Blueberry Symposium and study tour, USA July 2008

Phillip Wilk
NSW Department of Primary Industries (NSW DPI)

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Final report

Blueberry symposium and study tour 2008
BB07003

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NSW DEPARTMENT OF
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Title: Final report blueberry symposium and study tour BB07003

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Media summary

Members of the Australian Blueberry Industry recently participated in a study tour to the United States, organised and led by NSW DPI extension officer Phillip Wilk and Soils researcher Justine Cox, and supported with funding from Horticulture Australia Ltd. The group attended the 9th International Vaccinium conference in Oregon, and visited farms and research stations in California and Oregon. Participants from Victoria and NSW viewed production systems from cooler temperate regions and sub-tropical areas, investigated marketing strategies and emerging industry issues.

The study tour objectives were to: improve adoption of sustainable farming systems in the Australian blueberry industry; improve methods of marketing and promotions of the Australian product and assess current large scale US production techniques that may be transferable to the Australian industry.

The USA is the recognised leader and most sophisticated producer and marketer of blueberries world wide. The availability of blueberry is almost year round in the USA as seasonal production begins in Florida then continues into California and then to traditional cooler areas in Oregon, Michigan and the north eastern states.

The 9th International Vaccinium Symposium in Corvallis Oregon provided a forum where blueberry researchers, marketers and extension people from over 16 countries gave updates of the latest information relevant to the blueberry industry.

The study tour visited a number of farms, nurseries and research facilities in Oregon and California, highlighting production systems, varietal trials, and marketing methods. The pre-conference tour in Oregon provided an opportunity to see growing conditions similar to those in Victoria and Tasmania, while the post-conference tour in southern California highlighted growing conditions similar to northern NSW sub-tropical growing conditions.

The pre-conference farm tours visited the Willamette Valley, the main agricultural region of Oregon. Blueberries here are produced under cool season conditions for both domestic and export markets. Apart from 2000 hectares of blueberries, the region also produces grass seed, Christmas trees, hazelnuts, and nursery plants. As part of this tour, the group also visited Fall Creek Wholesale Nursery, which supplies most of the west coast of the USA with blueberry plants. Major retail outlets including supermarkets and farmers markets were also visited to view marketing methods.

During the post-conference tour, the group went to Ventura County in California meeting extension and research staff from University of California Cooperative extension and advisory service who accompanied them to local farms in the region to view production systems. Extension staff were able to provide great insight into market entry requirements, timing of production and the limitations to supply within the region.

The group then travelled to the San Joaquin Valley in central California. Here they visited Kearney Agricultural Research Centre at Parlier and met with research staff to view research being undertaken on blueberries, including organic mulching, varieties, pruning and production systems. The tour included visits to three farms in the region.

Farmer participants of the tour were asked to synthesise key messages gleaned at the end of each days travel. Observations during the tour highlighted:

- Blueberry marketing in the US is more diversified than in Australia, with greater variety of packing types, presentation to consumers and price range
- Research into new varieties is strongly supported by key growers and groups, in partnership with researchers
- Greater use of organic mulches is made in both Oregon and California, particularly during the establishment phase
- In contrast to Australia, very little use of made of netting for bird protection, substantially reducing production costs
- Machine harvesting is used more widely for fresh and processed product, resulting in increased reliance on optical sorting of fruit, machine-harvestable varieties, and impacting on orchard layout
- Almost all irrigation applied now comes from double-drip irrigation lines, with irrigation lines often suspended on adjustable trellises although all growers previously used overhead sprinklers and microjets

The outcomes of the study tour and symposium will be communicated to the broader industry by the final report, presentations to the Australian Blueberry Growers Association (ABGA) and reports in the industry journal over the next 12 months.

The project was funded by voluntary contributions by the participants with matching funds from the Commonwealth government through Horticulture Australia Limited.

Itinerary

Date	Activity	Town
July 8	Depart Australia Fly to LA, Portland	Portland
July 9	Pre-conference tour introduction	Portland
July 10	Pre-conference tour, 2 berry farms	Eugene
July 11	Pre-conference tour, cranberry farms	Bandon
July 12	Pre-conference tour, nursery and berry farm	Bandon
July 13	Pre-conference tour, return trip for conference	Corvallis
July 14-17	International Vaccinium Conference	Corvallis
July 17	Fly to LA, Visit 1 blueberry farm Ventura California.	Ventura
July 18	Visit farms in Obispo Ca. 3 blueberry farms Drive to Parlier, San Joaquin Valley, Ca.	Obispo Parlier/Reedley
July 19	Visit Kearney Research Station Parlier, Ca.	Parlier/Reedley
July 20	Drive back to LAX, depart for Australia	LA

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Project tour objectives

Tour objectives

- Improve adoption of sustainable farming systems
- Improve marketing and promotion of blueberries
- To investigates benefits of economies of scale for individual farm sustainability
- To discover current research in the world blueberry industry
- Discuss and improve adoption of current best pest and disease management practices
- Improve the international perspective of production and marketing for the Australian blueberry industry.
- Meet key people in the international blueberry industry

Tour Activities

The project tour addressed the objectives through the following activities:

1. Investigate orchard management systems research by
   - Meeting with Ben Faber, Extension specialist, UC Davis, Ventura County to view California coastal areas for low chill evergreen production systems on local orchards
   - Meeting with Manuel Jimenez, Extension specialist at Kearney UC Davis research station, Parlier and San Joaquin Valley to view low chill blueberry research and local orchards
   - Pre conference tour with staff from Oregon State University and USDA Corvallis, to view current research on high chill blueberry production.

2. Attend the Vaccinium Symposium to
   - Network with key researchers and blueberry industry people
   - Investigate current blueberry research relevant to Australian growers
   - Note world blueberry marketing issues in various countries

3. Investigate Californian blueberry production issues by
   - Visiting a number of blueberry farms in coastal California
   - Visiting farms in San Joaquin Valley, California

4. Investigate various domestic marketing strategies by
   - Visiting local retail markets to view blueberry products at point of sale
   - Visiting local produce outlets
   - Inspecting product at farmers markets
   - Determine costs of retail product

Scientific presentations from ISHS 9th International Vaccinium Symposium

Introduction

The information below is summarised from scientific presentations and posters presented to the International Society for Horticultural Science (ISHS) 9th International Vaccinium Symposium in Corvallis Oregon. Proceedings will be published in full at a later date and available from the International Society for Horticultural Science (www.ishs.org/acta/)

Symposium Structure

Oral presentations and posters were grouped under the following sections

1. Industry overview in North America
2. Post harvest fruit quality, marketing and health benefits
3. Pest and diseases
4. Physiology and production systems
5. Genetics and germplasm
6. Plant /soil nutrition and irrigation

The complete conference program can be seen at Appendix III

Vaccinium conference summary

David Brazelton (owner of Fall Creek Farm and Nursery 'An Overview of the blueberry industry in North America – grower perspective'

There are currently 90,000 acres (36,400 ha) with production occurring seven months of the year beginning in April and ending in October. Thirty states in the US currently grow blueberries divided into 6 major growing regions. These are:

1. North east (where low bush varieties are grown)
2. East coast (blueberries are grown in sandy soils with peat)
3. South east (Florida and Georgia where pest and disease pressure, frost and high density evergreen system present challenges)
4. Mid west (long winters and innovative growers)
5. West coastal California and San Joaquin Valley (have high pH water and soils, presenting challenges for growth). Mexico is being examined for earlier production at latitude 18º
6. Northwest in Oregon (has a very high production, with trellis system and irrigation lines up high).

British Columbia, California, and Mexico are fast growing regions for blueberry production. Approximately two thirds of the American crop goes to the processed market while the rest goes to fresh markets. The health benefits of blueberries and promotions have boosted production and demand worldwide.

Varieties currently grown

Southern highbush – *Star, Emerald, O'Neil, Jewel, Misty* with new varieties (*Springhigh, Snowchaser* and *Camellia)* looking promising

Northern Highbush – *Duke, Bluecrop, Elliot, Bluejay, Jersey* with new varieties *Aurora and Liberty*

Industry Organisation
The Industry is organised through several councils with no apparent peak national body. The main bodies are the US Highbush Blueberry Council, the North American, Blueberry Council, the Michigan Blueberry Growers Association, the British Columbia Blueberry Council and the Florida Blueberry Growers Association

Yadong Li –(Jilin Agricultural University, China) 'Current status and the future of the blueberry industry in China'
China has only been producing blueberries for 7 years and has **1,300 ha in total**, with **15,000 ha predicted by 2010.** For comparison China took 25 years to become the number one apple producer in the world with 30 million tonnes. China has 35 ha currently under tunnels, some in glasshouses and some in field. There is a seven month production supply to the fresh market. In tunnels the fruit is harvested from early April to early June.

All types of blueberries are currently gown in China including lowbush, rabbiteye and highbush. The Southern Highbush has great potential for expansion in both growth and area grown (this crop is currently using 8% of available area). The variety also provides the greatest high value/early market potential.

Total production of blueberries in 2007 was 370-400T. Growers receive $80/kg for fresh picked product. More than two-thirds of fruit is for the fresh market, with more than 80% exported to Japan or Hong Kong. Less than one-third goes to the processed market

One challenge looming for the Chinese is that labour costs are increasing by 30% a year.

Pilar Banados (Pontificia Universidad Catolica de Chile, Chile) 'Expanding blueberry production into non-traditional production regions: northern Chile and Argentina, Mexico and Spain'
All of these non-traditional areas have either low chill or no-chill accumulation during 'winter' with warm springs and hot summers. Soil types, pH and fertility vary greatly among regions from 100% sand in Spain to heavy clays in northern Chile. Only southern highbush are planted, either under plastic tunnels (Spain and part of Mexico) or in the field. These regions aim to produce early season blueberries in both the northern and southern hemispheres. Mexico may even be able to produce 2 crops/year earlier in the season than either California or Florida.

Country	Ha	Production (07/08) t
Chile	10,763	35,000
Argentina	4,450	8,800
Uruguay	550	600
Brazil	80	24

Northern Chile produces in October, November, and December at latitude 29 - 31^{o}. Blueberries are grown on 7% of the total land area equalling 600 Ha. *Dormex* occasionally is used to break dormancy. There is a huge variation in yields ranging

from 5t/ha to 18 t/ha. In Spain at latitude 37^{o}, production is March to April in an area that gets only 400 mm rainfall per year.

There are many new challenges for these areas and a good understanding of the physiological processes that regulate dormancy, flower bud initiation and differentiation and fruit development will be required. Timing of pruning is a big issue, as plants are not synchronised, so research into this is a priority. Transport to markets is by ship in cold storage, therefore fumigation for overseas markets is another issue.

