crop is $24,570 - $17,430 = $7,140.
This appears to give an advantage of about $17,000 for "own propagation" and installing trickle irrigation instead of overhead. For correct economic interpretation the cash flows should be discounted at the ruling interest rate to allow comparison of net present values.

APPENDIX 1

Extract from Neil Rennie in The New Zealand Farmer, 9th November, 1978.

The Costs of 1 ha of Blueberries

Capital Cost

(Excluding land and dwelling)	$
Canopy: Framework (3 m x 2 m wire grid)	4,000
Netting (12 mm galv. netting)	8,500
Irrigation: (Assuming a suitable bore is already present)	4,300
Plants: 1,660 at $2	3,320
Machinery and Plant	5,000
Working Capital	3,000
	28,120

Annual Cost

(Excluding depreciation, picking and packaging)	$
Irrigation: (Power, repairs and maintenance)	920
Fertilizer	100
Sprays	280
Running repairs and maintenance (buildings, canopy, plant and machinery)	500
Insurances and administration	500
	2,300
Interest and principal. $28,000 at 8½% for 20 years	2,960
	5,260
Living expenses	5,000
	10,260

NOTES: Canopy costs can be reduced by using a wider framework spacing or by using cheaper netting, but higher maintenance costs and shorter life span would probably lead to a similar cost in the long term. Irrigation should be capable of applying 30 mm/

week to the total area, and the bore and pump must therefore be capable of not less than 2.25 cu m/hr (500 gallons/hr). Plants could be put in at twice the density initially, and thinned after six years. This would give better returns in the early years. Machinery and plant will vary in individual circumstances and the figure given is a nominal one only.

The Returns on 1 ha of Blueberries

Year	Crop expenses[1]	Total expenses	Yield Kg/plant	Yield Total[2]	Income[3]	Taxable net Farm Income	Account[4] Balance
1	4,460	9,460				-4,460	-9,460
2	4,460	9,460				-4,460	-18,920
3	5,260	10,260	1.3	2,158	5,395	135	-23,785
4	5,260	10,260	2.2	3,652	9,130	3,870	-24,915
5	5,260	10,260	3.8	6,308	15,720	10,460	-19,405
6	5,260	10,260	5.4	8,964	22,410	17,150	-7,255
7	5,260	10,260	7.0	11,620	29,050	23,790	11,535
8	5,260	10,260	7.0	11,620	29,050	23,790	30,250
20	5,260	10,260	7.0	11,620	29,050	23,790	255,805

NOTE:

* Depreciation is excluded since capital repayment costs have been included under expenses.
* Based on 1,660 plants/hectare.
* Assumptions:

Long term average price	$4.00/kg
Picking and packaging	$1.50/kg
Net income	$2.50/kg

* Cash balance only; excludes interest and taxation.
* Return on capital:

Land	5,000/ha*
Capital	25,000.00
	$30,000.00

* Excluding dwelling.

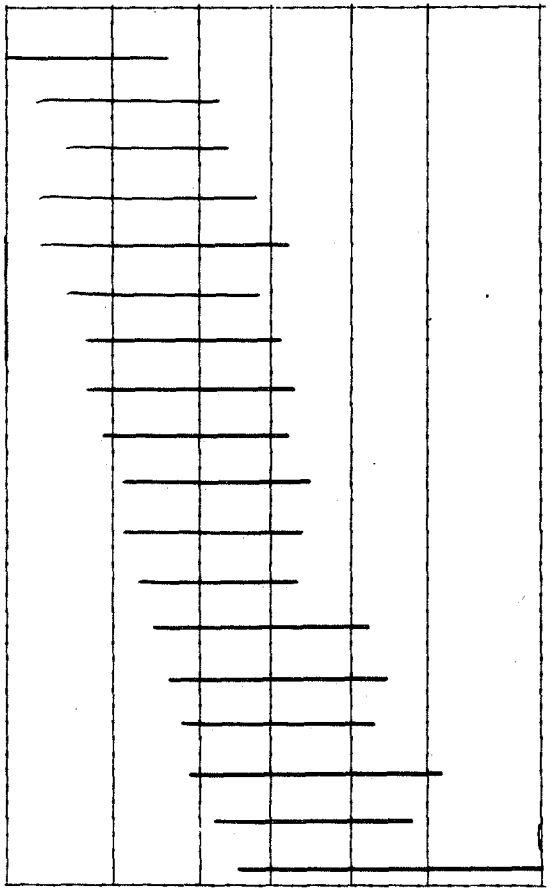
Compound rate of return over 20 years (ignoring tax) = 11% pa.

Compound rate of return (with approx. assessment for taxation) = 6½%

APPENDIX 2

Extract from Neil Rennie, New Zealand Farmer, 9th November, 1978.

