Hazelnut Preliminary Research Plan

Aim:

To assist the development of a hazelnut industry in Tasmania, while providing data for the Australian industry as a whole.

Resources:

Dr Sally Bound, TIAR is able to commit up to 30% of her time to the hazelnut industry from 1 July 2007. While Dr Bound's salary costs are paid by the University of Tasmania, all other costs associated with proposed work needs to be obtained through other sources, such as grant applications to funding bodies. These costs include vehicle expenses, employment of casual or part-time staff, equipment costs, and costs associated with trial establishment, treatment applications, trial maintenance and data collection.

Introduction:

The potential for hazelnut production in Australia has been established by Baldwin *et al*. (2007). These authors suggest that there are four varieties [Barcelona, Tokolyi/Brownfield Cosford (TBC), Lewis and Tonda di Giffoni] that are suitable varieties for the kernel market. While these varieties can be used in the initial establishment of an Australian hazelnut industry each of these varieties has limitations, and further evaluation of new and promising varieties will need to be conducted in the long term if the industry is to meet all of Australia's hazelnut needs.

Aside from the issue of varieties, there are four distinct phases in the development of the hazelnut industry:

1. propagation and supply of high quality trees
2. rapid establishment of orchards
3. production (management of established orchards)
4. processing and marketing

While disease and pest management issues are normally important in a developing industry, it appears that there are no major disease problems for hazelnuts in Australia. The two main pests of concern are Big Bud Mite, which is present in Tasmania, and sulphur crested cockatoos (Baldwin *et al*. 2007). Hares and rabbits also pose a problem, as do red-headed cockchafers and corby grubs (Diana French, pers. comm.).

While there is information available from overseas on propagation methods and orchard establishment, this is not always directly transferable to Australian conditions. There is

also the problem of ensuring that the appropriate information/knowledge is readily available to industry.

In developing a new industry it is important to understand not only what works, but why it works. Research needs can be divided into short and long term. Short term needs could be met through the development of a coordinated National Hazelnut Program. RIRDC would be the logical funding source for this program – this would necessitate the development of a joint RIRDC application between TIAR and Baldwin *et al*., Charles Sturt University.

Short term research needs:

Tree cost and establishment are major issues if the industry is to become successful.

In order to reduce tree cost from the current $12-13 per tree, a rapid propagation method of high quality trees is required. Initial work undertaken at *Hazelbrae* and in New Zealand (Smith & McNeil 1996) indicates that cuttings can provide high quality trees, however a detailed research program is required to develop a full propagation system that will produce a tall well feathered tree with a good root system. The aim for such a program would be to develop a propagation method with a success rate of ≥95%.

Once trees are available, rapid establishment is important to ensure high yielding orchards in a minimum time frame. Nut yield up to full canopy is related to trunk cross-sectional area (TCSA), therefore there are substantial benefits in enhancing early growth to minimise the time between planting and full canopy.

Issues that affect tree growth and hence require research/extension input include:

- effect of shelter on tree growth
- pruning and canopy management
- irrigation requirements (timing, drip versus mini-sprinkler)
- fertiliser requirements
- orchard floor management

Long term research needs:

Canopy management in established orchards.

Biennial bearing

Further evaluation of new and promising varieties, including development of a breeding program.

Plant spacing

Research Trials:

1. Propagation

As discussed above, trees can be established from cuttings. The aim is to develop a tree suitable for planting out within one season. Initial work at *Hazelbrae* suggests that development of a whip to approx 1.5 m and then heading at 1.2 m can produce a high quality tree. Issues that need to be examined are:

- type of wood, ie softwood, semi-hardwood, hardwood
- size of cutting
- timing and growth stage of parent material
- use of rooting hormones and/or wounding
- light and humidity levels
- use of bottom heat
- propagation medium / mulches
- pots versus 'in-ground'
- shelter versus open
- impact of extended daylength
- benefits of seaweed extracts
- use of fertiliser programs (type – foliar, liquid, granular; rates: applied on top of mulch or under)

Several replicated small plot trials can be established to answer these questions. It is recommended that all trials have ten replicates. According to Smith & McNeil (1996), cutting material should be taken before terminal buds on the parent plant become dormant. Juvenile wood (ie. vegetative shoots) is preferable to wood from trees that are flowering (Ponchia & Howard 1998; Smith & McNeil 1996).