Charles Forney (Agriculture and Agri-food Canada) 'Postharvest issues in blueberry and cranberry methods to improve market life'
Fruit quality loss during postharvest handling is primarily the result of decay, physiological breakdown, physical impact (eg bruising, compression) and dehydration. Blueberries respond to quite small changes in temperature (as little as 3^{o}C). However, Forney reported that there was some physiological breakdown in stored fruit after 9 weeks even at 0^{o}C. Rapid cooling following harvest extends market life, and forced air cooling is the recommended method. **The optimum storage temperature for blueberries is near 0^{o}C and a relative humidity above 95%. Controlled or modified atmospheres reduce decay with optimum CO_2 concentrations ranging from 10-12 kPa CO_2. Higher concentrations of 15KPa of CO_2 caused softening of fruit**. Postharvest technologies such as heat, UV light, ozone, gamma irradiation, UV-C and fumigation with antimicrobials have not shown good consistent results in preventing decay.

Ernestina Casiraghi (Universita degli Studi di Milano, Italy) 'Evaluation of quality and nutraceutical content in blueberries (*Vaccinium corrymbosum*) by near (NIR) and mid-infrared (MIR) spectroscopy'
There is potential for NIR and MIR to be cost effective tools to determine total soluble solids (Brix), total phenols, total flavenoids and total anthocyanins in berries. The emphasis on nutraceutical health benefits of blueberries has meant there is a demand for technology that can measure the actual active ingredients, assess varieties, and picking maturity for the best health qualities of fruit.

Bernadine Strik (Oregon State University, USA) 'The economics of establishing blueberries for organic production in Oregon- a comparison of weed management systems'
Strik described an experiment conducted at OSU research station conducted to examine relative establishment costs for organic production. Beds were established on silty loam soil, with organic matter of 3.7% and pH of 4.9. Single drip irrigation line was used in all cases, except under weedmat.

Three treatments were examined;
1. raised bed compared to flat ground,
2. feather meal fertiliser compared to 2 rates of fish emulsion
3. *Duke* variety compared to *Liberty*

Duke cost $3.15/plant, *Liberty* $3.45/plant. Therefore at a planting density of 4305 plants/ha, it cost $1292 more to plant *Liberty* than *Duke*. For year 1 fertiliser costs were $1551/ha for feather meal, and fish emulsion was $2685/ha. However, feather meal plants showed N deficiency.

Weed management	Cost/ha
Sawdust and hand weeding	$272
Yard compost topped with sawdust mulch+ acetic acid and hand weeding	$1791
Plastic weedmat with sawdust mulch around plants	$101

Weed management costs in year 1

	Sawdust + hand weed	Yard compost + sawdust +hand weed	Plastic mulch
Raised bed	$3830	$5654	$3065
Flat ground	$4497	$4806	$3065

Findings showed that for the first year costs ranged from $30,311/ha to $35, 534/ha. In all cases, cost of establishment on flat ground was cheaper than raised beds. For weed management weedmat **was** cheaper than sawdust and handweeding , which was in turn cheaper than yard compost with sawdust and handweeding.

Sheila Fitzpatrick (Pacific Agri-food Research Centre, Canada) 'Insect life histories in fruit, shoot and root environments of cranberry and blueberry'
The insect pests of the region have to deal with the seasonal resources provided by the plant. Most *Vaccinium* pests in Canada are constrained by the need to reproduce during the growing season yet enter diapause in time to withstand winter. Pest arthropods usually damage blueberry tissue as larvae feeding on fruit, flowers, buds, leaves, stems or roots. Larval development of soil dwelling root pests is prolonged compared to above ground pests. Today's IPM is focussed on replacing broad-spectrum organophosphate insecticides and on finding innovative and cost effective ways to use biological control agents, behavioural techniques and cultural practices. Pests mentioned include oriental beetle (*Anomala orientalis*), Black vine weevil (*Otiorhynchus sulcatus*), with most root pests being *Coleopterans* (beetles).

Kenna McKenzie (Agriculture and Agri-food Canada) 'Monitoring and emergence of flower thrips species in rabbiteye and Southern Highbush blueberries'
Commercial coloured sticky traps were evaluated for their effectiveness in monitoring flower thrips. The colours were standard yellow, white, green and thrips blue. White and blue sticky traps performed the best for monitoring thrips Another experiment found that white sticky boards captured most thrips compared with extracting thrips from individual flowers using several techniques. The chemical *Actara* reduced thrips but it negatively affected bees. *SpinTor* may be better for the beneficial insects.

Eric Hansen (Michigan State University USA) 'Response of highbush blueberries to post emergent herbicides'
Post emergent herbicides can be combined with pre-emergent herbicides applied in the spring, however chemical contact with the base of the canes can result in injury and reduction in plant health. An experiment compared *glyphosate* (Roundup Ultra), *paraquat* (Gramoxone), *carfentrazone* (Aim), *glufosinate* (Rely) and no post emergent (control). Each herbicide caused injury to young canes and leaves, but the number of young and old canes were not affected greatly by the treatments. Hansen therefore recommended spraying before new canes are initiated, directing the spray to

limit the contact with the base of the bush, and limiting use of herbicides if weed pressures do not justify it.

Hilary Sandler (University of Massachusetts, USA) 'Integrating conventional and alternative practices into cranberry weed management'
Although this study looked at weed control in cranberries, it could have applications for moss control in blueberries. Vinegar and household cleaner (Simple Green) were found to be effective in controlling moss, goldenrod, loosestrife, cinquefoil and dodder. An effective herbicide new to market is *Mesotrione* which looks promising.

Mark Ehlenfeldt (USDA, New Jersey, USA) 'Disease resistance in blueberry – step towards an integrated utilization approach'
Breeders are trying to assess disease resistance to pathogens such as stem blight, twig blight, anthracnose, mummy berry, and Blueberry scorch virus. Susceptible varieties to the various diseases were reported to be:

- Stemblight – *Duke, Ozark, Bluecrop*
- Twig blight – *Emerald, Legacy, Powderblue, Duke*

Of the varieties examined, the more resistant were reported as:

- Anthracnose - *Legacy, Elliot, Brigittablue, Little giant*(fruit) and *Burlington, Sharpblue, Berkley* (foliar)
- Mummy berry – *Elliot, Duke, Bluejay*

For Scorch virus, 96 varieties had been screened, and 18 have not been affected by the virus. A database of susceptibilities will be online at the end of 2008 on the USDA germplasm website.

Bob Martin (USDA, Corvallis, USA) 'Emerging and re-emerging virus diseases of blueberry and cranberry'
Blueberry scorch virus is a concern for growers in Pacific Northwest region of the USA, and has also been detected in New England, Netherlands and Italy. It is aphid transmitted in a non-persistent manner. There is potential for in-field control, however systems can take 2 years to develop so monitoring must continue for 2 years after last positive plant has been removed. **Blueberry shock virus** is pollen transmitted and infection occurs during bloom but no symptoms are seen until bloom the following year. Symptoms include flower and leaf drop. New leaves are produced but no fruit. Plants recover and produce normally in subsequent years, so recommended management is to wait for recovery! **Blueberry fruit drop** spreads in the field in a radial pattern, mostly in Bluecrop. **Blueberry mosaic virus** has been spreading. **Blueberry ring spot virus** has been detected in southern USA. None of these diseases are yet reported to be present in Australia.

Phil Brannen (University of Georgia) 'Utility of phosphonate fungicides for management of Phytophthora root rot of blueberry'
Current industry fungicides are *Mefenoxam* (Ridomil Gold) and *Fosetyl-Al* (Aliette). Neither product is very effective at "cleaning up" infected plants. Trials using *ProPhyt* (potassium phosphate and phosphorous acid) and *AgriFos* (mono- and di-potassium salts of phosphorous acid) were compared to standards. Findings showed that new phosphonates are as effective as current standards, and are cheaper and easier to apply.

Andres France (INIA Quilamapu, Chile) 'Silver leaf: first worldwide report of a new and harmful disease on blueberry'
Chondrostereum purpureum fungus has shown up in Chile on the *Brigitta* variety in 2005. Symptoms include flaking silver patches on the leaf surface. The pathogen kills the plant in about 3 years after infection, producing small and pink basidiocarp on dead wood or over the pruning wound. Two orchards were affected in 2005, but in 2006, 21 orchards were affected, 400km away from the most probable point of origin. Susceptible varieties include *Brigitta, Bluecrop and Duke*.

David Percival (Nova Scotia Agricultural College, Canada) 'Foliar disease impact and possible control strategies in wild blueberry production'
Septoria leaf spot and rust (*Thekopsora minima*) are significant diseases. In the case of *Septoria,* sporulation occurs May to July, with visual lesions present in July. For rust, obligate parasites with visual lesions are present in late July/early August. Percival described an experiment using four fungicides Chlorothalonil *(Bravo*), Boscalid and pyraclostrobin (*Pristine*), Pyraclostrobin (*Cabrio*) and Propiconazole (*Topas*). The disease incidence and severity was reduced by *Bravo,* but not the other fungicides.. Yields increased 100% over that of the control treatment. However, residue problems occur with applications of *Bravo.* The crop cannot be exported as there is a 0.1 ppm limit. *Pristine* may be useful where MRL concerns exist. There is a need for biocontrol but it is not effective at this stage.

Annemiek Schilder (Michigan State University, USA) 'Cytological and chemical evidence for an active resistance response to infection by *Colletotrichium acutatum* in "Elliot" blueberries'
A susceptible variety *(Jersey)* and a resistant variety (*Elliott)* were exposed to the *anthracnose* fruit rot fungus on the fruit. In the resistant variety, the fungal growth was very restricted and there seemed to be a barrier to fungal movement that indicated a plant defence mechanism. Anthocyanin levels were increased and may play a role in this defence mechanism.

Gustavo Lobos (University of Talca, Chile) 'Coloured shade nets influence leaf acclimation and harvest time in highbush blueberries"
Trials were undertaken to compare white, red and black netting with no net, at different densities (25, 50, 75% shading) in Michigan. It was found that nets slowed down fruit development and delayed harvest between 5-10 days, especially in the case of black net. Nets increased fruit size but decreased fruit soluble solids. Plants were not stressed under the netting.

Kenna McKenzie (Agriculture and Agri-food Canada) 'Pollination practices and use of bees'
Vaccinium flowers are adapted to vibratile (or 'buzz') pollination, although not all *Vaccinium* species require cross pollination. Bumble bees and many other indigenous bees forage for pollen and pollinate blueberries. Honeybees, on the other hand, are nectar foragers. Pollen foraging bees have been shown to be more effective pollinators for blueberries than nectar collectors. As indigenous bees are not numerous enough to pollinate commercial fields, managed bees are used. Honey bees had previously been the mainstay but now managed bumble bees and alfalfa leafcutting bees are being used in blueberries in North America. Bee friendly practices on farm will support bee populations for pollination.