TIME OF RIPENING, FRUIT CHARACTERISTICS AND PRODUCTION OF HIGHBUSH AND RABBITEYE CULTIVARS*



	Size	Scar	Colour	Firm	Flavour	Yield kg/ha***
Earliblue	8	7	8	10	8	18 700
Collins	8	7	8	10	9	21 600
Ivanhoe	9	9	7	9	10	
Stanley	5	5	6	7	8	15 800
Blueray	10	7	9	8	10	25 500
Bluecrop	9	9	9	9	8	20 700
Atlantic	8	7	7	8	8	
Berkeley	10	7	10	9	7	24 200
Rubel	6	7	7	8	7	
R9	8	8	8	9	7	
Jersey	8	7	7	9	7	30 700
Darrow	10	8	8	8	9	
Herbert	10	6	6	6	10	20 900
Dixi	9	6	8	8	9	25 200
Colville	10	7	9	10	9	21 700
Burlington	5	10	8	8	8	10 800
Woodard	8	8	10	9	8	12 500
Tifblue	8	10	10	9	8	10 000

*Information extracted from Eck and Childers (1) and Moore (2)
**Subjective rating scale of 1 to 10, with 10 being most desirable expression of a character and 1 poorest
***Production in sixth year after field planting (2)

APPENDIX 3

Eight stages of Development.
Extract from W.E. Ballinger and W. Kushman.
Relationship of Stage of Ripeness to Composition and Keeping Quality of Highbush Blueberries.
Journal of the American Soc. Hort. Sci. 95(2): 239-242. 1970.

Stage 1 - small, deep green.

Stage 2 - light-green to "whitish", enlarging rapidly, no red colour visible.

Stage 3 - same as #2 except for a trace of red visible near the calyx end.

Stage 4 - red colour on approximately half of the surface (calyx end).

Stage 5 - red colour completely covering the surface except for a small area at the stem end which was still greenish-white.

Stage 6 - entire surface bluish-red except for a trace of red colour near the stem scar.

Stage 7 - entirely blue surface but not with distended stem scar.

Stage 8 - entirely blue, more shallow from stem to calyx, and with distended stem scar.

Fruits of stages 1 to 6 were easily separated; those of stages 7 and 8 were separated with difficulty.

APPENDIX 4

Economics of Blueberries - an excerpt from a presentation.

1. Income depends on plants/ha, yield plants $/kg.

1660 plants/ha x 7 kg/plant (year 7 onwards)	=	11,600 kg
11,600 x $4/kg	=	46,400
less picking, marketing	=	17,400
less growing costs	=	4,000
		25,000 nett income in the seventh year.

2. Capital costs of one hectare

	$
Bird protection - frame	5,000
- netting	10,000
Irrigation	5,000
Plants 1660 at $3 each	5,000
Machinery and plant	5,000
Sundry (shelter, cultivation, etc.)	5,000
	35,000

3. Cash flow

Year	Date	
-	1980	*Purchase rooted cuttings, prepare cold frame, grow one year.
0	1981	Plant out, install irrigation. Running costs begin.
1	1982	Establish canopy
2	1983	First fruit
3	1984	Yield 1.3 kg/plant
4	1985	" 2.2 "
5	1986	" 3.8 "
6	1987	" 5.4 "
7	1988	" 7.0 "
8	1989	" 7.0) break even point
9	1990	" 7.0)

*These are no longer available. It is usually only two year plants that are sold.

BRIEF OUTLINE OF HORTICULTURE BULLETINS

(presently available from the College Bookshop)

Bulletin No.

15 "Temperate and Sub-tropical Fruit Production" - D.I. Jackson. (A general guide for students, but will have interest to the commercial grower and the enthusiastic home orchardist.) 97pp. $1.50.

18 "Basic Winemaking" - D.I. Jackson and D.F. Schuster. (The basic principles and practices used for making wine from grapes.) 63pp. ~~$0.75.~~

19 "Edible Tree Nuts in New Zealand" - P.B. Bull., D.I. Jackson and S.M. Smith. (The nuts which will grow in New Zealand and notes on their culture.) 104pp. ~~$1.50.~~ $3

20 "Tree Maintenance" - J.O. Taylor (ed.). (Principles and practices of tree maintenance including planting, transplanting, pruning and tree surgery for New Zealand conditions.) $3.50.

22a "Grapes and Wine" - Papers in Viticulture. $2.00.

22b "Grapes and Wine" - Papers in Winemaking and Wine Evaluation. (Taken from courses in grapes and wine at Lincoln College, November 1978.) $1.00.

23 "Culture of Blueberries and Cranberries" - G.S. Spackman and D.I. Jackson. $0.90.

24 "Socio and Economic Factors Affecting Vineyards in the Year 2000" - I.R. Lewis and G.F. Thiele. (A paper presented at the 20th International Horticultural Congress, August 1978, in the Symposium "Vineyards in the Year 2000".) $1.50.

25 ~~"Short Term Cropping of Blackcurrants." G.F. Thiele. $0.50.~~

26 "A Decade of Strawberry Production." G.F. Thiele. $0.45.

27 "Outdoor Playing Surfaces." J.O. Taylor. (A Report of Proceedings of a Seminar covering theoretical and practical considerations of turf culture.) $3.50.

28 "Park Presentation of Graphic Communication." J.O. Taylor. $3.00.

30 "Floriculture" - R.B. Stevens. (an introduction to the principles and practices of commercial floriculture in New Zealand.) $1.65.

31 "Wanganui River Survey" - P.J. Devlin, M. Hoskyn, D.G. Simmons. $3.~~00~~.

32 "Riversdale" - P.J. Devlin. Not available.

33 "The Recreational Hunter and other forest users in L.S.F.P." D.G. Simmons, P.J. Devlin. ~~$3.50~~ $6

34 "Whakapapa Village Dept. 1 Plan" - P.J. Devlin. In Press.

35 Papers in Fruit and Nut Production.

a. Background to Fruit Production. $4

b. Pip and Stone Fruit Production.

c. Nut Production.

d. Blueberry Production. $4

(Proceedings of a course in Fruit and Nut Production at Lincoln College, November 1980. A number of papers from Bulletin 29, "Alternative Land Uses" (now out of print) are also included.)

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