Two 4m x 18m tunnels will be available at *Hazelbrae* to commence propagation trials. These will each have one end covered with 1 layer of 70% shadecloth and the other end covered with a double layer of 70% shadecloth.

Data that can be collected in these trials would include:

- strike rates
- growth rates, including number of nodes, internode length, leaf size, TCSA, height and branching
- root mass
- carbohydrate levels

Some of this data collection requires destructive sampling, however the majority of these measurements can be taken without interfering with cutting/tree development.

While most of this work would be undertaken at *Hazelbrae*, some development work can be undertaken at New Town Research Laboratories (NTRL) and the University of Tasmania where glasshouse facilities are available. Limited bottom heat facilities are available at NTRL. A key issue with producing hazelnuts from cuttings is minimising the time they are in the open (David McNeil, pers. comm.), therefore a suitable transport method would need to be organised, or stock plants kept at NTRL.

The issue has been raised of costs associated with hardening off of glasshouse grown cuttings – a benefit/cost study should be included to determine any advantages/disadvantages of glasshouse grown cuttings compared with shadehouse grown.

2. Establishment

Enhancement of early growth to minimise the time between planting and full canopy is important in reaching full production in the shortest possible time frame. In addition to setting up of replicated small plot field trials, a full literature review should also be undertaken.

2.1 Experimental design and data analysis

Either a randomised complete block or split plot design would be used, depending on treatment combinations. All trials should have a minimum of six replicates. Plots may be single tree plots, multiple tree plots or rows, depending on treatments.

Data will be analysed by analysis of variance and/or regression analysis. Spatial modelling will be used in the shelter establishment trial. Where appropriate, analysis of covariance will also be used.

2.2 Data collection

All trial sites should be monitored for environmental conditions, in particular temperatures, relative humidity, wind speed, light levels.

Data that can be collected in all tree establishment trails would include:

- time of budburst and different growth stages, including termination of apical buds
- photosynthesis rates
- water use
- tree height and spread
- TCSA
- number of branches and branch length
- % canopy cover each year up to full cover

- leaf analysis
- other measurements that may be of value include: leaf size, % dry matter and root mass. However % dry matter and root mass would require destructive sampling – this could be catered for by halving the planting distance in relevant rows, to allow for removal of every second tree for destructive sampling during the course of the trial.

2.3 Effect of shelter on tree growth

Wind is recognised as an important factor in tree establishment, however there is very little information available in the literature on the impact of wind on tree growth. The new planting at Meander will offer an ideal opportunity to collect data on the effect of existing shelter belts on tree growth. By setting up monitoring equipment to measure soil and air temperature, relative humidity and air speed at strategic points in this orchard, the impact of wind can be mapped against tree growth. Costings are currently being obtained for logging equipment. Extra trees should be planted in strategic rows at this site to enable destructive sampling each year for the first 4-5 years to measure root growth and percentage dry matter.

The impact of artificial wind breaks on early tree growth should also be examined, as planting of wind break trees at the time of orchard establishment will not provide shelter in the early development years when protection is most important.

Other trials that would provide valuable information are:

2.4 Whips versus feathered trees

In most perennial crops, the use of a well feathered tree at planting provides the best start for an orchard. There has been some discussion that in the case of hazelnuts, whips may provide a better option, providing they are appropriately headed at planting. Discussions to date have indicated that heading should be done at 1.2 m, however Rapley (1989) indicated a heading height of 0.60 m. Suggested treatments for a trial to compare whips versus feathered trees could include:

1. whip, at least 1.5 m tall headed at planting to 1.2 m
2. whip, headed in the nursery before termination of growth
3. feathered tree

2.5 Irrigation requirements (timing, drip versus mini-sprinkler)

Irrigation is critical in the establishment of any orchard. At least two trials should be established at different sites to study the impact of amount of water, timing and how it is

delivered. Timing can be set by regular application and/or use of tensiometers. Suggested treatments for an irrigation trial include:

1. drip – one dripper per tree
2. drip – 2 drippers per tree
3. mini-sprinkler

The drip treatments could be expanded to include drippers at 2 or 4 L/hour if desired. A split plot could also be set up to assess timing, ie regular application compared to when required as measured by tensiometers.