Justine Cox (NSW Dept of Primary Industries, Australia) 'Comparison of plastic weedmat and woodchip mulch on low chill blueberry soil in NSW, Australia'
Cox outlined an experiment that was established to compare the effect of black plastic weedmat and woodchip fines on soil chemical, physical and biological properties, as well as plant growth and soil temperature. Southern highbush 'Star' were planted in northern NSW on 2 properties with several different soil types. The woodchip better buffered the temperature compared to plastic weedmat. Temperatures were less extreme under woodchip. Microbial activity followed a seasonal pattern related to temperature and moisture, but there was no difference between the mulch treatments. Plant size was greater under woodchip in one out of 3 sites. Soil pH decreased in the woodchip to 3.9 so lime was used to raise levels.
Future measurements include yield data in October 2008, root distribution and more analysis of soil water relations.

Gerard Kruwer (University of Georgia, USA) 'Effect of mulches on the establishment of organic blueberries in Georgia'
A six year study was conducted to determine the effects of various mulches on the performance of organically grown '*Brightwell*' rabbiteye blueberries. Treatments included plastic woven mat with 4L of pine bark to seal the planting hole cut in the mat, pine straw (10cm deep), pine bark (10cm deep) and an unmulched control. Pine straw needed to be reapplied in year 3 and 6, and pine bark in year 5. Weed control was typically done 4-5 times a year. In years 1 to 4, this was by organic 'burn down' compounds, and by hand weeding in years 5 to 7. Only limited weed control was required with the mulch treatments in the first 2 years. Over time, the amount of hand weeding increased, especially in the plastic mat as it deteriorated. Costs per hectare over the 7 years were $1,048/ha for plastic mat, $6,720 for pine bark and $19,656 for pine straw (or "free" if local supply organised). The organic blueberries returned at least 50% more than conventionally grown berries, but had higher input and weed control costs**.** It was reported that pine bark and pine straw were superior, and that pine bark fines should be avoided. Amongst other alternatives discussed, peanut shells produced excellent growth and were free. Wheat straw is cost effective if the farmer can grow it themself. It leaches allelopathic compounds into the mounds controlling some weeds providing a natural pre-emergent herbicide effect. However, a 15cm layer however only lasts 2 years. Plastic tunnels provide about 1^{o}C of frost protection without heat, and worked well for freeze protection with limited heating (-4^{o}C outside, 0^{o}C inside). Covers advanced ripening about 1 week.

Sujaya Rao (Oregon State University, USA) 'Native bee pollinator diversity in Oregon blueberries and cranberries'
Producers rely on the European honeybee (*Apis mellifera*) and rent 2-5 hives per acre. However, honeybees are not efficient pollinators for blueberries, as they are not capable of buzz pollination, and are not tolerant of the cool weather conditions that prevail during flowering. The prices for hive rental have increased due to limited availability resulting from pests and diseases such as mites, *Nosema*, and colony collapse disorder. Native bees, especially bumble bees, are better pollinators for blueberries. Unfortunately growers in Oregon cannot hire native bees like most other states due to previous introduction of diseases with bees. Therefore native bees in Oregon are especially important to commercial growers. Using blue vane traps, researchers have discovered at least 10 genera of bees in blueberry orchards (15 -23 species depending on location).

Luis Valenzuela-Estrada (Penn State University USA) 'The anatomy and morphology of blueberry roots'
Blueberry root systems are composed of very fine roots lacking root hairs. These very fine roots may be only 40 µm (compared with 570µm for citrus, 260 µm apples and 400 µm grapes). A study to examine anatomical, morphological and functional differences of roots according to their branching hierarchy was conducted. Six different root branching orders were found from the biggest at 200 µm, to the finest at 40 µm. Roots had different functions depending on their size. The roots in the first 3 orders (finest) had the fewest vessels, highest nitrogen concentration and were the only ones with mycorrhizal fungi colonisation.

Jim Hancock (Michigan State University, USA) 'Funding blueberry breeding in the future: the new paradigm'
Most blueberry breeding programs were public and adequately supported by AES (agricultural experiment stations) and industry. Public breeders routinely used varieties and elite germplasm from each others' programs. The new reality is that hard support for public breeding programs has largely dried up. Expensive, field oriented programs have lost favour to more basic research programs that generate funds. It is assumed that the public sector will take over all crop breeding, however, a number of private breeding efforts have emerged. All the "public" breeding programs that have survived patent and licence new their varieties. Only a small proportion of the royalty stream gets to the breeding program but it is enough to keep some programs going, with the others privatising or disappearing. .

There are a range of types of intellectual property available to breeders: Plant patents (US), Plant Variety Protection (US), Utility patents (mostly US), Plant breeders Rights (International), and trademarks (International). From these IP sectors, the types of royalties available to companies and universities are plant royalties, production royalties, plant rental fees and surface area fees. The immediate consequence of widespread licensing is that free germplasm exchange is now discouraged. The germplasm base of breeding programs will become more limited (as the rate of improvement = amount of genetic variability).
Hancock recommended the development of reciprocal breeding arrangements, use of others germplasm for crosses, independent trialling of the resulting families of plants, release of the best hybrids in consultation with the germplasm developer who should be paid a royalty, depending on level of ancestry (eg. 10c for first generation plants, 5c for second generation plants and so on). The potential downsides are that better breeders will lose some of their advantage, and are likely to pay more royalties. In addition, there will be a proliferation of similar varieties. However, having an expanded germplasm base will outweigh these negatives.

Eduardo Holzapfel (University of Concepcion, Chile) 'Selecting and management of irrigation systems for blueberry'
As blueberry root distribution is predominantly in the top 30cm (with a few found at 40cm depth) this study aimed to determine the most efficient water delivery systems. Critical information when selecting and managing irrigation include the irrigation method, the optimal irrigation system, the effect of different systems on water management, plant/water relationships, root distribution, water demand, irrigation frequency, soil type and environment... Holzapfel investigated furrow, sprinkler (pivot), microjet and drip irrigation systems. It was reported that mulch significantly reduced the salt content of the soil and. reduced the water requirement by 20%.

A water balance approach is better for scheduling, rather than capacitance probes. To determine water demand, use pan evaporation, meteorological stations and empirical equations, eg ET.

David Bryla (USDA Corvallis, Oregon) 'Irrigation management effects on yield and fruit quality of highbush blueberry'
Currently in Corvallis 90% of blueberries are irrigated by sprinklers and 10% are on drip. Recommendations for irrigation are to water 25-50mm/week, applied every 1-7 days as needed. A study was set up to compare 3 irrigation systems – drip, sprinklers, microsprays, using two cultivars, *Elliot* and *Duke*. Three irrigation rates – 100% Evapotranspiration (Etc) (optimum), 50% Etc (defecit) and 150% Etc (excessive) were applied. Berries were firmer in 2006 than 2007 but firmness generally decreased as more irrigation was applied. Berries were firmer with sprinklers than drip. Brix was higher with under-irrigation by sprinklers and microsprays, suggesting water stress increased Brix. Titratable acidity was higher with under-irrigation by sprinklers and microsprays. Bryla suggested that drip irrigation (2L/h@ 0.3 m spacing, 2-3 times/week) is a more efficient system, with improved yields but more care is required to not over-irrigate as berry firmness is reduced and can affect quality in storage and transport**.**

Tommaso Eccher (Universita degli Studi, Italy) 'Long term effects of ericoid endomycorrhizae on the growth of micropropagated plants of *Vaccinium corymbosum* L. in the field'
Most ericaceous plants develop mycorrhizae in the field. Micropropagated plants are aseptic and are scarcely infected even when planted in the nursery. Eccher designed procedures to inoculate the fungi into the roots (in vitro) of micropropagated plants in the 1990s. In 1999, about 1000 different cultivars were inoculated with 10 different fungal strains. There were significant interactions between cultivar and strain. The present study looked at the growth of plants inoculated and grown for 8 years in the field (at 3 different locations in Lombardy). Cultivars used were *Atlantic, Berkeley, Bluehaven, Blueray, Herbert, Lateblue* and *Tophat.* Plants inoculated with different strains of mycorrhizae showed a long term interaction. Some of the strains which increased the growth of a cultivar were ineffective or even decreased the growth of others. Significant interactions were found between fungal strain, environment, and soil conditions.

Alexis Vega (Universidad Mayor, Chile) 'Blueberry mycorrhizal symbiosis outside of the boundaries of natural dispersion for ericaceous plants in Chile'
Blueberries growing in Chile occur in areas not typically suitable to blueberries, eg soil pH over 7.5. Technical solutions have been developed to overcome some of these problems. Little attention has been given to mycorrhizal fungi so studies have been designed to assess the importance of these fungi in Mediterranean environments with no native Ericaceous plants. Vega's study used one year old tissue culture propagated or cutting propagated Southern highbush (cv *O'Neal*). The plants were inoculated with one of three treatments: 1) Commercial inoculum;, 2) VAM inoculum; or 3) field blueberries' mycorrhizal roots (ER mycorrhiza). It was observed that field blueberry plants formed mycorrhiza with native arbuscular and ectomycorrhizal fungi with a lower percentage of infection. In a pot study on 2 month old plants with and without mycorrhizal inoculation, there were varying results with no clear trends. VAM (vesicular arbuscular mycorrhizae) were able to infect blueberry plants both in the field and in the greenhouse. There was no difference in plant growth with or without mycorrhiza.

David Yarborough (University of Maine, USA) 'Organic production of wild blueberries II fertility and weed management'

A study on organic low bush blueberries (*Vaccinium angustifolium*) had treatments of: Sulfur (applied at 0 or 1000lb/acre); Pruning methods (mow or burn)and Fertiliser applications (0, 22 and 45 kgN/ha). Sulfur lowered the pH each year to a toal of 0.7 units after 3 years. Leaf N and P were not affected by sulphur or pruning methods, but were increased by the higher rate of fertilisers after the 2nd year pruning. Mowed treatments had significantly higher grass and broadleaf weed cover than burned treatments. Sulfur reduced the weed cover (although it also increased aluminium to 300ppm), no and low fertiliser rates also reduced the weed cover. Soil pH of 4 still supported blueberries but reduced the weeds (and also decreased nutrient availability). Organic yields were still much lower than conventional fields. Burned plots had higher yields than the mowed plots. Combining burn and sulphur interaction increased yield by 3 times.

Evaluation and Discussion of site visits

The following evaluations and discussion summaries were compiled as tour participants debriefing notes on the most notable information gained during each site or farm visit. Group summaries were compiled after leaving each enterprise as a regular daily debriefing. Key implications for the Australian blueberry industry were included for each visit.

Summary

Location Visited:

1. Steve Erickson**,** Pan American Berry growers
   6826 55th Ave. Salem, Or.

2. Paul and Sandy Norris, Norris Farms,
   8181 Oakhill Rd, Or. 97470

3. Stan Danskey, E & S Farms Inc. Woodburn, Or.

4. David Brazelton, Fall Creek Nursery, 39318 Jasper-Lowell Rd, Lowell Or. 97452

5. Willamette Research & Extension Centre, Oregon State University Site 15210 Milney Rd. Aurora, Or. 97002

6. Sandy Davis, Forbidden Fruit Orchard, Cebada Canyon Road, Lompoc Ca. 9346

7. Rachel Whitney, Southern Highbush Blueberries
401 Lamberts Rd, Carpinteria, Santa Barbara Ca. 93013

8. Will Gerry, 2388 Gerry Rd. Camarillo Ca. 93010

9. Stahlbush Island Farms Corvallis (during conference) Or.

10. Lagomarsimo Farms, Reedley, Ca.

11. Kearney Agricultural Research Centre, University of California, Parlier, Ca

Farm Summaries

Date: 10 -22 July 2008 **Farm Sizes:** 3-100 ha

Harvesting methods

Hand harvesting is the most common method for the fresh market produce. When prices drop in the market, machine harvesting is used for fresh markets. Once berries get soft, machine harvesting is used for the processed market. Machine harvesting also occurs at night as it is cooler.

Watering methods

Most growers use a double drip line. Overhead sprinklers were the preferred method but most now only use overhead sprinklers to cool fruit or minimise frost damage. A range of electronic moisture monitoring devices is used to measure soil moisture levels and schedule irrigation. In California's Central Valley, all water is from underground aquifers with a high pH (7-8). All water is acidified before and during fertigation.

Bird controls

A range of different devices are used including cannons, balloons, kites, electronic distress calls. No netting is used as it is too expensive for large orchards. The use of falconers with tame birds has been tried with some success.

Varieties: The major varieties grown are;
Northern Highbush; *Duke (machine) Bluecrop, Bluejay, Brigitta, (newer varieties) Aurora, Liberty, Ozarkblue, Draper, Bluegold*.
Southern Highbush; *Star, O'Neil, Emerald, Snowchaser, Jewel, Springhigh, Misty.*
All plants supplied from Fall Creek Nursery are from tissue culture.

Fertilisers

Fertilisers were applied by fertigation and granular if growers use organic mulches. N Furic is supplied through drippers in areas with high pH soils or water. Up to 170kgN/year is applied.

Yield Tonnages

In some larger sheds in Oregon they pack 1818 kg/hr or 45.5 t/day. Pickers can harvest up to 227kg/person/day. This must be a strip pick! No sorting! In Australia we pick 40-60kg/day. Yields for *Duke* in Oregon are around 15t/ha for a middle pick.

Marketing

Marketing is done through major companies such as Hirst, Sunnyridge Farms, Driscoll's and Hortifruit. These companies deal in berry fruit supply and marketing worldwide. Their product goes to USA, Europe, Japan, Hong Kong and UK. Most growers supply fruit to fresh and process markets. Starhlbush Island Farms had customers that demanded 12 different grades of product for selling. Small berries less than 12 mm are generally best for processing. Smaller growers sell to specialty shops or farmer's markets if close to major population centres e.g. L.A. or Portland. In some areas they can attend a market every day of the week.

Harvest Time

In the northern hemisphere harvest begins in coastal California and Florida in April then California's Central Valley in late April-May. In Oregon and north east USA, harvest is July to August. There is a move to plant blueberries in Mexico which will give an earlier crop and also possibly a late one (April- October).

Cultural Practices

For machine harvesting to be cost effective growers need a minimum of 30 acres (12 Ha.). A *Litteau* harvester produced in Oregon cost around $142,000 US and requires reasonably flat ground (slopes of less than 10 degrees) to operate on.. While in Australia we normally do a field sort before sending product to the packhouse, this is not routinely practiced in USA due to high labour costs. Product is usually colour sorted on the packing line and hand sorted to remove inferior quality product that passed through.

All farms we visited incorporate sawdust into mounds when planting and then covered the mounds with organic mulches. The organic mulches used consisted of material that was low cost and easily obtained in different regions. Research is being conducted at Oregon State University and Kearney research station in California using plastic mulches or weedmat to reduce labour costs for weed control.
In Australia the use of weedmat on blueberry mounds has been the standard practice. Plastic weedmat has created problems associated with redeveloping blueberry mounds every 7-8 years. The weedmat is not able to be reused resulting in piles of plastic waste that either goes to landfill or gets stored on farm. We are returning to using organic mulches instead of plastic weedmat in Australia. Organic mulch is more expensive but it also has many plant and soil health benefits.

Growers usually deflower plants in year 1 and year 2 with southern highbush to help with their establishment. Pruning is commonly done on lower parts of the plants to help with machine harvesting. This allows the apron on the machine to fit snugly around the tree butt which minimises berry losses on the ground during harvesting. Trellising is common in both southern and northern highbush varieties. This helps with harvesting but also allows better orchard and berry quality management by keeping laterals upright. It has a dual role, carrying the irrigation drip line. This adjustable trellis can be raised and lowered. It could be useful for Australian growers but unfortunately in northern NSW growers renew their mounded rows every 7-8 years. This would add a significant extra cost burden to these growers. It may be useful for Victorian growers.

Issues

Shock virus was observed on *Liberty* plants in a number of regions in Oregon. The virus infects whole laterals and causes fruit and leaves to fall. The plant recovers and grows out of it once it has been infected. It is thought to be pollen transferred. It may infect single limbs or all limbs that if left will become healthy in subsequent years. Australia does not yet have this virus problem.

Growers in the US are having trouble getting sufficient European honeybees to pollinate their blueberry plants. In recent years there has been a decline in bee numbers. Growers are encouraging Blue Orchard Mason bees and bumblebees in to

their orchards. Research has shown that these 'buzz' bees are better at pollinating crops such as blueberries that have very small flowers.

The tour group visited two organic farms in USA. Only part of one farm was organic while the other section was a conventional farm. The certified organic section of the farm had to be defined by a boundary fence. Blueberry rows were required to run on the contour for organic certification. The other organic property had a Sustainable certification.. *Food Alliance* is a non-profit organization that certifies farms processors and distributors for sustainable agricultural and business practices. These businesses use *Food Alliance* certification to make creditable claims for social and environmental responsibility, to differentiate product and to protect and enhance brands. To gain certification, suppliers need to:

- Provide safe and fair working conditions
- Ensure health and humane treatment of animals
- Use no genetically modified crops
- Reduce pesticide use
- Protect soil and water quality
- Protect wildlife
- Improve management practices

Key information gained from farm visits applicable to the Australian Blueberry Industry (Grower comments)

The manager (Steve Erickson) at Pan Pacific told us that "**it would be an economic disaster if the retailers started to demand particular varieties of blueberries**". This might be good for a retailer to have a point of difference to gain a market advantage, but the disaster would be for the growers who have dozens of different varieties to sell. Steve said that they sold blueberries by fruit characteristics and wanted to continue to do so.

Addition of organic matter before planting is something that should be considered in Australia, particularly with most of our soils being lower in organic matter than most US soils.

We saw **solid blocks of varieties** planted at Pan American Farms. This shows that for these varieties at least, there was no need for cross-pollination. This simplifies the harvesting regime with all varieties in a block being the same.

Lower prices of retail fruit in the USA should warn Australian growers that **the high prices that Australian growers receive will come under pressure** if or when more foreign fruit comes into Australia.

"The **mechanical harvesting of fruit** for the fresh market was the most striking aspect of this farm visit." Some machine harvesting was done at night as it is cooler. The **increasing cost of labour in the US** is driving them to more mechanisation. The use of mechanical harvesting, mechanical sorting and packaging are two examples of mechanisation that we saw at Pam American Farms. **The need to use more mechanisation in Australia is obvious** considering that Australian labour is twice the cost of American labour and far less available. The **use of guest foreign workers** in Australia is something that we can adopt from the American experience.

This grower had 100 to120 workers living on the property. Due to the range of crops that he grew, there was a **variety of work for most of the year**. Having **on-farm accommodation** gave a more permanent structure to the work force

The hand picking methods appeared to produce fruit of similar quality to mechanically harvested fruit. It is not that the mechanically harvested fruit was very high quality, more that the **hand harvested fruit was very rough**. The owner told us that he had pickers that could pick up to 500lbs of fruit per day. This astonished most people present including other Americans. Hand picking at Norris Farms was less of a sorting process than just a harvesting process. This called for a much higher rejection rate in the sorting and packaging room. Norris Farms **hand harvested plants at least twice before the mechanical harvester went through** for the fresh market fruit. Once there was soft fruit on the plants, the mechanically harvested fruit went to processing quality. **Using this technology in Australia could lower production costs** for the producer meaning that blueberries may be consumed in larger amounts by a greater number of consumers. At the retail prices that we saw in America, the growers would be only able to pay their pickers and make no money at all for themselves.

At Pan American Farms in Oregon they **harvest before the dew has evaporated off** the fruit in the morning. Steve believes that this is possible because the water dries off the fruit in their packing environment. This was of great interest especially when a paper was delivered at the symposium on post harvest that state emphatically that **dew covered fruit did not store as well.**

The growing of Rabbiteyes in Oregon is quite unusual as they were **grown in plastic tunnels.** The tunnels had not had plastic on them since last year because of wind damage. The tunnels protected the crop from frost and advanced ripening by 2-4 weeks.

The **use of overhead watering in conjunction with drip** was interesting. The overhead sprinklers were u**sed for frost protection as well as establishment and cooling in extreme heat**. The necessity of **very clean water for the sprinklers** was made clear. Dirty water marks the fruit. **Constant overhead watering is conducive to disease**, thus the drip system supplies the bulk of the irrigation. Agents wanted growers to use drip irrigation to minimise diseases such as *Pseudomonas* showing up on fruit as small marks.

The **vertical integration** involved in this business (Stahlbush Island Farms) could be a lesson for Australians. Where we become so specialised in Australia, we open ourselves to the danger of going out of business when other businesses change that we rely on. This business made its own harvesters and most other specialised machinery. The fruit and vegetables that they grew were all value added by the company.
A huge range of crops were grown and marketed. This is very atypical of most Australian farming.

Nursery Summary

Farm/Location Visited: David Brazelton Fall Creek Nursery, 39318 Jasper-Lowell Rd, Lowell Oregon 97452

Date: 11th July

Background Information

Fall Creek Nursery supplies the whole of the mid-west to western part of USA with blueberry plants. There are four associated nursery locations that multiply plants and grow them on which total 40 ha in size. Plants are tissue cultured at one location then grown out at another. Stock comes in from breeders and is checked for diseases. Only the nursery is able to multiply up the lines of varieties that are supplied. They have 55 different blueberry varieties that are being multiplied for various locations. Ninety five percent of the plants produced are tissue cultured which equates to 1 million plants per year. To gain access to the nursery there are special entry requirements. Footbaths are used for all personnel so on farm diseases are not transferred to the nursery.

This nursery has the capacity to produce both northern highbush and southern highbush at the one location. Southern highbush are frost sensitive and are grown under cover to avoid the below zero winters.

The potting mix used is made up from three products sourced locally - Douglas Fir bark, pumice and peat moss. Douglas Fir bark is supposed to suppress root rot.