2.6 Fertiliser requirements

Fertiliser recommendations developed for European and USA soils are not applicable to Australian soils. While these can be used as an initial guide it is important to develop recommendations suitable for Australian soils and conditions. There is already evidence from New Zealand data to suggest that recommendations for boron are too low.

Fertiliser requirements during tree establishment are also likely to be different to the requirements of a mature orchard.

A study of fertiliser requirements would require the establishment of trials at several sites with varying soil types. Treatments would need to be developed in consultation with growers.

2.7 Pruning and canopy management

Pruning methods that maximise tree growth and encourage canopy fill are vital during the tree establishment phase. It is imperative that tree shape be established from the beginning. Pruning in the first 1-3 years would also be dependent on type of planting material, ie whip or feathered tree. Trials at 2-3 sites could be established to examine different pruning methods. Specific pruning treatments would need to be developed in consultation with growers.

2.8 Orchard floor management

Covering soil with a mulch has been shown to strongly influence crop growth and development as well as the environment (Larsson 1997). Mulches reduce water evaporation and increase infiltration, resulting in greater soil moisture (Schonbeck *et al*. 1993; Lal 1995). The use of mulch also has the potential to increase crop production and fruit quality (Bound, 2003) and to effectively suppress weeds, reducing or removing the necessity of herbicides (Hanninen 1998; Taylor 1998). As they decompose, organic mulches may improve soil physical and biological properties, reducing soil erosion,

minimising soil compaction, increasing water holding capacity and microbial activity, slowing the release of nutrients and controlling soil temperatures (Foshee *et al*. 1996).

Some mulches are more beneficial than others, depending on their components. In studies of a range of mulching materials, Bound (2003) indicated that with some materials there was improvement in soil structure after only one season, along with an increase in beneficial soil macrofauna.

It would be advantageous to include mulching trials at different sites to demonstrate the advantages and to provide scientific data on the benefits of mulching for tree establishment in hazelnuts, including reduced water use and improved soil health and crop quality.

Treatments should include options that are readily available and are inexpensive, such as shredded green-waste, mowed living mulches, straw and brassica green crops. An untreated control treatment (herbicide to control weed growth) must be included. Examples of possible mulching materials include:

1. poppy marc + sawdust
2. pyrethrum mark
3. hemp straw
4. shredded green waste
5. silage
6. pea straw
7. mustard green manure, mown regularly and left as mulch

If soil moisture sensors are installed in each plot, each treatment can be irrigated as required according to soil moisture levels – this allows the water savings in each treatment to be determined. It is suggested that micro-sprinklers be used in preference to drippers.

Assessments should include:

1. Water usage and soil characteristics: standard soil tests can be used to look at changes in soil pH, electrical conductivity, water holding capacity, water infiltration rates, nutrient levels, bulk density, compaction, soil temperature fluctuations, weed retardant effects.
2. Soil biota: the calico strip assay as described by Cox (2005) can be used to compare differences in levels of soil biota. Micro-flora and fauna levels can be assessed by microscopic examination of soil samples. Sieving of soil samples from each plot (replicate) will ascertain the number and diversity of macro-fauna such as earthworms, beetles, ants, collembola etc. Soil respiration measurement, using an ADC SRS-1000 portable soil respiration system if available will give an indication of biological activity (i.e. microbial and root) or soil life.

3. Crop productivity and quality: measures of total yield, marketable yield, disease/pest incidence, nutrient levels, growth and other quality parameters such as nut weight, kernel weight, kernel:nut ratio, nut and/or kernel shape (length/width), % blanks/shrivelled kernels.

3. Big Bud Mite

Lincoln University in New Zealand currently have a Masters student studying Big Bud Mite (David McNeil, personal communication). To avoid duplication of effort it would be advantageous to establish a link with Lincoln University and encourage the student to include Tasmanian sites in their studies. Some travel funds may need to be provided to cater for this.

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