We saw large boxes of plants on palettes that were being readied for shipment being packed with 340 five or six inch bags being laid on their side. Smaller plants in tube tray cells were also being made ready for shipment in cardboard boxes. 300 smaller plants are packed per box with 12,000 plants to a palette. Commercial growers in the mid-west are sent plants in the September to October period while growers in California are sent plants in November. The nursery has the capacity to store plants at 1-2^{o}C which means that orders can be produced ahead of time and then sent out to the grower when required. Fall Creek has international customers and plants can be sea freighted for 2-3 months if they are kept refrigerated at 1-2 ^{o}C. The nursery also markets advanced plants to other nurseries and retail outlets for the home garden trade. We were told it was quite a lucrative business and customers get introduced to the taste of blueberries.

The nursery has a call out service for commercial growers that can advise on best planting practice and guarantee their delivered product.

Key information gained from nursery visit applicable to the Australian Blueberry Industry (Grower comments)

The **growing of most plants from tissue culture** was an eye opener. When we saw plants at Pan American that were growing side by side, we could see that tissue cultured plants were far more vigorous than cutting grown plants. This is a lesson for Australia where tissue cultured plants are a rarity.

The **stock plants are kept in an insect free environment**, only four stock plants per variety.

The evergreen low chill varieties were able to be grown in this cold winter climate by **having them housed through the winter under plastic**.

The **age-old problem of pots drying out on block edges was overcome by a drip line** on the edge pots to supplement overhead sprinklers.

The gallon containers that the **majority of the plants were grown in were plastic bags**, which are rarely used in Australia. New Zealand has always used a lot of bags. They are **more labour intensive to fill than a rigid pot**. **American labour is cheaper than ours**. The new containers that they were moving to were a very light rigid pot from China.

The **palletised shipment of plants** is a great idea along **with the cooling of plants** to delay development for later shipments at the correct planting time are ideas we could use in Australia.

Research Station Visits

Location: Willamette Research & Extension Centre, (NWREC) Oregon State University Site (OSU)15210 Milney Rd. Aurora, Oregon 97002

Date: 10th July

Farm size

65 ha.

Research

Berry Crops Production/physiology research program

Dr Bernadine Strik conducts state-wide extension educational programs for the commercial berry crop industries (blueberries, blackberries, raspberries, strawberries, cranberries, hardy kiwifruit, and minor berries) and teaches undergraduate and graduate students from her campus office in the Department of Horticulture, OSU, Corvallis. In addition, she is the Berry Crops Research Leader at the NWREC with research interests focusing on whole plant physiology, improving yield and quality, machine harvest efficiency, alternative production practices, plant nutrition, and cold hardiness of all berry crops. Bernadine serves as the OSU lead on the UDA – ARS Cooperative Breeding program for berries. A summary of research program activates is available at: http://oregonstate.edu/dept/NWREC/Staff/Strik/Strik.html

Management of organic blueberry production

Objectives: Conventional and organic blueberries have been established at NWREC for research on:

- The effect of raised beds on soil and plant water status, plant growth and economic feasibility
- The effectiveness of organic fertilizer treatments at various rates for yield, plant nutrient status, and growth
- Whether an early and late fruiting cultivar differ in management under organics
- Economic analysis and comparisons among treatments at end of study
- Comparison of weed management treatments and organic production systems on the growth of 10 blueberry cultivars with compost incorporated pre-plant

Treatments applied

Planting methods, cultivars, weed management and fertiliser treatments are being investigated

A. Raised or flat beds
B. Cultivars: Duke or Liberty
C. Three weed management approaches:
   1) sawdust mulch (75-100mm) + hand (or mechanical) weed management
   2) compost (yard debris 25-50mm deep) + 50mm sawdust mulch + organic vinegar) 20%)

3) weedmat fabric with sawdust mulch in the 200mm diameter plant hole

D. Organic fertilisation
   1) Feather meal at 2 rates
   2) liquid fish fertilizer at 2 rates

Using Grafted Blueberries to Improve Mechanical Harvesting

Principle Investigator: Wei Q. Yang

A 1000m² field *Vaccinium elliotti* plot was established at the NWREC in late 2005. The experimental plot was under drip irrigation and fertilised with 10kg and 56 kg of N, P, K using triple 16 fertiliser in 2006 and 2007, respectively. Three inch deep and 4 feet wide sawdust mulch was applied to control weeds within the planting row. Two hundred fifty *V. elliottii* plants of three selections (NC823-2, NC284-5, and NC824-8) from Dr James Ballington of North Carolina State University were used for this study.

Objectives

- To develop small fruit cultivars for the Pacific Northwest commercial, processing industry
- Collect and evaluate germplasm, and when useful to incorporate this germplasm into advanced breeding material for the use in Willamette and other breeding programs.

For further details, see
http://ars.usda.gov/pandp/people/people.htm?personid=1718

Blueberry Cultivar Evaluation

Principle investigators: Chad Finn and Bernadine Strik

Initially planted in 1990, this ongoing blueberry trial has been an extremely valuable source of information on the performance in the Northwest of blueberry selections developed elsewhere and more recently, of selections developed by the cooperative USDA – ARS/OSU breeding program. Currently, dozens of selections are in trial with standards such as *Duke*, *Bluecrop* and *Elliott*. Each year yield data are collected and observational notes made. This information comes from researchers and growers to make recommendations on which selections perform well and which should be discarded. Since this trial was established over 138 genotypes (64 cultivars) have been evaluated and currently there are 78 genotypes in trial.

Replicated trials

2000 trial

Aurora and *Draper* look 'very nice' in Oregon. '*Aurora*' is sweeter than Elliott but it is 5 – 7 days later. '*Draper*' has very nice quality but can be erratic from plant to plant with some pollination problems in some years.

2001 trial

Liberty appears to have good yields and provides an alternative to *Ozarkblue*. The fruit quality is excellent and while the fruit are somewhat flattened they are attractive with good flavour.

Rabbiteye Trial
'*Ochlockonee*' and '*Powderblue*' are the most promising
'*Maru*', *Rah*i and *Onslow* while very large fruited are poorly shaped and low yields

Location Visited: Kearney Agricultural Research Centre, University of California, Parlier

Date: 17th July

Background

The region is known for very sandy soils with pH 7 – 8 and low organic matter. Soil has hardpan impermeable under lying layer. Winter rain is the predominant rainfall which averages 250 mm /year. Groundwater is used for irrigation but is high in bi-carbonates. There are a total of 2000 ha blueberries in San Joaquin Valley and these are mainly southern highbush varieties. The San Joaquin Valley of California aims to harvest fruit for the early market when prices are still high. Harvest in this area starts after coastal California and Florida in April-May. They plan to harvest before high chill production in Oregon begins. Water for irrigation is predominantly ground water with a pH of 7-8. This needs to be acidified regularly to be useful for blueberry production. Our host at this site was Extension Officer, Manuel Jimenez.
.
The crops researched at Kearney are; low chill stone fruit, vegetables, tropical fruits, blueberries and grapes.

Size: 280 acres (112 ha). 90 staff

Blueberry Research

The main areas of research for blueberries are;

- Economics of using hoop houses to advance the harvest
- Organic mulch trials to assess longevity of mulches
- Organic mulches compared to plastic mulches benefits and costs
- Planting trials incorporating mulches into mounds before planting
- Pruning methods and timing to concentrate flowering and advance harvest
- Effects of high soil pH on mature blueberry plantings by the addition of lime.

Varieties

The main varieties grown in this region are similar to coastal California including;
Star, Reveille, Centurion, South Moon, Misty, Emerald, Legacy.
Emerald has a problem with prolonged flowering.
Star is excellent as it has a condensed flowering period and good flavour.
South Moon is a Florida variety that has high crunch.
Maru – poor variety

Mulching trials (Toxicity)

This trial is to test various organic mulches for acceptability and toxicity. In this region there are few low-cost organic mulch options. Many stone fruit orchards are being removed which may offer a possible source of organic mulch. In 18 months

organic mulch usually disappears as it breaks down in the soil. Organic matter in local soils is extremely low at less than 1%. The main organic mulches used are chipped peach trees, bark, pine, sawdust, pinebark fines. The mulch is spread out and incorporated into the mound. Interrows are usually covered with mulch as ground covers do not survive the harsh dry climate.

New planting system

Soils in this region have a hard pan impermeable layer approximately half a metre below the soil surface. The surface soil is very loose and well drained. Growers usually deep rip the soil to open this impermeable layer before planting blueberries. This is to reduce root rots during winter when water moves downwards then horizontally following this hard layer. Planting is usually done in Autumn. A mound is formed with a furrow down the centre. Organic mulch is laid in the furrow then young plants are planted into the centre of the mound. Plants are established with up to 50 mm of potted soil above the soil surface. In 6 months the mound is raised up to the plant surface and organic mulch is applied over the mound. This method is used to improve establishment and survival of new plants (*diagram)*

Plastic Hoop Houses

This research uses two varieties *Jewel* and *Star*. Star is preferred as it has a short concentrated harvest and flowering period and has acceptable eating qualities. The work focuses on using plastic hoop houses to advance the harvest time of the blueberries to hit the early market and also concentrate flowering in to a shorter period. This region harvests blueberries after coastal California and Florida (April May) and before Oregon. The cost of production in an evergreen system is more expensive than a deciduous system so growers here need to finish harvesting before high chill areas begin. If they can advance the harvest even a few weeks it will fill a void in the marketplace. The preliminary costing to produce fruit in plastic tunnels is $25,000 /ha. It is not economical even with the higher prices gained for early fruit. Growers in California are now interested in growing blueberries in Mexico for two reasons; to take advantage of their lower labour costs and, by moving further south, the crop is advanced into the early April, high value market.

Economics of using plastic mulch and organic mulches

After 4 years there is no difference in size of the plants with organic mulch or plastic weedmat. Plants with plastic weedmat mulch show a decline in yields. Under organic mulches there are no measured changes in yields.

Key points

Many Blueberry growers are smaller farmers, so they need ways to start up with reduced costs.

Mulch is difficult to source in this region so stone fruit trees are being used but their toxicity is unknown.

Current recommendations are to prune heavily in summer straight after harvest, then lightly in winter.

Many growers have solid blocks of one variety only. No pollinators.

Farm /Location visited: Oregon State University USDA National Clonal Germplasm Repository

Date: 15th July

David Bryla USDA Corvallis,Oregon
Research:Testing fertigation vs granular application of nutrients
The following fertiliser treatments were applied to mature blueberry plantings. Granular urea fertiliser applied with overhead sprinklers (1/3 April, 1/3 May, 1/3 June). Liquid fertiliser applied with drip tape with UN32 (liquid urea, ammonium sulphate, N furic (urea/sulphuric acid), weekly fertigation

All beds were mounded with sawdust mulch incorporated at mounding with a layer of sawdust as a mulch cover at planting.
Soil solution samplers were used to determine nitrate and ammonium concentrations under the root zone (at 10cm depth).
Granular fertilisers recorded huge peaks of soil ammonium when it was applied (600-1000ppm). However, fertigated soil) remained low and constant (1-2ppm).
Salinity was recorded at two levels. Salt levels of 3 dS/m stresses blueberry plants while levels of 10 dS /m or greater will cause death.

Fertigated soils recorded no deaths from salinity levels which averaged low levels at 1dS/m salinity.
The pH levels were originally at 6.5 so 2 tonnes Sulfur was applied (split application) to bring down pH to 6 at planting. Fertigated soils further reduced pH to 4.5 (at the high N treatment due to the acidifying nature of the N fertiliser).

David proposes that many of the existing recommendations for blueberries regarding preferential nitrogen uptake by blueberry plants in the nitrate or ammonium forms are incorrect. He further states that more work needs to be done to verify this.

Key information gained from nursery visit applicable to the Australian Blueberry Industry (Grower comments)

The idea that excited me the most here was being able to grow blueberries in a soil and climatic environment that I would have thought was very unfriendly to blueberries (California). This opens up the **possibility to grow blueberries in many other parts of Australia where we previously thought that they would not grow provided water is not limiting.** Places such as Kumbia, Emerald and St. George in Queensland would suit southern highbush evergreen blueberry growing. These areas get sufficient winter chill but do not get the humidity and constant showers that delay coastal picking in northern NSW.

The **method of planting into a trench** was interesting. The plant is placed on the top of the planting mound with a trench through the middle that is later filled with mulch after being planted with the top 20cm of the root ball out of the soil.

The **use of vinegar as a weedicide** is interesting. It has been used for some years to kill liverwort in pots, it works well. I don't think that it works well on established weeds.

The **close planting trial at the research station** has changed the industry. Everywhere that we went they were planting at 750mm, whereas this would have been 1500mm before the Oregon trials were done. **It is even more imperative to closer plant in Australia, than in America. We have invested more in an area under netting and need the faster return on money that closer planting gives.**

The Americans could learn a lot from seeing the way that we net in Australia. **All the netting that we saw in the US was very poorly erected.**

Farmers markets seem very important in US. It seems that people happily pay more for fruit outside of a supermarket. This is a lesson for Australians.

The **concept of using falconers** in Australia is worth some study. It seemed that this is the most effective form of bird control other than netting. In areas that were big enough to justify the expenditure, where snow was a problem, perhaps falconry is the answer.

The problems with neighbours and the "Right to Farm" in an area is similar to areas in Australia on urban fringes except **the document that new urban dwellers sign is an agreement that has teeth in favour of agriculture.**

Most properties used **adjustable trellis wires to suspend the drip lines** which were a good idea. The extra twisted loops that were coiled on the drip line have to be used however, to make sure that the drips don't run along the line before falling to the soil. It was easy to inspect drippers if they were clogged.

Summaries and recommendations for the Australian Blueberry Industry

Marketing

1. Increased demand for blueberries

Australia currently markets fresh blueberries in 125 gram clear clam shell containers. It was observed that in US fruit and vegetable retail outlets, blueberries were sold in a range of containers to suit consumer demands. The packages ranged from 880g (2US lbs), 450g (1USlbs) and smaller 100g lunch box sized packs. In the farmers markets in Portland, produce was being sold in recycled one pint cardboard containers (¼ US lb). Produce was being marketed in mixed trays of berries (raspberries, blueberries, boysenberries) that not only looked really colourful but added another dimension to encourage customer sales. As volumes of product increase in Australia, prices will come down and we will need to have various ways to market our product.

Fig 1. Marketing in recycled punnets

Fig 2. Marketing through retail stores

Fig 3. Blueberry packs for school lunch boxes

2. South American competition

At present countries such as Argentina and Chile export blueberries by sea freight to the US market due to their counter season production. Chile has 10,500 hectares planted which includes 600 hectares of southern highbush. Chilean export markets in the northern hemisphere are similar markets to Australian markets. They export Southern Highbush varieties to the USA and UK in September –November. They also have the capacity to hold fruit picked later in the season to take advantage of the February –April period in the USA before their Californian or Mexican product begins to harvest. Chilean cost of production however is much lower than Australian due to lower labour costs. Chile signed a free trade agreement (FTA) with Australia in 2008. Even with this FTA signing it does not mean that Chile will automatically gain

access to the Australian blueberry market. Biosecurity Australia will independently manage phytosanitary conditions before access is granted. We will never be able to compete with Chile or other South American countries on cost alone. We will only compete on quality or social equity issues. (eg.. the rights of workers in developing countries to earn a decent wage)

3. Anthocyanin levels

The paper **Evaluation of quality and nutraceutical content in blueberries (*Vaccinium corrymbosum*) by near and mid-infrared spectroscopy** presented at the symposium described methods to easily identify anthocyanin levels in blueberries. This work to identify varieties high in anthocyanins levels may be a blessing for agents wishing to distinguish varieties for a point of sale different but may be a disaster for growers. This may open a huge 'can of worms' if agents wish to purchase product on the antioxidant levels of ripe fruit varieties. If they are able to distinguish varieties high in antioxidant levels, will they pay more or less for fruit with higher or lower levels? Varieties always differ throughout the season and from season to season with their levels of antioxidant. This may in fact act as a trade barrier and restrict market access. If breeders are selecting new varieties on anthocyanin levels as well as quality at the initial stage then growers may benefit if these varieties are publically available. Growers using a hand held NIR device may also be helped in terms of knowing when to pick fruit at the optimum time when there is a maximum anthocyanin level in fruit.

4. Mechanical harvesting

Greater use of more mechanical harvesting, packing and sorting equipment will need to be used in future to lower production costs. This suggests that growers will need to work together to have sufficient volumes to pack to justify the expense. Orchards will need to be set up for mechanical harvesting. Varieties will play a major part in allowing mechanical harvesting like the northern highbush variety '*Duke*' in the U.S. that can be picked in one go. This will mean contracted flowering varieties will be preferred.

Fig 4. Large machine harvester in Oregon

Orchard management opportunities

5. Trellis system

In many blueberry orchards both high and low chill producing areas growers using an adjustable trellis wire system that was supported on posts 300 to 500 mm above the beds. This had a dual purpose. One was to support the plants and keep the long laterals with fruit upright and off the ground due to food safety issues. The second

was to use the trellis to attach a double drip line which allowed growers to see if drippers are actually functioning. A small plastic coil spring is used to stop the water running along the drip pipe. The upright nature of the plants with the trellis system, aids with herbiciding weeds on top of the raised beds without affecting blueberry plants. This system would be useful for Rabbiteye varieties and for northern highbush varieties. However, it may problematic for northern NSW where beds are redeveloped every 7-8 years.

Fig 5. Adjustable trellis system used in Oregon

6. Organic mulch

On almost every farm we visited both in high and low chill areas growers routinely incorporate organic mulch into mounds before planting. The mulch used is in the majority of cases the cheapest or most abundant substance available in that region. Many soils in California and Oregon were low in organic matter. Incorporation of a carbon source is essential for optimum plant growth and root development. In Australia it would also benefit growers on similar soils or heavy soils that may help to minimise root diseases and waterlogging. Our recommendations have always been to incorporate a green manure crop before mounding blueberry beds. This needs careful planning and needs to be done at least 12 months before mounding takes place which does not always suit many operators who like to maximise their returns by getting plants back in the ground as soon as possible.

Fig 6. & 7.Organic mulches used both in the interrow and on mounded beds

7. Small machine harvesting

The use of small machine harvesters to lower production costs in Australia is vital for long term survival of the industry. This will hinge on obtaining varieties that are able to be machine harvested for the fresh and processed market like '*Duke*'. It would also necessitate the use of varieties with a narrow flowering and harvest period.

Fig 8. Small machine harvester pulled by a tractor

8. Spray equipment

Over row spray equipment was observed on one farm. It was pulled by a quad bike and is something similar to what is currently used in the grape industry in Australia. It allows growers to spray while minimising spray drift. Overspray is collected by trays at the bottom of the unit and recycled back into the spray tank. It was very effective and would cut spray time and could be adapted to use here. The narrow row spacing of many orchards would allow smaller machinery to be used effectively. If permanent netting is used the smaller equipment would not interfere with the netting.

Fig 9. Over row spray equipment

9. Netting

Netting costs in Australia are one of the limiting factors to industry expansion. Most commercial blueberry orchards in Australia are netted as opposed to those we saw in USA where most are not. The main reasons for this are the cost and, in areas with heavy snowfalls, netting would collapse under the weight of snow. Most growers in USA have been using electronic bird distress scare noises located in the orchard as well as bird kites, gas guns and balloons. All are unsatisfactory at stopping bird damage to the crop. There was a suggestion by one large grower to use a falconer as a contractor who would be employed to keep birds at bay. It was tried by one operator with some success this season.


Fig 10. &11 Bird scaring devices in use in Oregon blueberry orchard

10. Overhead sprinklers

Overhead sprinklers were used for late season frost protection or to cool fruit if the temperatures are over 30ºC in the orchard. All growers we saw used drip irrigation for regular fertigation or irrigation. Most irrigation was done with a double drip line suspended above the ground. A paper delivered by Dr David Bryla "**Irrigation management effects on yield and fruit quality of highbush blueberry"** was quite succinct on this topic: *'Recommendations are that drip is a more efficient system, with improved yields but more care is required to not over-irrigate as berry firmness is reduced and can affect quality in storage and transport.'*

11. Tissue culture plants

The growing of most blueberry plants in western USA from tissue culture was an eye opener. We saw plants at Pan American Farms that were growing side by side with non-tissue cultured plants. We could see that tissue cultured plants were far more vigorous, uniform and advanced than cutting grown plants of the same age. This could be a lesson for Australia where tissue cultured plants are rare. This may be a method for Australian producers to provide the industry with cheaper healthier plants with better establishment potential.

12. Close planting of highbush

The high cost of establishing a blueberry block has forced growers to use close planting within rows. This helps to combat weeds and provide good returns from limited space. In Oregon and California, plants within a row are spaced between 600mm and 800 mm. At both Kearney research station and Oregon State University, high densities plant trials on northern and southern highbush were being conducted. The high density plantings gave growers better returns provided growers were prepared to regularly prune heavily. In Australia, the high costs of establishment and netting means that growers should be maximising their returns with high density plantings.

13. Solid blocks of one variety.

After visiting both research stations and grower properties in a number of areas of west coast USA and seeing large blocks of single varieties, I am not convinced that information commonly available to blueberry growers on the necessity of planting multiple varieties in a block for pollination purposes is correct. However, for Rabbiteyes, this may be necessary for pollination.

Industry Communications Strategy

1. A copy of this final report will be submitted to both Horticulture Australia limited and to the Australian Blueberry Growers Association to store in their library as a future reference for growers to access.

2. All attendees on the study tour will supply two journal articles that are to be published in the industry journal over the next 12 months. Two articles for each journal will be submitted by the industry development officer in NSW.

3. An article on the major outcomes of the study tour will be in The Land in October 2008(see appendix).

4. A summary of the symposium and study tour will be presented to industry at the AGM on 15th October in Melbourne.

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Appendices

Appendix I

Agriculture Today Article October 2008

Blueberry growers see bright future

A group of blueberry growers and researchers from NSW and Victoria recently returned from an International Blueberry Symposium in Portland Oregon in the USA full of confidence for the future of the Australian industry.

Group leader, NSW DPI District Horticulturist Phil Wilk said that the tour and symposium was a real eye opener.

“There is still a huge potential unmet demand for blueberries world wide. Countries such as China and Chile are planting large orchards to meet this worldwide demand.”

“While some countries have been growing blueberries for many decades, the well publicised nutraceutical benefits attributed to blueberries in recent times has resulted in demand outstripping supplies and many countries are now expanding their production from cooler temperate regions to milder sub tropical areas.

This movement into warmer regions has been to provide year round supplies of blueberries to the market due to the increased demand.

This trend has also occurred in Australia, with the major blueberry production areas now in northern NSW in the Lismore and Corindi areas which produce about 80% of the total Australian blueberry crop under sub tropical conditions. The remaining Australian production is in temperate areas of NSW, Victoria and Tasmania.

The major themes from the conference included minimising the cost of production for fresh product, varieties for non traditional growing regions and machine harvesting organic production systems, post harvest and fruit quality, plant nutrition and irrigation.

According to Mr Wilk, there were some key messages that came from the symposium for the Australian blueberry industry.

“Although China is counter-season to Australian production, Chile is not. Australia signed a free trade agreement with Chile in 2007 therefore we will expect them to be ‘knocking on our door’ in the next few years wanting to export produce. The cost of production in Chile is approximately half of the cost of production here in Australia.”

“In contrast to Australia, machine harvesting is very common in the USA. In many places, blueberry varieties are planted that can be hand picked when prices are ‘healthy’ and later machine harvested when the price drops.”

“There are producers in Australia that already machine harvest but only for the processing market. Orchard production systems need to be laid out for future machine

harvesting which may mean that steep land where many blueberries are now grown will not be desirable."

It may be necessary in future to harvest smaller farms using smaller mechanical harvesters owned by contractors or groups of growers. These tow behind machines are already being used on some properties in the USA for young plants. This will lower production costs which will then be passed onto the customer as well as increasing the per capita consumption of blueberries.

Australians already know of the health benefits of blueberries but average consumption still remains low. The Australian Blueberry Growers Associating is now investing grower funds in marketing and advertising campaigns to address the issue of low consumption.

The symposium in Corvallis at the Oregon State University campus had over 300 participants from over 16 countries including Finland, Holland, Germany, Latvia, Estonia, Morocco, Peru Argentina, Chile, Italy, Poland, China, USA, South Africa, New Zealand and Australia.

Preceding the symposium the growers visited a number of farms in the Willamette Valley in Oregon to view high chill blueberry production systems followed later by a post conference tour to the San Joaquin Valley in California to view low chill evergreen blueberry production systems.

Countries such as Australia and China are relative newcomers to blueberry production although blueberries have been produced in Australia from the mid 1970's in small quantities.

Short to medium term prospect for blueberries in Australia looks bright and if these issues are addressed, the long term future looks even brighter.

Fig 1. Small mechanical harvester

Fig 2. Participants on the blueberry study tour in Reedley California

Appendix II

Australian Blueberry Journal Spring 2008

To prune or not to prune? The question is when and how?

Penny Tideman, Ticoba Blueberries, Comboyne NSW. Attendee of 9th International Vaccinium Symposium and USA blueberry tour July 2008.

Having just completed pruning our 6 ha of blueberries, pruning was on my mind when I joined the recent USA Blueberry tour. We all know that pruning can affect fruit size, crop yield and the harvesting date. So the question is, how can we get a high yield of good sized fruit, early in the season from the varieties we grow?

Knowing ***when*** to prune in colder areas, growing "northern high bush varieties" is relatively easy – during the winter when plants are dormant. This practise is followed by the blueberry growers we visited in Oregon, similar to most southern Australian growers.

For those of us growing Southern high bush, ***when*** is a much more difficult question. In California, all the growers we visited said they pruned in the summer, straight after harvest. Short of employing an army of pruners, in our experience, summer pruning can end up being late summer, autumn and early winter pruning.

So how critical is the timing? According to research presented at the Vaccinium Symposium and carried out by a team from the Pontificia Universidad Catolica de Chile, Santiago, Chile, it is extremely critical. They studied the effect of "Summer Pruning Date in Star, O'Neal and Elliot."[1] Basically their research showed that pruning carried out in mid December (straight after harvest) led to a greater number and length of lateral shoots, with more flower buds and finally larger berries. Just one month later, the length and number of lateral shoots decreased noticeably, and later pruning resulted in no increased lateral development.

What was surprising about this study was their finding that summer pruning did not bring on earlier ripening, but could even "delay harvest by up to 14 days comparing December pruning and the control (no pruning)". "Bloom time and first pick was delayed by 7 days when summer pruning was done in February." The conclusion is that immediate post-harvest summer pruning is important for yield, but delays harvesting dates. Furthermore, irrespective of the date it is done, summer pruning increases the size of the fruit.

The study also mentioned that summer pruning doesn't eliminate winter pruning. Most Californian growers said they pruned lightly in the summer and again in the winter. Both summer and winter pruning seemed to vary from just tipping back shoots to serious plant part and shoot removal. See photos of recent summer pruned "Legacy" at the Kearney Research Station, Reedley, compared with summer pruned (tipped) "Emerald" at Legomarsina Farm, both in the Central Valley, California.

Fig 1 Summer pruned Legacy at Kearney Research at Station Central Valley California

Fig 2 Recently (1 week) summer pruned Emerald Legomarsina Farm Central Valley California

The question of **how** to prune Southern Highbush remains debateable. It seems to lend itself to all types of pruning, with the different summer and winter pruning techniques mentioned above being just a few.

One of my particular interests was how to bring back the height of large bushes (2m+), particularly "Rabbiteyes", without seriously jeopardising yields. Manuel Jimenez, blueberry specialist with the Uni of California Kearney Agriculture Research Station recommended cutting back one side of the bush (at approx 45^{o} angle), leaving the other side virtually unpruned, allowing the unpruned side to still bear fruit. The unpruned side would then be cut back heavily the following year.

The only grower we met growing "Rabbiteye" varieties in Oregon, Stan Danskey from E& S Farms Inc. Salem, recommended pruning the Rabbiteyes quite hard immediately after harvest (summer pruning) followed by 5-6 tip prunings during the rest of the growing season to force bud bearing laterals to develop before winter. A study at the Universidad de Talca, Chile found that opening the canopy (of the Rabbiteyes) has the biggest impact on fruit quantity and quality. The more light, the more flower bud formation. [2]

Fig 3 Rabbiteye at E & S Farm, Oregon. Bushes approx 1.6m high. Hoops hold plastic during harvest period to prevent rain damage.

Standard pruning techniques are used by most Northern Highbush growers both in America and Australia. Research on pruning of both Northern and Southern Highbush is at present being done by Dr Bernadine Strik, co-convenor of the Vaccinium Symposium. A DVD "A grower's Guide to Pruning Highbush Blueberries" is

available from the ABGA Library or Phil Wilk, NSW DPI, which shows the basic principles of high bush pruning.

Surprisingly few farms engaged in mechanical pruning. All the farms we visited during this tour pruned by hand. Considering the size of many of the blueberry farms, several hundred hectares being regularly quoted, it is hard to image they can cope with the sheer volume of pruning without mechanical methods. America's low basic wage ($8 per hour) has something to do with it, but as many Symposium attendees comment, "times are changing, and labour costs will increase." As a result, just as new varieties are being bred to be more suitable for mechanical harvesting, new varieties are also being developed which respond well to mechanic pruning.

My thanks to Phil Wilk and Justine Cox for organising the tour, HAL for providing some financial support, and my co-participants for an informative and entertaining experience.

***References**:*

1. *The Effect of Summer Pruning Date in 'Star', O'Neal' and 'Elliot', Banados, Uriba & Donnay, Facultad de Agronomia, Departmento de Fruticultura y Enologia, Laboratorio de Investigacion & Desarrollo en Berries, Pontificia Univesidad Catolica de Chile, Santiago, Chile.*
2. *Light Environment within Mature Rabbiteye Blueberry Canopies Influences Flower Bud Formation, Yanex P, Retamales, JB & Del Pozo A, Instituto de Biologia Vegetal y Biotecnologia, Facultad de Ciencias Agrarias, Universidad de Talca, Chile.*

Appendix III

ISHS 9th International Blueberry Symposium Programme

9th International *Vaccinium* Symposium Schedule

9th International Vaccinium Symposium **Events will occur in or around the CH2M Hill Alumni Center, Oregon State University**		
Date and Time	**Program**	
Sunday 13 July	**Registration** 3:00 - 7:00 pm Foyer CH2M Hill Alumni Center	
6:00 – 9:30 pm	**Welcome Reception Dinner,** between CH2M Hill Alumni Center and LaSells Stewart Center. Casual dress, outdoor event featuring a menu of traditional Northwest fish barbecue and entertainment by Native American dancers	
Monday, July 14		
7:30 – 8:00 am	**Poster set-up foyer CH2M Hill Alumni Center, refreshments available**	
8:00 - 12:00 noon	**Registration**	
	Presenter(s)	**Title**
8:00 - 9:00 am	**Opening session**	
	Dr. Bernadine Strik, Professor, Department of Horticulture, Oregon State University and Dr. Chad Finn, Research Geneticist, US Department of Agriculture – Agricultural Research Service; Horticultural Crops Research Laboratory	Call to order: Convening of the meeting
	Dr. Norman Looney, President ISHS	ISHS Welcome
	Dr. Stella Coakley, Professor and Associate Dean, College of Agricultural Sciences, Oregon State University	Oregon State University Welcome
	Dr. Anita Azarenko, Head, Department of Horticulture, Oregon State University	Department of Horticulture Welcome
	Dr. Robert Martin, Research Leader USDA ARS Horticultural Crops Research Laboratory, Corvallis, Oregon	USDA Agricultural Research Service Welcome
9:00-9:30 am	Bob Donaldson, Chairman, Oregon Cranberry Growers' Association and David Brazelton, President, Fall Creek Farm and Nursery Inc., Lowell, Oregon	An Overview of the *Vaccinium* Industry in North America - Grower Perspective

	Session 1 - Post-harvest, Fruit Quality, Health Benefits, and Marketing	
	Moderator - David Brazelton, President, Fall Creek Farm and Nursery Inc., Lowell, Oregon	
9:30-10:00 am	OP01 Amy Howell	Update on Health Benefits of Cranberry and Blueberry
10:00 - 10:30 am	Break	
10:30-12:00 noon	**Session 2 - Post-harvest, Fruit Quality, Health Benefits, and Marketing**	
	Moderator - Jungmin Lee, USDA-ARS Horticultural Crops Research Laboratory, Parma, Idaho	
10:30-11:00 am	OP02 Charley Forney	Postharvest Issues in Blueberry and Cranberry and Methods to Improve Market-life
11:00 - 11:15 am	OP03 Charley Forney	Effects of Postharvest Light and ABA Treatments on the Composition of White Cranberry Fruit
11:15-11:30 am	OP04 Lara Giongo	A Three-Year Highbush Blueberry Survey in Different European Locations for the Fresh and Processing Markets.
11:30-11:45 am	OP05 Laura Jaakola	Molecular Aspects of Bilberry (*V. myrtillus*) Fruit Ripening
11:45-12:00 noon	OP06 Ernestina Casiraghi	Evaluation of Quality and Nutraceutical Content in Blueberries (*Vaccinium corymbosum*) by Near and Mid-infrared Spectroscopy
12:00 - 12:15 pm	OP07 Ross Penhallegon	Lingonberry Yield Trial for the Pacific Northwest
12:15-12:30	OP08 Bernadine Strik	The Economics of Establishing Blueberries for Organic Production in Oregon – a Comparison of Weed Management Systems
12:30 - 1:30 pm	Lunch	
1:30 - 3:15 pm	**Session 3 – Pests and Diseases**	
	Moderator - Carolyn Scagel, USDA-ARS Horticultural Crops Research Laboratory, Corvallis, Oregon	
1:30 – 2:00 pm	OP09 Sheila Fitzpatrick	Insect Life Histories In Fruit, Shoot And Root Environments of Cranberry and Blueberry

2:00 - 2:15 pm	OP10 Kenna MacKenzie (Oscar Liburd)	Monitoring and Emergence of Flower Thrips Species in Rabbiteye and Southern Highbush Blueberries
2:15- 2:30 pm	OP11 Rufus Isaacs	Developing Integrated Fruitworm Control Strategies in Blueberry, in Preparation for Pesticide Restrictions
2:30 - 2:45 pm	OP12 Kenna MacKenzie	The Biology and Pest Potential of Cranberry Tipworm (Diptera, Cecidomyiidae) on Lowbush Blueberry
2:45 - 3:00 pm	OP13 Bill Cline	Blueberry Red Ringspot Observations and Findings in North Carolina
3:00 - 3:15 pm	OP14 Kim Patten	Cranberry Pest Management with OP Alternative Insecticides
3:15 - 3:30 pm	Break	
3:30 - 4:30 pm	**Session 4 - Pests and Diseases**	
	Moderator - Eric Hanson, Department of Horticulture, Michigan State University, East Lansing, Michigan	
3:30 - 3:45 pm	OP15 Eric Hanson	Response of Highbush Blueberries to Postemergent Herbicides
3:45 - 4:00 pm	OP16 Hilary Sandler	Integrating Conventional and Alternative Practices into Weed Management in Cranberries.
4:00- 4:15 pm	OP17 James Polashock	Species Identification and Variation in the North American Cranberry Fruit Rot Complex
4:15 - 4:30 pm	OP18 Mark Ehlenfeldt	Disease Resistance in Blueberry – Steps Toward an Integrated Utilization Approach
4:30 - 7:00 pm	**Wine and Cheese Reception/ Poster Session, Foyer, CH2M Hill Alumni Center**	
	Dinner on own, see handout brochure for options	
Tuesday, July 15, 2008		
7:30 am	**Refreshments available**	
8:00 - 9:55 am	**Session 5- Pests and Diseases**	
	Moderator - James Polashock, USDA-ARS, Plant Science Institute, Genetic Improvement of Fruits and Vegetables Laboratory, Chatsworth, N.J., and Beltsville, Maryland	
8:00 - 8:40 am	OP19 Bob Martin and Frank Caruso	Emerging and Reemerging Virus Diseases of Blueberry and Cranberry

8:40 - 8:55 am	OP20 Phil Brannen	Utility of Phosphonate Fungicides for Management of Phytophthora Root Rot of Blueberry
8:55 - 9:10 am	OP21 Andrés France	Silver leaf: First Worldwide Report of a New and Harmful Disease on Blueberry
9:10 - 9:25 am	OP22 David Percival	Foliar Disease Impact and Possible Control Strategies in Wild Blueberry Production
9:25- 9:40 am	OP23 Annemiek Schilder	Cytological and Chemical Evidence for an Active Resistance Response to Infection by *Colletotrichum acutatum* in 'Elliott' Blueberries
9:40 - 9:55 am	OP24 Mark Sweeney	Blueberry Scorch Virus Management in British Columbia
9:55 - 10:15 am	Break	
10:15 - 12:00 pm	**Session 6- Physiology and Production Systems**	
	Moderator - Thomas Walters, Northwest Washington Research and Extension Center, Washington State University, Mount Vernon, WA and Puyallup, WA	
10:15 – 10:45 am	OP25 Yadong Li	Current Status and the Future of the Blueberry Industry in China
10:45 - 11:15 am	OP26 M. Pilar Bañados	Expanding Blueberry Production into Non-traditional Production Regions: Northern Chile and Argentina, Mexico and Spain
11:15 - 11:30 am	OP 27 Mark Ehlenfeldt	Domestication of the Highbush Blueberry at Whitesbog, New Jersey 1911-1p16s
11:30 - 11:45 am	OP28 Gustavo Lobos	Colored Shade Nets Influence Leaf Acclimation and Harvest Time in Highbush Blueberries
11:45 - 12:00 pm	OP29 Jorge Retamales	Light Environment within Mature Rabbiteye Blueberry Canopies Influences Flower Bud Formation
12:00 - 1:00 pm	Lunch – buffet	
1:15 - 5:30 pm	Local tour	Stahlbush Island Farms, Corvallis USDA ARS blueberry genebank

1:15 - 5:30 pm	1:30 – 3:30 pm Stahlbush Island Farms, Corvallis Tour of a commercial blueberry farm that is owned and managed by the Chambers family and that has an emphasis on processing. We will see different aged fields, innovations in field design, use of GPS, automation of irrigation systems, and cultivar choices. 3:45 – 5:15 pm USDA ARS National Clonal Germplasm Repository, Corvallis - genebank • Introduction • Tissue Culture / Cryogenics Laboratory • Genetics Laboratory o featuring SSR technology for clonal identity / diversity determination • Pathology o testing and elimination • Primary collections – greenhouse and screenhouse • Field plantings	
5:30 pm	Return to hotel	
6:30 - 10:30 pm	**Western Theme dinner – Parker Plaza, OSU** Wear your jeans and come to enjoy an evening of western music, line dancing and, for the hearty, a mechanical bucking-bull (outdoor event)	
Wednesday, July 16, 2008		
7:30 am	**Refreshments available**	
8:00 - 9:45 am	**Session 7 – Physiology and Production Systems** **Poster take down**	
	Moderator - Jorge Retamales, Universidad de Talca, Talca, Chile	
8:00 - 8:30 am	OP30 Kenna MacKenzie	Pollination Practices and Use of Bees
8:30 - 8:45 am	OP31 Justine Cox	Comparison of Plastic Weedmat and Woodchip Mulch on Low Chill Blueberry Soil in NSW, Australia
8:45 - 9:00 am	OP32 Gerard Krewer	Effect of Mulches on the Establishment of Organic Blueberries in Georgia
9:00 - 9:15 am	OP33 Ester Uchendo and Barbara Reed	Cryopreservation of In Vitro Grown Blueberry and Cranberry Shoot Tips
9:15 - 9:30 am	OP34 Sujaya Rao	Native Bee Pollinator Diversity in Oregon Blueberries and Cranberries

9:30- 9:45 am	OP35 Luis Valenzuela-Estrada	The Anatomy and Morphology of Blueberry Roots
9:45 - 10:15 am	Break	
10:15 am-12:30 pm	**Session 8 – Genetics and Germplasm**	
	Moderator - Nahla Bassil, USDA ARS National Clonal Germplasm Repository, Corvallis, Oregon	
10:15- 10:45 am	OP36 Jim Hancock	Funding blueberry breeding in the future: The new paradigm
10:45 - 11:15 am	OP37 Jim Ballington	The Role of Interspecific Hybridization in Blueberry Improvement
11:15 - 11:30 am	OP38 Nahla Bassil	Blueberry Microsatellite Markers Identify Cranberries
11:30 - 11:45 am	OP39 Dario Chavez	Studies with *Vaccinium darrowii* Camp. and other *Vaccinium* species from Florida
11:45 - 12:00 noon	OP40 Roger Haring	Detection of Colchicine Induced Tetraploids of *Vaccinium arboreum* with Flow Cytometry
12:00 - 12:15 pm	OP41 Jennifer Johnson-Cicalese	Breeding for Fruit Rot Resistance in *Vaccinium macrocarpon*
12:15 - 12:30 pm	OP42 Nicholi Vorsa	A Blueberry by Cranberry Hybrid Derived from a *Vaccinium darrowii* x (*V. macrocarpon* x *V. oxycoccos*) Intersectional Cross
12:30 - 1:30 pm	Lunch	
1:30 - 2:00 pm	**ISHS Vaccinium Working Group Business Meeting**	
2:00 - 3:00 pm	**Session 9 - Plant and Soil Nutrition/Irrigation**	
	Moderator - Linda White, Department of Horticulture, Oregon State University, Coos Bay	
2:00 - 2:30 pm	OP43 Teryl Roper	Mineral Nutrition of Cranberry: What We Know and What We Thought We Knew
2:30 - 2:45 pm	OP44 Joan Davenport	Evaluation of Six Different Soil Test Phosphorus Extraction Methods for Relationship with Cranberry.
2:45 - 3:00 pm	OP46 Carolyn DeMoranville	Cranberry Phosphorus Management: How Change in Practice Can Reduce Output in Drainage Water
3:00 - 3:30 pm	Break	
3:30 - 5:15 pm	**Session 10 - Plant and Soil Nutrition/Irrigation**	
	Moderator - David Yarborough, University of Maine, Orono	
3:30 - 4:00 pm	OP47 Eduardo Holzapfel	Selection and Management of Irrigation for Blueberry

4:00 - 4:15 pm	OP48 David Bryla	Irrigation Management Effects on Yield and Fruit Quality of Highbush Blueberry
4:15 - 4:30 pm	OP49 Tommaso Eccher Marco Bacchetta	Long Term Effects of Ericoid Endomycorrhizae on the Growth of Micropropagated Plants of *Vaccinium corymbosum* L. in the Field
4:30 - 4:45 pm	OP50 Alexis Vega	Blueberry Mycorrhizal Symbiosis Outside of the Boundaries of Natural Dispersion for Ericaceous Plants in Chile
4:45 - 5:00 pm	OP52 David Yarborough	Organic Production of Wild Blueberries II. Fertility and Weed Management
6:30 – 10:30 pm	**Closing Banquet, CH2M Hill Alumni Center** **Semi-formal dress; indoors; live music**	